1. Introduction

Gunung Lumut Protection Forest is located in the District of Paser, ca. 90 km Southwest of Balikpapan, the most developed and economically important city in East Kalimantan. The protection forest is comprised of almost 42,000 ha of Dipterocarp forest, mainly lowland forest, and two main watersheds, i.e. Telake river in the Northwestern part and Kendilo riverin the Western, Southern, and Eastern parts. The two rivers empty into Gunung Lumut, and are vital water sources for 68 settlements surrounding the area, including the main towns of Tanah Grogot, Batusopang, Muara Koman and Long Ikis (Figure 1).

Gunung Lumut or Mount Lumut (ca. 1,200 m above sea level (a.s.l.)) is one of the highest Northern peaks of the Meratus mountain range. Borneo Island is the second largest center of plant biodiversity in Indo-Malayan region, after New Guinea. A report of geology research in 1999 by the Environmental Education Center (Pusat Pendidikan Lingkungan Hidup (PPLH)) of Mulawarman University (UnMul) highlighted Gunung Lumut as one of the most important centers for the Island's flora and fauna diversity.

The existence of this megabiodiversity center has been threatened by rampant illegal logging activities by several logging concessions since 1970. A Ministerial decree was issued in 1983 by the Ministry of Forestry (Forestry Ministerial Decree No. 24/Kpts/Um/1983), and declared Gunung Lumut forest as a protection forest that is forbidden for any logging activities. However, this Decree has not effectively protected this area from illegal logging activities. The activities are still continuing and have even intensified in the period of 2000 – 2005 when a large number of small concessions (IPK) surrounding the protection forest were granted by the *Bupati* (Head of the District). Several big companies, such as PT. Telaga Mas and PT. Mentari are still operating in the area. The designation of this forest area as a protection forest was based on a 'top-down'

Figure 1. Map of the Gunung Lumut Protection Forest

decision making by the central government, putting aside its social and economic impacts on the local communities. The new designation limits the access of local communities, which consist of indigenous people and immigrants, to forest resources while they are heavily dependent on forest for their livelihood. The designation also denies the communities' role in managing the forest, and ignores their traditional wisdom.

The new designation of Gunung Lumut forest has separated the communities from their main livelihood resources. Being dependent on forest resources for generations, they usually have limited options for income generation alternatives. In many cases, this has created a new problem of local communities involved in illegal logging activities.Rampant illegal (and legal) logging by companies and communities, combined with extensive encroachment and forest conversion into (mainly oil palm) plantations, have accelerated the degradation of Gunung Lumut forest. Currently, only about 60% of the forest is in a relatively good condition which is indicated by its flora and fauna diversity. Forest degradation has also caused various disasters such as long drought during dry season, and floods and landslides during rainy season. The local government and communities have reported increasing number of natural disasters in recent years, as consequences of continuous degradation of Gunung Lumut forest. These disaters have impacted not only on local settlements, but also industries in the downstream area.

Local communities' rights and roles should be acknowledged and accommodated into forest management policy. This has been a priority concern of local stakeholders that was expressed

in a multistakeholder workshop at the end of 2004. The workshop has resulted in a 'sustainable management of Gunung Lumut forest' declaration by local stakeholders. As a follow up to the declaration, Tropenbos International Indonesia (TBI Indonesia) programme, an organization which is supported by the KNIP Programme of The Royal Netherlands Embassy a Biodiversity Assessment, has facilitated and supported the following organizations to conduct biodiversity assessment of Gunung Lumut protection forest:

- Borneo Orangutan Survival Foundation (BOSF)
- Center for Environmental Studies, University of Leiden (CML)
- Center for International Forestry Research (CIFOR)
- Centre for Forest and Nature Conservation Research & Development (*Puslitbang Hutan dan Konservasi Alam*) of FORDA
- Forestry Research and Development Agency (FORDA)
- Indonesian Science Institute (LIPI)
- Nationaal Herbarium The Netherlands (NHN)
- Naturalis
- PeMA Paser (Traditional Community Forum Paser)
- Primate Research and Development Institute (*Loka Litbang Satwa Primata, Samboja*)
- Wanariset Herbarium, Mulawarman University, Bogor Agriculture Institute (IPB)

1.1. Objective

The main objective of the Biodiversity Assessment was to undertake studies to collect baseline data and information of Gunung Lumut forest's natural resources, particularly flora and fauna, and its socio-economic aspects relating to communities living within and around the forest. The Biodiversity Assessment also aimed at:

a. improving existing information about flora and fauna in the area, especially if compared to other areas in Kalimantan;
b. helping to identify crucial sites in the protection forest where endangered or endemic species live;
c. providing basic knowledge to understand the impacts of local communities' socio-economic activities on the area and its biodiversity
d. developing a database, both in Indonesia and the Netherlands, that includes all data collected during the expedition.
e. helping to create local communities' and public audience' awareness on the Gunung Lumut forest's invaluable natural heritage
f. assisting young scientists from both countries to improve their skills through working with experts representing various disciplines; and
g. identifying crucial issues for further studies and follow-up action/s.

A report presenting recommendations and data collected from the Assessment will be provided for relevant government agencies, in order to support the improvement of the current Gunung Lumut Protection Forest management plan, as well as to support its endorsement to be a Biosphere Reserve.

1.2. Expected Results

The Assessment and its follow up activities, including workshops (see Chapter 2, also Appendix 1. Programme and Schedule), are expected to:

a. raise local communities' and public's awareness on Gunung Lumut forest's invaluable natural heritage
b. encourage local community to actively participate in conserving and managing the area;
c. promote partnership among relevant stakeholders in implementing sustainable management of Gunung Lumut protection forest;
d. provide a database consisting of biophysical and socio-economic data and information about Gunung Lumut Protection Forest, and make it accessible to wider public;
e. improve local stakeholders' skills on nature and forest conservation and management;
f. provide a concept for the Forest's sustainable management for local government and relevant stakeholders; and
g. use the assessment results to promote Gunung Lumut Protection Forest as a Biosphere Reserve.

1.3. Location

The field assessment was carried out by three expert groups representing Zoology, Botany, and Socio-Economy, and was focused on several locations in area (Figure 2). The socio-economic assessment was conducted in two settlements, i.e. *Mului Hamlet* on the West side and *Rantau Layung* Village on the East side. The flora and fauna data was collected from three locations representing different altitudes and different forest types in the area. The teams established 'permanent' camps in two different locations, i.e. on the logging road side ca. 7 km from Mului Hamlet that has access to the sub-montane forest (ranges between 600 – 1200 m a.s.l), and at Perayan river (close to Rantau Layung Village) (ranges between 400 – 600 m a.s.l). An additional flying camp was also built at the peak of Gunung Lumut. Table 1 shows geographical information of the camps' locations.

Table 1. Geographical Information of the Camps' Locations

Camp	Latitude	Longitude
Logging road side, ca. 7 km from Mului Hamlet	01°27'1.17"S	115°59'2.12"E
Perayan river	01°36' 38.54"S	115°58'37.55"E
Peak of Gunung Lumut	01°24'17.84"S	115°59'17.43"E

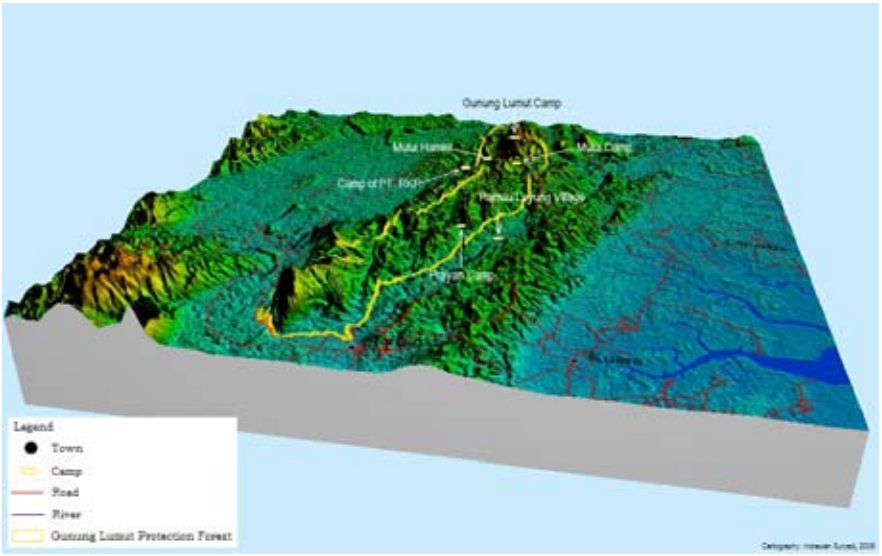

Figure 2. Location of the biodiversity assessment

General description on the forest or habitat condition in each camp and assessment area:

- **Main Camp or Mului Camp:**
  The main camp area mainly consists of lowland Dipterocarp forest. The topography is dominated by steep to very steep slopes. Only a small part of the area is relatively flat, i.e. along the concession road that connects the Camp of PT Rizky Kacida Reana (RKR) to Long Ikis (through Mului Hamlet).. Part of the forest is still relatively in good condition, because the concession was established not long before the declaration of Gunung Lumut as a protection forest in 1983, giving it only little opportunity for logging the forest. We can still find old hauling and skidding roads, as well as some small scale and low intensity (illegal) timber cutting activities in the area, which are indicated by the findings of fresh log remains.
- **Mului Hamlet Camp:**
  Mului Hamlet is located at the Northwest side of the protection forest, right at the border of the protection forest that faces the logging road that connects PT RKR to Long Ikis. Forest in Mului Hamlet is dominated by sub-montane forest that is relatively in good condition, although there have been some disturbances to the forest. A small part of the area has been cultivated by local people for agriculture purposes. Decade-length cultivaton has also promoted the growth of shrubs (*Imperata* grass) along the Mului River (circa 5–7 m on both sides of the river), although the quality of the water is still good for drinking or bathing.
- **Perayan River Camp:**
  This camp is located within a three-hour walking distance on the South of Rantau Layung Village, right adjascent to Perayanriver. The camp area is surrounded by flat to steep and very steep land. The Northern part of the area is dominated by limestone, while the Southern one by granite rocks. Small encroachment activities by local people were found, but the forest which is mainly lowland tropical forest is still in very good condition. High timber stock in the forest is indicated by the presence of many big commercial trees.

- **Gunung Lumut Flying Camp:**
  The camp was located on the top of the mountain (ca. 1,200 m a.s.l.) and was used as the center for the zoological and botanical assessments covering forest on the area between 900–1,200 m a.s.l. Forests in the area are mainly sub-montane and montane forests, and are quite distinctive if compared to the ones in the other areas, in which they are comprised of small trees and a very humid micro climate due to the continuous presence of mist. The forest floor and trees are totally covered by moss from which the mountain is named after (*lumut* = mosses). To reach the top, one needs to walk for approximately 4 hours from Mului Hamlet.

1.4. Participants

Participants of the Biodiversity Assessment consisted of researchers representing various partner institutions, as well as representatives from local community groups and local government. Over 80 participants were divided into three working groups as follows:

a. *Zoology Team*, which consists of representatives from local community groups and expert team specializing on invertebrates (butterflies, dragonflies and moths); and vertebrates such as birds, large mammals (particularly primates) and small mammals;
b. *Botany Team*, which consists of representatives from local community groups and expert team specializing on higher plants, lower plants, ferns and fungi; and
c. *Socio-economy/Anthropology Team*, which consists of representatives from local community groups, local government, and expert team specializing on social sciences.

A full list of team members and other participants is given in Appendix 2.

2. Methodology and Data Collection

2.1. Assessment Process

The Biodiversity Assessment was conducted through a series of step-wise activities (Figure 3). The preparation started in 2004 and involved planning and designing, team formation, etc. The field assessment to collect flora and fauna as well as socio-economical and anthropological data and information, including flora and fauna specimens for further identification and analysis was conducted in November-December 2005. The preliminary findings and results of the field assessment were presented and discussed in a workshop in Balikpapan in December 2005, which was attended by the team members, local government, and other relevant organizations/parties. The workshop was followed up with a more detailed and comprehensive analysis until June 2006. Analysis of the collected flora and fauna specimens was mainly conducted by the participating research organizations, and TBI Indonesia supported through developing a database consisting of all of data collected during the field assessment, as well as from the analysis.

Findings, results, and outputs of the identifications and analysis have been presented and discussed in a final workshop at Tanah Grogot, Paser District, East Kalimantan in July 2006. It is expected that the local government will use the report as the basis for further improvement of the management of Gunung Lumut Protection Forest.

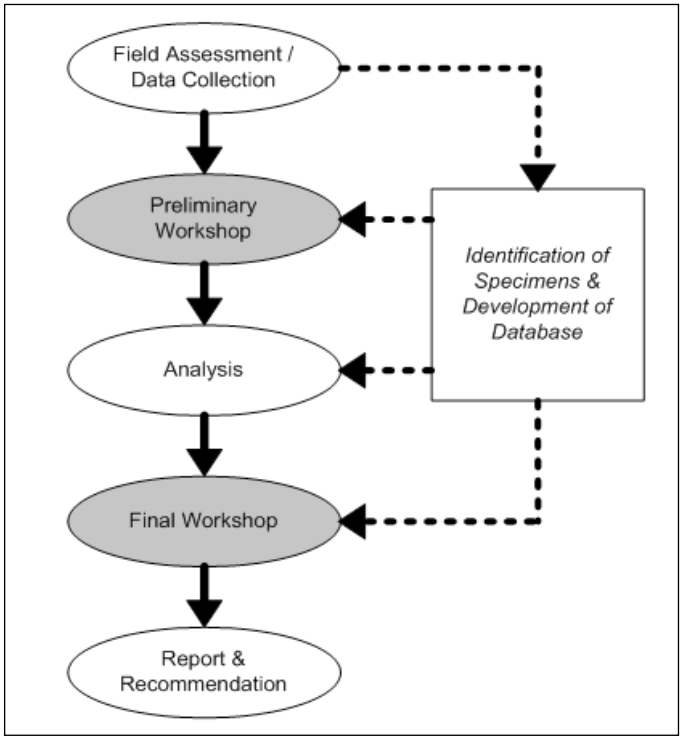

Figure 3. Assessment process

2.2. Tasks

The assessment was mainly focused on 3 aspects: 1) Zoology (Fauna), 2) Botany (Flora), and 3) Socio-economy/Anthropology. For each aspect a team was assigned to conduct the following activities:

Zoology:

- conduct a general fauna inventory in the designated field sites;
- collect at least two specimens of each species discovered during the inventory. The specimens will be stored at the participating research institutions, including Indonesian Repository Institution (LIPI) and natural history museums;
- prepare a checklist of all collected species, and complete the species' information, including distribution origin, habitat, etc.;
- provide comparison to the checklist, such as checklist of species from the whole Borneo Island

Botany:

- conduct general flora inventory in the designated research/observation sites;
- collect at least five specimens of all fertile plant species discovered during the inventory to be later distributed to Wanariset, Herbarium Bogoriense, NHN, and other herbaria;
- prepare a checklist of all collected species, and complete the species' information, including distribution, origin, habitat, etc. using the BRAHMS database

Socio-economy/Anthropology:

- conduct participatory socio-cultural and socio-economic studies on local community's profile, livelihood, and income generating activities.
- conduct participatory mapping on local community's resource uses and distribution;
- identify customary law that is relevant
- conduct SWOT (Strength Weakness Opportunity Threat) analysis on community-based ecological tourism.

2.3. Methodology of Field Assessment

The Zoology Team focused on collection and assessment of animal data such as insects (dragonflies, butterflies, and moths), birds, primates, large mammals, and small mammals, while the Botany Team collected data on general vegetation, such as higher and lower plants, as well as mushroom or fungi. The Socio-economy Team assessed and collected data on legal and socio-economic aspects of Gunung Lumut, including forest resources, landscape type and and other forest potentials such as ecotourism. Data was collected using the following methods.

2.3.1. Zoology

a. Insects

Collection of Insect data was conducted in two areas. The first was near Rantau Layung at the junction of Perayan and Seranum Rivers on 13-21 November 2005, and the second along the road to Mului on 23 November – 2 December 2008.

The locations represent two different altitudes, the Rantau Layung at 160 m a.s.l, and the Mului at between 150 and 230 m a.s.l. The second location has greater altitude variance, from Mului River at 255 m a.s.l to the top of Gunung Lumut at 1215 m a.s.l.

The team also conducted observations at a subcamp (flying camp) located above 670 m a.s.l. Observations at this camp could not be conducted intensively due to time constraints and unfavorable weather conditions.

The observations were mainly focused on Lepidoptera and Odonata, and less intensively on Coleoptera. Data was collected from transects that were established along the rivers using the following methods:

- Butterfly specimens were collected along forest trails and roads using 30 cm diameter-insect nets;
- Dragonfly specimens were colected along forest streams and water bodies using 30 cm diameter-insect nets
- Specimens of aquatic insect larvae, such as Odonata, were collected using an aquatic net (Davis net); and
- Collection of moth and other insect specimens were conducted on the evenings using white sheets with 160 Watt mixed light, or 16 Watt blacklight.
- Specimens were preliminarily identified on site, using literature guidelines (some were available at the camps), or based on the scientists' knowledge. The identification was later confirmed by the Leiden Museum which compared the collected specimens with its collection of preserved specimens.
- Most of the insect specimens were dry-preserved using silicagel, but tenerals, very small species, and DNA samples of selected species were stored in a preservation bottle containing 70% or 98% ethylalcohol.

Table 2 presents a list of the collection sites with altitude and longitude/latitude.

Table 2. List of Collecting Sites

Collecting sites	Latitude	Longitude	Elevation
Sungai Nango, junction Sungai Perayan	01°36′24″S	115°58′18″E	170 m
Sungai Lepapo, junction Sungai Perayan	01°36′37″S	115°58′29″E	170 m
Sungai Mului	01°25′49″S	115°57′40″E	267 m
Anaksungai Sepu	01°26′37″S	115°59′56″E	401 m
Also	01°26′44″S	115°59′57″E	402 m
Sungai Sepu	01°27′18″S	116°00′11″E	398 m
Serari river (Junction Sungai Mului)	01°25′55″S	115°57′43″E	247 m

b. Birds

Bird data were collected around the 3 camps, Mului Hamlet, and 2 additional flying camps. The first additional flying camp was built on about 2.5 hour-walking distance to the West from the Perayan River camp, and the second one on about 2 hour-walking distance to the East from the Mului Camp, providing a view towards the Southern part of the area. At each of these camp sites, 2 kilometer long trails were laid across at least two habitat types (e.g. riverine and ridge top).

Bird diversity was assessed using a combination of 3 different techniques: 1) bird watching using binocular (Nikon, 10 x 40), 2) sound identification, and 3) bird catching using mist-nets.

Identification of bird location was conducted along the trails mostly early in the morning (06.30 – 10.00) and late in the afternoon (15.00 – 17.30), but the recording was conducted the whole day in selected places. On each observation site, eight to ten nets were set up at two or three points in the forest area or along the river with 30 – 50 m distance between each other, for a maximum three days and were monitored every two hours, but monitoring could be more intensive during rainy days.

Bird observation was mainly conducted at the forest side of the area, along the rivers, tree fall gap area, fig trees or others. Observation was conducted for 20 – 30 minutes on each site, documenting all birds seen or heard. Each individual bird caught in the mist-net was identified, photographed and immediately released. The IUCN status of each bird species was determined using IUCN Red Checklist (2004) and the guild classification by Boer (1998).

c. Primate and Large Mammals

Primate and large mammal observation used direct and indirect encounter techniques. The direct encounter technique consisted of Concentration Method Triangle Count and Transect and Direct/Concentration Count methods, and indirect encounter technique used Call/ Triangle Count and Signs methods. Data from direct and indirect encounters were combined and validated with information that was collected from interviews with local people and fellow reseachers who conducted research in the other locations.

The data collection was conducted in total 18 days: 8 days in an area of 2.5 km2 around Perayan River Camp, 6 days in Mului Camp, and 4 days in Gunung Lumut Camp. On each site, two 4 km-length transects were divided using orange flagging markers into 25 m-length sub-transects. In each sub-transect, the team recorded the number and species name of all encountered primates, their perpendicular distance from the sub-transect boundary (using compass to determine the position of a group or individual primates from the nearest marker), as well as the site elevation. An estimate of the number of individuals present was made if there was evidence that only part of the group was seen. Results were processed using Transect 2.x or other appropriate data analysis software.

Primate and large mammal observations required accurate maps, such as maps of land cover or vegetation, topography, accessibility, hydrology and administrative boundaries, as well as field equipment, such as binocular, camera, Global Positioning System, compass, altimeter and others materials, including gypsum, alcohol and plastic bags.

d. Small Mammals

Small mammal (bats and rodents) observations used direct encounter and capturing techniques. Inventory of small mammals needed equipment such as binocular /monocular, SM trap and camera trap.

Bats were captured using 1-2 6 & 12 m-length 36 mm mesh mist-nets and a four-frame harp trap. Mist-nets were set up across rivers, forest pathways, a cave entrance, or dead hollow fallen trees that were used by bats as roosting places. The harp trap was set along walking trails between dense vegetation. Small mammals trapped in the mist-nets and harp trap were monitored every hour from 6 -10 pm.

Rodents were collected using 20-40 local wired 14 x 11 x 11 cm sized cage traps, within each a bait (a mixture of peanut butter and shrimp paste/***petis***). Each trap was set up for 1-8 nights on each site along the forest tracks or roads, and observed twice a day (in the morning at 6.00-7.00

am, and in the afternoon at 4 -6 pm). Wired cage traps were set up along the trails or near the trees on 10-20 m intervals.

The trapping and mist-netting were conducted in 7 observation sites, i.e.:

Site 1:
Sungai Perayan Camp. Altitude: 111 m a.s.l., coordinates: 1036'36.8"S and 115058'46.4"E. The location consisted of secondary forest and a fragment of limestone-based primary forest.

Site 2:
Batuwok Cave. This is a karst cave ca.1 km from Rantau Layung Camp. Altitude: 195 m a.s.l., coordinates: 1036'36.5"S, 15058'45.6"E.

Site 3:
Between Mount Lampu and Mount Oker. The coordinates are: 1036'5"S and 115057'46.8"E. The vegetation consisted of fragmented primary forest.

Site 4:
Mului Basecamp. Altitude: 390 m a.s.l., coordinates: 1027'40"S and 115059'54.1"E. The vegetation consisted of logged-over forest (secondary forest).

Site 5:
Along the road to Mului, near river. Altitude: 439 m a.s.l., coordinates: 10208'48.3"S and 115058'40.5"E. The vegetation is logged-over forest (secondary forest).

Site 6:
Along the road to Long Ikis, at the boundary of the Protection Forest. Altitude: 533 m a.s.l., coordinates: 1028'48.3"S and 11601'18.6"E. The vegetation is a fragmented primary forest.

Site 7:
Gunung Lumut Camp. Coordinates: 010 24.787'S and 1150 58,480'E.

The trapping and mist-netting data was combined/validated with data collected from interviews with local people, and mammals pictures in ***Panduan Lapangan Mamalia di Kalimantan, Sabah, Sarawak & Brunei Darussalam*** book written by Payne ***et al.*** (2000).

2.3.2. Botany

a. General Survey of Botanical Diversity

Inventory of botanical diversity was conducted in all research locations. The inventory covered all plant groups, specifically ferns and lianas, in all micro-habitats. Plants were collected on site (encountered fertile plants were collected, labeled, measured (diameter and height), described (growth form, flower and/or fruit characteristics, habitat characteristics, GPS position/

distribution, etc.), and photographed. Collected plant specimens were diluted in 70% alcohol in an airproof plastic bag (Schweinfurt method). These specimens were later dried and pressed in the Wanariset Herbarium (East Kalimantan) and sent to Bogor, Leiden and other partner herbaria around the world.

Plot layout and measurements

The 10x10 m line transects were established on at 50 m horizontal interval in each observation location, except on Gunung Lumut, which were established at 50 m altitudinal intervals. From each plot, the team collected species data, as well as data on habitat variables (location (GPS-coordinate), altitude above sea level, inclination, topographic position (swamp, river valley, lower slope, middle slope, upper slope, ridge), canopy openness, direct- and diffuse light, leaf area index, signs of disturbance (gaps, skid trails, tree stumps, paths).

In each plot, only trees over 1.3 m height were measured (height and diameter) and identified. On Gunung Lumut a slightly adapted method was used. The method allows flexibility for plot size extension or reduction as long as it covered 50 individual tree samples (sensu Sheil et al. 2003).

The 10x10 plots were also divided into several 3x3 m sub-plots from which fern species were identified and measured (number of individuals per species and cover estimation). All collected tree and fern specimens were sent and stored at the Nationaal Herbarium Nederland, Leiden University Branch.

Data analysis

- Forest structure data
  Forest structure was analyzed against its variance in tree density (in diameter classes of 0-2.5 cm, 2.5-5 cm, 5-10 cm and > 10 cm), canopy density, light intensity (direct- and diffuse-light), and leaf area index. Differences between locations were determined with Kruskal-Wallis tests.
- Diversity data
  Fisher's alpha for tree genera was calculated for each plot. Species level data were not used because these have not been sufficiently identified yet. Variation in Fisher's-alpha between locations was then determined using Kruskal-Wallis tests. The increase of genera to the number of individuals collected in each location is decribed in a curve. Each curve was based on the average of 10 random curves from the same location. Each curve described the increase of the number of genera as more individual samples were collected, and made it possible to determine whether the maximum number of genera had been reached. For ferns a species area curve (increase in species with addition of plots) was constructed, whereby only one replicate per curve was calculated.
- Genera composition data
  Diversity in floristic composition between locations was identified using Principal Component Analysis based on number of identified individuals per genus per plot. Data were standardized and log-transformed to minimize bias caused by abundant genera on

the analysis. The analysis was done for all locations (including Sungai Wain and Meratus), including locations in the Gunung Lumut Protection Forest.

- Altitudinal gradient analyses
  The effect of altitude on forest structure, generic diversity and generic composition was analyzed using both simple and polynomial regression. Generic composition data was based on the location of the plots on the first axis of a PCA that was based on the number of individuals per genus in Gunung Lumut plots only.

All analyses used Statgraphics for Windows 2.1 (Statistical Graphic Corp., Rockville, USA), except the Principal Component Analyses which used MVSP 3.01 (Kovach Computing Services, Anglesey, UK).

b. Higher and Lower Plants

Data on higher and lower plants was collected in 16 days from the areas around the three camps (Mului Camp, Sungai Perayan Camp, and Gunung Lumut Camp - 10 days around Mului, 2 days in Gunung Lumut, and 4 days in Rantau Layung). The data was collected using general exploration method along ridges, along rivers and streams, valleys, slopes and flat lands in both secondary and primary forests. This method is recommended and assumed to be more effective in finding more plant species than other methods. Besides collecting plant data, the team also made general observations on forest structure and composition.

Vegetation composition and plant habitats was observed in an area that was divided into several 10x10 m plots: 10 plots near Sungai Perayan (at ca. 400 m altitude), 10 plots near Mului village (at around 800 m altitude) and 10 plots near the top of Gunung Lumut (at ca. 1100 m altitude). Only woody plants with at least 1.3 m height were collected.

Scientific herbarium collections were made if the material contained flowers, fruits or both, which are valuable and authentic scientific data for research and taxonomic work. Only limited exploration and botanical collection was carried out in this area in the past. For this reason, the herbarium collection from this expedition is very important.

The herbarium collection procedure in this expedition followed international standards, recording all relevant species information, such as locality and distribution, habitat, date of collection, name of collector and the plant's morphological characteristics. All collections were made at least in triplicate. One set was stored at the Wanariset Herbarium, one set at Herbarium Bogoriense, and the rest -except the specimens of higher storey plants- at the Nationaal Herbarium in Leiden.

The team also collected data on fruits and seeds that are consumed by animals. The data included tree crown shape, presence of buttresses, bark characteristics, flowers and fruits (including dissected seed and inner parts of the fruit). This information was also illustrated in full color in digital photographs, as well as in line drawings.

c. Fungi

The team also collected large fruit bodied-fungi from the same three areas - Mului Camp, Sungai Perayan Camp, and Gunung Lumut Camp. The small fruit-bodies fungi were not collected because they could usually hardly be recognized when dried due to shrinking or breakage into pieces.

Mushrooms were gathered in strips of 10 m (sometimes more) along both sides of trails, from the bottom towards the top of mountain.

The team also collected mushrooms that grew on the soil, living trees and dead wood. They were labeled, photographed, stored in plastic bags and brought to camp for identification and preserved.

Mushroom species were identified by the shape, size, macroscopic morphological characteristics, both externally and internally (caps and stipe) (Appendix 3) (Breitenbach and Kränzlin, 1991), for which the fruitbody was splitted using a knife. The main data collected for identification were as follows:

a. Cap (pileus): shape, size, color, hardness, toughness, wetness.
b. Stem (stipe): shape, size, color, hardness, toughness, wetness.
c. Lower surface of cap: poroid or gill (lamellae), color.
d. Ring (annulus, cortina): present or not.
e. Flesh: color, texture, thickness.
f. Taste (flavor): bitter, hot, pleasant.
g. Odor: fragrant, rotten, stinging/strong.
h. Cup (volva): present or not, shape.
i. Edibility: edible, not edible, poisonous.
j. Substrate/Habitat: soil, litter, dead wood, living treeto determine whether the mushrooms are as mycorrhizal, parasitic, saprophytic, useful for drug or food, some references written by Bigelow (1979), Nonis (1982), Imazeki ***et al.*** (1988), Jülich (1988), Bresinsky and Besl (1990), Breitenbach and Kränzlin (1991), Læssøe and Lincoff (1998), Pace (1998) were used after the species were identified.

In order to make a permanent collection, the mushrooms were dried in an oven heated with a kerosene stove until they were completely dry. Dried mushrooms were then preserved in a plastic bag containing naphthalenes. The preserved specimens were then brought to and stored in the Laboratory of Forest Protection at the Faculty of Forestry, Mulawarman University in Samarinda.

2.3.3. Socio-Economy and Anthropology

The socio-economic study was conducted mainly in two settlements: 1) Rantau Layung Village and 2) Mului Hamlet. Primary and secondary socio-economic data were collected during the assessment.

Primary data included:

1. Natural resources
   - flora and fauna being used by the local community;
   - landscape type; and
   - income generation resources (including ecotourism).
2. Human resources and their livelihoods
   - history of settlements;
   - socio-cultural;
   - land use and land tenure; and
   - contribution of Gunung Lumut resources to local community's income and economic activities
3. Local perception on the area's legal status and identification of potential threats
   - local perception on conservation and the legal status of Gunung Lumut Protection Forest as well as local investment in the area; and

The primary data were collected through general observation, community meetings, focus group discussions (FGD), and personal interviews, while general observation was useful to provide before the interview takes place.

The secondary data consisted of demographic data (population and ethnic composition), education level, public facilities, land use systems and topography, and were collected from several sources e.g. local government, research institutions and mass media.

Community Meetings

Community meetings were carried out in Rantau Layung and Mului to obtain general data, particularly on land types and land uses in the settlements and surroundings as well as villagers' seasonal activities.

Focus Group Discussions (FGD)

Based on the previous community meetings, the team divided the community into four groups based on gender and age (old men, old women, young men and young women) for FGDs. Each group consisted of five to seven members selected during the meetings.

In the FGDs, several topics were discussed, including specific information on useful natural resources, landscapes, land uses, and other income generating resources including for ecotourism.

Using the Pebble Distribution Method (PDM) scoring exercise (Sheil D. et. al, 2003), a number of methods were explored to assess people's judgment on the importance of various products and landscape units. In each exercise, informants were asked to distribute 100 counters (buttons, seeds or pebbles) between labeled and illustrated cards represented various levels of 'importance'. At least three examples were demonstrated by the Interviewer in order to ensure that participants understood the way the exercise worked.

Personal Interviews

Detailed information on individual or household income and expenditures, land ownership, usage of local resources, and local investment in the surrounding environment were collected through in-depth interviews.

15 out of 50 households in Rantau Layung and 11 out of 18 households in Mului were interviewed using semi-structured questionnaires. The interviewees were selected to represent different households, age range, gender, occupation, educational background, etc. (Table 3). The interviews and discussions were focused mainly on local resource utilization e.g. flora and fauna, perspectives on conservation and protection area, and personal expenditure as an approach to have information on local revenue.

Additionally, some key-informants both in Rantau Layung and Mului were interviewed in order to get better description on the history of the settlement and the way people have managed their land. These informants included the Village Head, customary leaders, old women, and informal community leaders like teachers and ***ustadz*** (Islamic teacher).

Table 3. Characteristic of Respondents (Personal Interview)

Category		Rt. Layung (n=15)	Mului (n=11)
Age class (years old)	21 - 30	5	3
	31 - 40	4	1
	41 - 50	5	7
	51 - 60	1	0
Gender	Female	4	0
	Male	11	11
Occupation	Farmer	12	8
	Company worker	0	2
	Others	3	1
Educational background	never went to school	2	8
	un-accomplished elementary school	6	1
	finished elementary school	5	1
	finished secondary school	0	0
	finished high school	2	1
Ethnic	Paser	14	11
	Other(s)	1	0

3. Results and Discussion

3.1. Zoology

3.1.1. Insects

3.1.1.1. Odonata, Moths and Mines

The area has medium diversity in aquatic habitats, e.g. a) larger, open streams, (b) half-shaded forest streams, (c) smaller, fully shaded streams, (d) trickles and seepage areas (shaded), and (e) standing waters were encountered during the assessment. The Protection Forest was selectively logged below 600 m about thirty years ago. Larger trees are, however, still present near the streams, due to unpresence of logging along the river banks.

A preliminary list of the species encountered per habitat is presented in Appendix 4.

Insect density was generally low. Usually, temporary territoria of dragonflies and damselflies are taken within minutes after a holder of a territorium is collected.

Species of genus *Vestalis* were commonly found along all streams. All specimens found during the field work period were males. There was an unusual occurrence, in which out of several largely found genus in Borneo Island, such as *Drepanosticta* and *Coeliccia*, the team only found one species.

Moth diversity was relatively high, but detailed information will be available only after preparation and identification of the material. Blacklight collecting technique gave better results, especially for Microlepidoptera. The number of different sites for light collecting was probably somewhat limited. Setting up automatic light traps in several places in the forest is recommended for similar expeditions in the future.

Types of fauna on Gunung Lumut at 650 m a.s.l were quite different from those found in the other forest types. Similarly, there was a big difference in the types of fauna found in Mului and Perayan base camps. Best results were obtained from the two night- collection in Gunung Lumut, in which very different species composition was found in the area.

Poor references on fauna diversity in Indonesia made it difficult to compare the results with fauna diversity in other regions in the country. The expedition recorded new species from the Nepticulidae, Tischeriidae and Heliozelidae families. The expedition was probably the first team that has successfully identified the families Tischeriidae and Heliozelidae in Indonesia.

3.1.1.2. Butterflies (Lepidoptera)

At both locations, (the camps near Rantau Layung and along the road to Mului), the team had not sufficient time to obtain a reliable estimate of the total butterfly diversity. Every day, four to six new species were added to the list. The list kept on increasing until the end of the observation, indicating that there many more species can be expected that have not been encountered during the observation. A list presenting the number of species per family is presented below. The numbers are approximate, since they were mainly based on preliminary identifications, which still need further examination in the museum.

Table 4. Number of Macrolepidoptera Species per Family for Borneo as a Whole, for the Two Locations Separately, and the Two Locations in the Gunung Lumut Protection Forest Together

Family	Borneo	Rantau Layung	Mului	Total GLPF
Hesperiidae	214	11	15	23
Papilionidae	45	10	10	14
Pieridae	42	18	11	19
Lycaenidae	377	17	25	34
Riodinidae	16	1	5	6
Nymphalidae	238	37	50	69
Totals	932	94	116	165

The table clearly shows that (a) Mului area was richer in species diversity, even though the locality was collected one day longer, and (b) there was huge difference between families in terms of observed species number to the known total species number in Borneo. Particularly family Lycaenidae was under-represented with only less than 10% found in Gunung Lumut during the expedition. This under-representation might be due to their inconspicuous appearance, and their restricted occurrence in only particular habitats. It was unclear to what extent the season of collection may have influenced the numbers.

The table also suggests a composition difference between the two locations. In the Rantau Layung area, there were 49 species (165 - 116, 50.2%) that were not found in Mului area. Similarly, there were 71 species found in Mului area (165 – 94, 61.2%) that were not found in Rantau Layung area.

3.1.2. Birds

During the field assessment, 137 bird species were identified. More than 90 species were identified until the seventh day of observation. The number increased to 120 species on the tenth day, and to more than 130 on the twentieth day. The list of bird species at the research area in Gunung Lumut Protection Forest is presented in Appendix 5.

The structure of the bird community, in some cases, can be used as an indicator for changes in the habitat structure. Community structure of birds in virgin forest, secondary forest and disturbed forest area, are usually different, mostly because there is a difference in vegetation structure and micro-climate (Boer, 1998) that also affect the availability of food resources. The bird communities observed in Gunung Lumut area can also be found in other areas in East Kalimantan, such as in Meratus and Mentoko in Kutai National Park, which have vegetations categorized as old secondary forest. Additionally, bird species from sub-montane forests were also found in Gunung Lumut.

3.1.2.1. Discussion of species by main group

Some interesting species have been found during the expedition:

- **Raptors (*Accipitridae*)**
  Three species of eagles were found (see Appendix 5) mostly in the open area (along logging roads or rivers). *Ictinaetus malayensis* (Black Eagle) inhabits forests, where they were usually flying around over the canopy. Also the Crested Serpent Eagle (*Spilornis cheela*) was frequently seen flying around over forest canopy in Gunung Lumut. They sometimes perched on large branches in shady parts of the forest.
- **Pheasants (*Phasianidae*)**
  The research area is a good habitat for Argus Pheasants (*Argusianus argus*). On average, the sound of pheasants could be heard seven times a day, and its display sites could be found almost every day.
- **Kingfishers (*Alcedinidae*)**
  Many of small rivers within the area provide suitable habitat for many water birds, especially for the family of Alcedinidae. It was not so difficult to find some species of Kingfisher in this area. A shy forest bird such as *Alcedo euryzona* was often found close to the stream in Rantau Layung Camp.

- **Cuckoos (*Cuculidae*)**
  Identification of these family members family was usually conducted by sound, since direct observation was difficult because they usually move very fast, hide in a dense vegetation near the canopy, and do not alight on the ground.
- **Hornbills (*Bucerotidae*)**
  Presence of Hornbills is one indicator of good fruiting trees in the forest. The team identified five species of Hornbill in the area, with a relatively high frequency of encounter. One of the species, *Rhinoplax vigil,* could be heard almost every day during the research period.
- **Trogons (*Trogonidae*)**
  Trogon is the group of species that is usually waiting and catching their prey in dense vegetation (Arboreal foliage gleaning insectivore). Some species were caught in the research area, one of which the Red - naped Trogon (*Harpactes kasumba)* was mist-netted.
- **Woodpeckers (*Picidae*)**
  The best example of this bird is the white - bellied woodpecker (*Dryocopus javensis*) that can be easily found in open lowland forest. It forages at all levels of the forest. The smallest woodpecker in Gunung Lumut is the Rufous Piculet (*Sasia abnormis*), which was found in lower and middle stroreys of secondary forests.
- **Bulbuls (*Pycnonotidae*)**
  Bulbul is a group of birds, which are commonly found in the tropical forest. These birds usually have good survival capability because they can adapt to a variety of food resources, because of which they can be frequently found in different habitat types. Bulbuls are primarily classified as frugivorous although they also eat insects. Most species are normally found at the forest edge, but some species, such as *Pycnonotus cyaniventris, P. melanoleucos* and *P. atriceps,* are primary forest inhabitants and rarely found in the forest edge or open area. *P. zeylanicus* is one of the Bulbul species that usually lives along forest rivers, but it was never heard nor seen in the research area of Gunung Lumut.
- **Orioles (*Oriolidae*)**
  The family members are recognized with their beautiful songs (Songs of Oriol). One of the species, *Oriolus xanthonotus* was identified along the logging road near the main camp.
- **Babblers (*Timaliidae*)**
  Babblers are generally gregarious and noisy, and most of them have rather harsh and chattering calls. Some of them are understorey specialists and live close to the ground, in lower dense shrubs up to around three meter high trees. This species group consists of strong singers and can be esily caught with mist-nets, such as *Macronous gularis, Malacocincla malaccensis* and *M. sepiarium.*
- **Trushes (*Turdidae*)**
  One of the species, the White-rumped Shama or Murai Batu (*Copsychus malabaricus*), is famous for its beautiful song. The Murai song was often heard in almost all corners of Gunung Lumut forests. The team identified four species from this family in this area (see Appendix 5).
- **Flycatchers (*Muscicapidae*)**
  A migrant species, the Siberian Blue Robin *Luscinia cyane* (juvenile) was captured in a mist-net at flying camp near and above the Mului River.

- **Sunbirds (*Nectariniidae*)**
  The smallish, olive and yellow spider hunter, *Arachnothera longirostra,* is commonly found in a secondary forest area. They are frequently seen flying very fast across the jungle trails, making a recognizable flight call.
- **Flowerpeckers (*Dicaeidae*)**
  Dicaeum monticolum/celebicum was found at the top of Gunung Lumut (>1,000 m a.s.l.).
- **Pitta (*Pittidae*)**
  Two species of Pittas, Garned Pitta *(Pitta granatina)* and Banded Pitta *(Pitta guajana)* were captured in mist-nets.
- **Other Families**
  Pellorneum capistratum, Napothera atrigularis, Lophura bulweri, Polypectron schleiermacheri, and many others (for complete data see Appendix 5) were found only once during the research period (Boer, 1994, 1998, 2002, 2004), which indicates that these species might comprise a small population in the area.

3.1.2.2. Guild Composition

Birds (avifauna) are primary and secondary consumers in the forests and many of them have specific food preferences. For the reason, avifauna trophic structure can be determined based on the structure of existing food resources and food chain or web pattern (guild classification).

Below is the list of avifauna trophic types according Boer, 1994, 1998; and Lambert, 1992:

- Raptor (R)
- Arboreal Frugivore (AF)
- Terrestrial Frugivore (TF)
- Arboreal Foliage Gleaning Insectivore (AFGI)
- Arboreal Foliage Gleaning Insectivore/Frugivore (AFGI/F)
- Sallying Insectivore (SI)
- Sallying Substrate Gleaning Insectivore (SSGI)
- Bark Gleaning Insectivore (BGI)
- Terrestrial Insectivore (TI)
- Terrestrial Insectivore/Frugivore (TI/F)
- Nectarivore/Insectivore (NI)
- Nectarivore/Insectivore/Frugivore (NIF)
- Insectivore/Piscivore (Insec/Pisc
- Nocturnal Predator (Noc Pred)

Table 5 shows 14 different trophic groups that were found during the assessment:

Table 5. Group of Taxa and Feeding Guild of Birds Diversity

Group of Taxa	Trophic group	Feeding guild	Number of Species	Number of Individuals
Specialist	Frugivore	Terrestrial	4	7
		Arboreal	13	22
	Insectivore	Terrestrial	6	8
		Arboreal	6	81
		Bark gleaning	6	9
		Sallying	30	33
		Aerial	21	22
Generalist	Insect-Frugivore	Terrestrial	4	26
		Arboreal	14	27
	Frugivore/ Predator	Arboreal	9	25
	Insec/Piscivore		3	5
	Insec/Nectarivore		8	8
	Ins/Nectar/Frugivore		6	24
Carnivore	Predator	Raptor	2	2

Most of the species consume fruits, nectar, large insects or arthropods that can be found in dead leaf clumps or flushed by army ants. Most birds can only adapt to particular kinds of food, hence their abundance and distribution is determined by their food supply. Huge food resources diversity in tropical area allows *generalist* species that do not depend on one particular food type, to also inhabit the area. Generalist birds consume two or more food resources, which allows them to survive better in changing seasons over time.

The area was dominated by generalist or insectivorous birds that indicated that the area has been severely disturbed. The generalists can better adapt to changes in their habitat than specialist birds. Most species of Bulbul or of the family of Pycnonotidae, for instance, are generalist birds. They consume insect, flower, and fruit. Frugivores are now to be found in this area, because their habitat strongly supported in availability of fruiting trees. Many Figs (Ara) were present in this area.

3.1.2.3. Altitude and Bird Species Composition

Bird species composition changes as altitude changes. Generally, the number of biodiversity decreases when altitude changes from lowland to sub-montane and montane forests. Therefore, biodiversity protection is most critical in the lowland forest.

Gunung Lumut area is the home for most of Borneo's lowland bird families, including the rare species of White-crowned Hornbill, Great Argus, Laughing Thrush and others. Appendix 5 shows a list of bird species and their distribution in/around the research area.

- **Lowland Species**

In Borneo, more than 400 bird species are found in the lowland forest, distributed in various habitats, such as mangrove, coastal area, swamp forest, heath forest and inland forest. Gunung

Lumut Protection Forest is quite large (c. 42,000 ha) with a huge range of habitats from lowland to sub-montane forests. The bird fauna here is largely intact, although forests are relatively disturbed by logging and encroachment. Table 6 shows some of the lowland bird species found in the area.

Table 6. Some Lowland Bird Species

Pitta granatina	Dryocopus javensis
Pitta sordida	Alcedo euryzona
Pitta baudi	Ceyx erythacus
Rhinoplax vigil	Stachyris erythroptera
Anthracoceros malayanus	Copsychus malabaricus
Sasia abnormis	Lonchura malacca

The distributional pattern of bird species in Gunung Lumut is similar to Peninsular Malaysia as described by Wells (1985). Some species are extreme lowland (between 300 – 900 m a.s.l) specialists, such as Crested Fireback *(Lophura ignita),* Great Slaty Woodpecker *(Mulleripicus pulverulentus)*, Greater Racket-tailed Drongo *(Dicrurus paradiseus)*, White-chested Babbler *(Trichastoma rostratum)*, Ferruginous Babbler *(Trichastoma bicolor)*, Black-throated Babbler *(Stachyris nigricollis)*, Purple-throated Sunbird *(Nectariana sperata)*, Crimson Sunbird *(Aethopyga siparaja)* and White-bellied Munia *(Lonchura leucogastra)*.

- **Sub-montane and Montane Species**

Sub-montane to montane forests are located over than 900 m a.s.l. In these areas bird biodiversity is relatively low, but they may be the home to some endemic, rare, or isolated species, and therefore it is important to conserve these areas, too. The Little Cuckoo-Dove *(Macropygia ruficeps)* is an endemic species specific to montane forest. It was also found in Pa` Raye forest area (400 – 900 m) in Kayan Mentarang National Park (Boer, 2002), at 200-250 m in Gunung Mulu in Sarawak and in the forest at Barito Ulu. It is considered a wide ranging species (Wells et al, 1979 and Wilkinson *et al*, 1991).

A few of the montane or sub-montane bird species were also seen at lower altitudes, such as the Black Eagle *(Ictinaetus malayensis)* because it wanders over large distances and huge ranges of altitude. The Siberian Blue Robin *(Luscinia cyane)* has been captured at mountain level as a young bird (Van Balen, personal communication). The Siberian Rubythroat *(Luscinia calliope)* was recorded from North Borneo (MacKinnon & Phillipps, 1994). This species breeds in North East Asia, migrates in winter to India, South China, and South East Asia.

The following are some endemic bird species that were recorded in Gunung Lumut Protection Forest: *Dicaeum monticolum, Prionochilus xanthopygius, Cyornis superbus, Lophura bulweri, Polypectron schleiermacheri, Lonchura fuscans* and *Pachycephala hypoxantha.* The latter endemic species, Bornean Whistler *(P. hypoxantha),* has only been recorded twice in Kalimantan (in Kayan Mentarang National Park: (Puak Highlands and Lalut Birai) by a WWF Biodiversity survey team.

3.1.3. Primates and Large Mammals

The team collected data on primates and large mammals in the area as presented in Figures 4, 5 and 6.

Gunung Lumut Protection Forest is a relatively good habitat for primate and large mammals. Primate and large mammal diversity was relatively high and most of the species of East Kalimantan could be found in the area.

At least 9 primates and 14 large mammals species were identified in the three main study areas. Some other mammal footprints were also found, but could not yet be identified. A list of identified primates and large mammals species is given in Appendix 6.

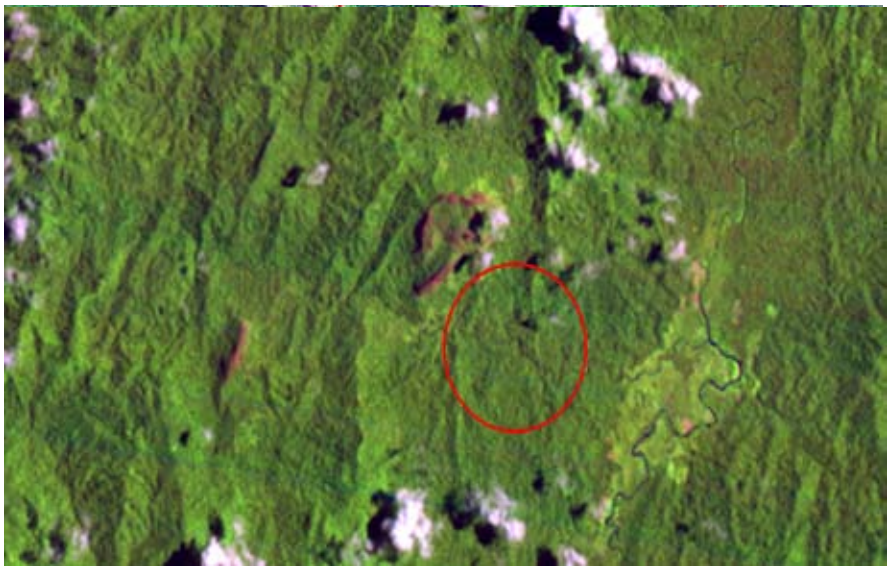

Figure 4. Exploration area surrounding Perayan river camp

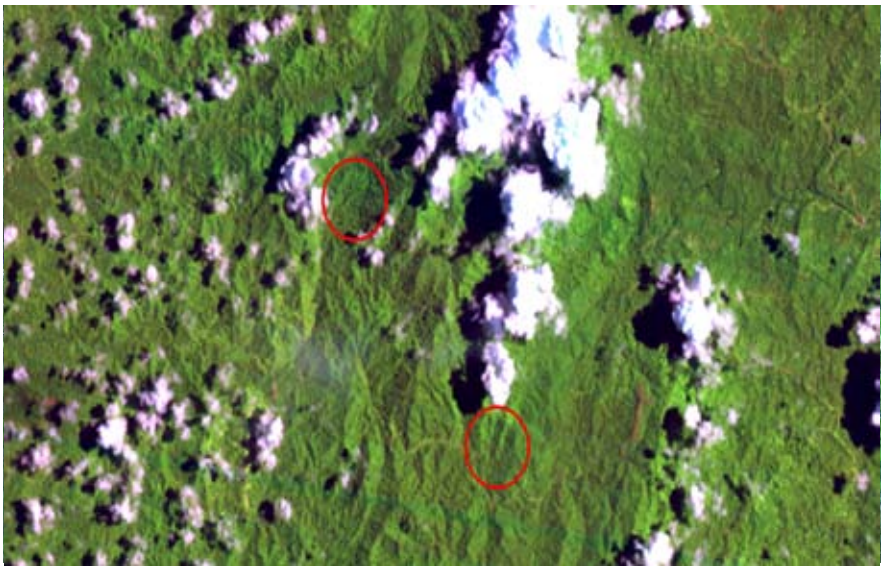

Figure 5. Exploration Area Surrounding Mului and Gunung Lumut Camp

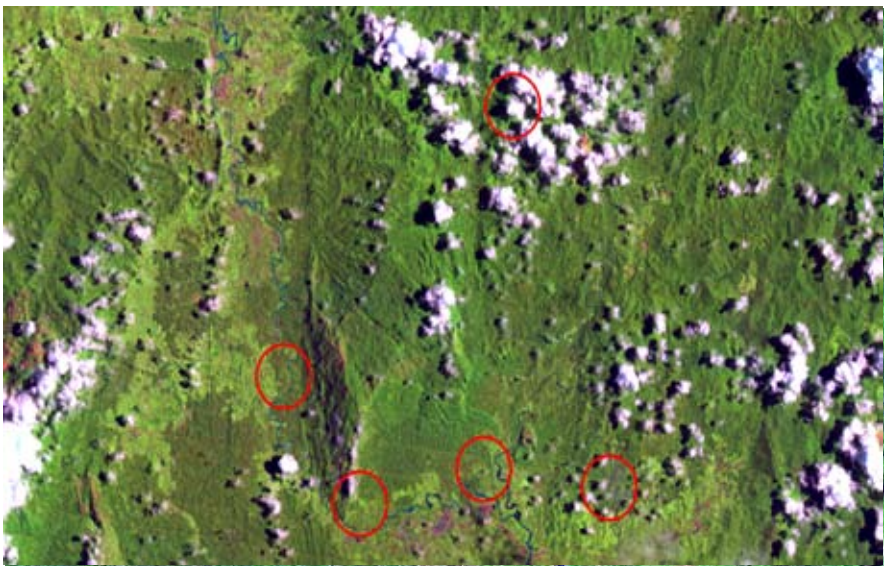

Figure 6. Exploration Area Surrounding Kendilo River

3.1.3.1. Primates

The following are short descriptions of primates identified during the assessment.

- **Owa kalawat / Klawit (*Hylobates muelleri*) – Bornean Gibbon**

Bornean gibbon (*Hylobates muelleri*) is the dominant primate species found in the area around the 3 camps. The group density was relatively similar to densities of Gibbon found in Kayan Mentarang National Park, i.e. between 2 and 2.6 groups/km2 (Nijman, 1997).

The group structure of Bornean gibbon living around Perayan River seems to be less favourable because it did not have intact groups (consisting of at least 5 individuals) like in Mului and Gunung Lumut Camps. Generally, the area in Sungai Perayan Camp appears to be a relatively unfavourable habitat for the Bornean Gibbon compared with the area around Mului and Gunung Lumut Camps.

Bornean gibbon is protected by Indonesian law, and is included on CITES Appendix I and listed as Lower Risk/Near Threatened by IUCN (2002).

- **Lutung Dahi-Putih (*Presbytis frontata*) - White-fronted Langur**

Only a few White-fronted Langur were found in the study areas: three groups in the area around Sungai Perayan Camp and two groups in Mului Camp.

- **Lutung (*Presbytis cristatus*) - Silvered Langur**

Only a few Silvered Langur were found during the assessment: one group in the area around Sungai Perayan Camp, two groups in Mului Camp and one group in Gunung Lumut Camp.

- **Lutung Merah (*Presbytis rubicunda*) - Red Leaf Monkey / Maroon Langur**

The Red-leaf monkey (*Presbytis rubicunda*) was only found by the Ornithology Team once in Sungai Perayan Camp. According to the local people, the species has never been found in the area before. Red-leaf monkey can be identified by its voice that is quite similar to that the one of *Presbytes hosei.*

- **Monyet Ekor Panjang (*Macaca fascicularis*) – Long-tailed Monkey**

The Long-tailed monkey was the most frequently found species in Gunung Lumut Protection Forest, specifically in the central and in the Northern areas of Sungai Perayan. This species was mostly found in small groups. They were sighted mostly when they were seeking food along the rivers, especially fig trees (*Ficus sp.*). This species is not protected by Indonesian law, but included on CITES Appendix II and listed as Lower Risk/Near Threatened by IUCN (2002).

- **Beruk (*Macaca nemestrina*) – Pig-tailed Monkey**

The Pig-tailed monkey was only found twice in Sungai Perayan Camp, in small groups of 5-7 individuals, while in Mului Camp only one solitary individual was seen. The Pig-tailed Monkey is not protected by Indonesian law, but included on CITES Appendix II and listed as Vulnerable by IUCN (2002).

- **Kukang (*Nycticebus coucang*) – Slow Loris**

The Slow Loris is a nocturnal primate (active in the night) that is commonly found in Kalimantan forests. Slow loris is mainly insectivorous, but sometimes it eats fruit or small animals. Information about their existence in the area was obtained from interviews with local people in Mului Hamlet and in the Northern part of Gunung Lumut. The team also found one live specimen that was kept as local people's pet. The Slow Loris is protected by Indonesian law and included on CITES Appendix II.

- **Krabuku (*Tarsius bancanus*) – Western Tarsier**

The Western Tarsier is a nocturnal species that is rarely found in Kalimantan forests. Information about its existence in Gunung Lumut area was obtained from interviews with local people and local hunters around Mului Camp, who have previously seen and caught live specimens. The Western Tarsier is mainly insectivorous, but sometimes it also eats fruits, reptiles and small animals. This species is protected by Indonesian law, is included on CITES Appendix II, and listed as Data Deficient by IUCN (2002).

- **Bekantan (*Nasalis larvatus*) – Proboscis Monkey**

During the research period, the Proboscis Monkey was found only in the Southern part of Rantau Layung Village. But it was reported that a group of this species was also found around Melihat Mountain rivers at the Southern boundary of Gunung Lumut (Rachmawan, 2006).

3.1.3.2. Large Mammals

The following are short descriptions of large mammals identified during the assessment.

- **Sambar Deer (*Cervus unicolor*)**

Sambar Deer is a common large mammal species in Gunung Lumut. Their footprints were found at riversides and in the forest around Sungai Perayan Camp. Around Mului camp, the team found their tracks and there was one life specimen captured by local people. It was also seen once around Gunung Lumut area.

Figure 7. Sambar Deer (Rusa sambar, Cervus unicolor) (Photo by Rinaldi)

- **Kijang (*Muntiacus muntjak*) - Common Barking Deer**

A life specimen of the Common Barking Deer was found only once around Gunung Lumut Camp area, but their footprints were also found around Sungai Perayan and Mului Camps. This species was recorded twice by the Ornithology team near Sungai Perayan.

- **Napu (*Tragulus napu*) - Greater mouse-deer**

The Greater Mouse-Deer was found once around Mului Camp, and the team only found their footprints in the other locations.

- **Kancil (*Tragulus javanicus*) - Lesser Mouse-deer**

The Lesser Mouse-Deer was identified only by its passing tracks, especially in the area around Sungai Perayan Camp.

- **Babi Berjenggot (*Sus barbatus*) - Bearded Pig**

The Bearded Pig is a very dominant large mammal in Gunung Lumut area. A lot of wallows and footprints of this species were found in the forest, while in Sungai Perayan camp one skull was collected.

Figure 8. The Wallow of the Bearded Pig
(Babi berjenggot, Sus barbatus) (Photo by Rinaldi)

- **Kucing Hutan (*Felis planiceps*) - Flat-headed Cat**

The Flat-headed Cat could only be identified through its footprint found in Sungai Perayan Camp.

- **Musang Luwak (*Paradoxurus hermaphroditus*) - Common Palm Civet**

The Common Palm Civet was identified through its footprint found in Sungai Perayan Camp, and also by direct night observation in Mului Camp.

- **Musang Air (*Cynogale bennettii*) - Otter Civet**

The Otter Civet was identified only by its footprint in Sungai Perayan Camp.

- **Beruang Madu (*Helarctos malayanus*) - Sun Bear**

There was no direct observation of Sun Bears, but its presence was recognized through its nail markings on some trees around Sungai Perayan and Gunung Lumut Camps. Local people informed that this species population has dramatically decreased due to illegal hunting.

- **Tenggalung Malaya (*Viverra tangalunga*) - Malay Civet**

Another nocturnal animal is the Malay Civet, a member of the Civet Cat or Musang family.

- **Musang Gunung (*Diplogale hosei*) - Hose's Civet**

Hose's Civet was found once in the area of Mului Camp.

- **Landak Raya (*Hystrix brachyura*) - Common Porcupine**

The Common Porcupine is very well known and often eaten by local people. One live specimen was captured by local people in Mului, and footprints were identified along foraging and exploration paths aorund Gunung Lumut Camp.

- **Linsang (*Prinodon linsang*) - Banded Linsang**

The Banded Linsang was identified only through its footprint in the area around Sungai Perayan Camp.

Figure 9. Footprint of the Banded linsang
(Linsang, Prionodon linsang) (Photo by Rinaldi)

- **Berang-berang Wregul (*Lutra perspicillata*) – Smooth-coated Otter**

The Smooth-coated Otter was identified only through its footprint found around Sungai Perayan Camp.

Figure 10. Footprint of the Smooth-coated otter
(Berang-berang Wregul, Lutra perspicillata) (Photo by Rinaldi)

Figure 11. The nail markings at a Tree of a Sun bear
(Beruang Madu, Helarctos malayanus) (Photo by Rinaldi)

- **Other species**

Some squirrel species were also found in the study areas. These include Black-eared Pygmy Squirrel (*Nannosciurus melanotis*), Plain Pygmy Squirrel (*Exilisciurus exilis*), Jentink's Squirrel (*Sundasciurus jentinki*), Tufted Ground Squirrel (*Rheithrosciurus macrotis*), and Three-striped Ground Squirrel (*Lariscus insignis*).

Figure 12. Black-eared Pigmy Squirell (Nannosciurus melanotis) (Photo by Rinaldi)

3.1.4. Small Mammals

During the assessment, the team collected 110 specimens of 18 small mammal species (14 species of bat and 4 species of rat) (presented in Appendix 7). None of them was endemic to Kalimantan.

All specimens collected during the assessment only represented 9.3% of all known small mammal species in Kalimantan. During the assessment, no tree shrew was captured and identified, which was unsual since Kalimantan is known to have nine tree shrew species. The number of species found or identified might increase by increasing survey duration, kind and number of small mammals catching equipment, human resources and number of survey locations, like what happened in a similar survey in Gunung Halimun National Park

The small mammal survey in the Gunung Halimun National Park in 2003 (Suyanto, 2003) achieved a better result in terms of number of species found. From 6 surveys (21 days each) in the 40,000 ha national park area (comparable to the size of Gunung Lumut which is 42,000 ha), 27 small mammals (only rodents and bats) were identified, which represented approximately 28.4 % of the known rodent and bat fauna in Java. The survey was carried out by a special survey team consisting of one researcher, one technician and two field assistants. The team also used various traps, including wire traps and Sherman traps for trapping rodents and shrews.

The success of the trapping is also influenced by weather and number of survey locations. The survey in Gunung Lumut was conducted during wet (rainy) season, while it is generally known that trapping and mist-netting are likely to be more successful during dry season. Small mammals are not evenly distributed throughout Gunung Lumut areas (shown in Appendix 7), for which reason setting up traps in more locations would likely to give better results.

The occurrence of *Cynopterus minutus* (formerly known as a subspecies of *C. brachyotis*[1]) and *Rattus tanezumi* were also indicators that the forests are relatively disturbed, because such mammal species were also identified in the other heavily damaged forests, such as in Bukit Bangkirai and East Kalimantan after forest fire (Suyanto *et al.*, 2003). The team found one individual of *R. tanezumi* (Asian house rat) on study site 4, three, nineteen, one and five individuals of *C. minutus* on study and site 1, 4, 5 and 6 respectively(see 2.3.1).

Cynopterus spp. and other fruitbats are known as seed dispersers and pollinators that play an important role in the rehabilitation of damaged forests and in maintaining forest ecosystem health (Fleming and Heithaus, 1981; Marshall, 1983; Howe, 1984; Whittaker and Jones, 1994).

Besides bats, rodents are also very important in maintaining forest ecosystem health. Both groups are also known as important source of food for carnivorous birds, mammals and reptiles. Rodents play important role in accelerating the organic cycle through their habit of cutting hard organic materials such as stems, branches or twigs of plants. Like bats, rodents are also important seed dispersers because they have a habit of carrying nuts and fruits into their nests, some of which are usually littered on the way.

Some species of rodents and bats are consumed as food by people in some regions in Indonesia (East and Central Java, Mentawai, Flores, North Sulawesi, Papua). Some species are also utilized as medicines, such as bats to cure asthma, and squirrel to cure diabetes (Suyanto, 2003). But some small mammal species are also known as vectors for various diseases, such as shrub thypoid, leptospirosis, salmonellosis, plague, thypoid, HLV (Herman-like Virus) and histoplasmosis.

3.1.5. Other Mammals

The data on other mammals were obtained from interviews with local people. Detailed results of the interviews are summarised in Appendix 8. From the interviews, the team also identified the occurrence of two other primate species besides twelve species of large and one species of small mammals that were identified on the locations. In total, the research identified 11 primate species, 26 large mammal species and 19 small mammal species from Gunung Lumut Protection Forest. About half of the identified primates and large mammals are classified as protected species, either by Indonesian Law and/or listed on CITES Appendix of IUCN.

1 Kitchener and Maharadatunkamsi (1991) re-examined many specimens of Cynopterus spp. and supported the opinion that C. minutus was a distinct species. Corbet and Hill (1993), Koopman (1993) and Payne et al. (2003) however still considered it as a subspecies of C. brachyotis)

3.2. Botany

Gunung Lumut Protection forest is one of the plant diversity-rich regions in Borneo (Figure 13). An extensive botanical study on tree genera from 28 plots across Borneo (Slik et al. 2003) found that tree genera composition in Kalimantan is generally more homogenous compared to Malaysian Borneo and Brunei (Figure 13). If compared to the other forests in Kalimantan, Gunung Lumut Protection Forest has a higher plant diversity, which is surprising since the area is a rather isolated mountain range with peaks up to ca. 1200 m altitude, which is partly formed by limestone outcrops, that are usually correlated with high level plant endemism.

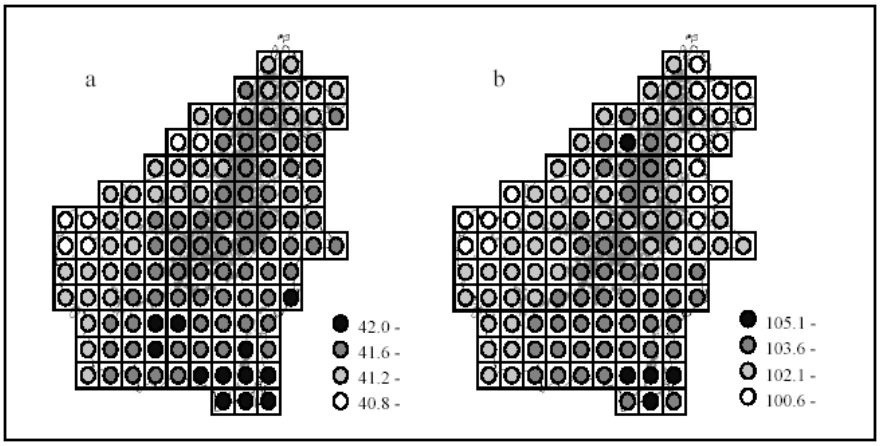

Figure 13. Average tree family (a) and genera (b) diversity patterns across Borneo based on random draws of 640 individuals from 28 locations across Borneo

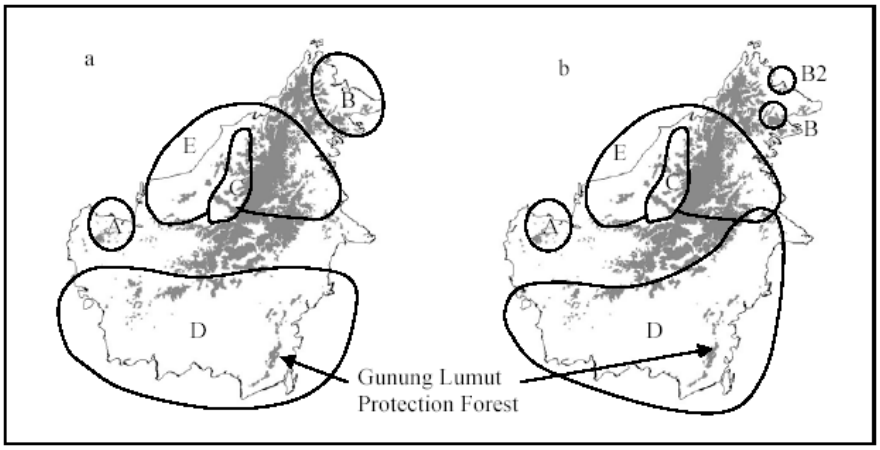

Figure 14. Floristic relations within Borneo based on (a) steinhause similarity and (b) sorensen similarity of 28 locations across Borneo

3.2.1. General Botanical Diversity

The team collected plant data and specimens in order to describe a general picture of Gunung Lumut's forest structure, plant diversity and composition. As comparisons, similar data from two other forest areas, i.e. Sungai Wain (representing undisturbed lowland coastal forest, located about 15 km NW from Balikpapan) and Meratus (representing undisturbed lowland forest, located at the Northern end of the Meratus Mountain Range, ca. 80 km West from Balikpapan) were used.

An overview of plant specimen's collection from Gunung Lumut Protection Forest is presented in Table 6. In total, the team collected 239 angiosperms, consisting of 65 families and 143 genera (Appendix 9), and 278 ferns, consisting of at least 181 taxa (Appendix 10). The team also identified 59 plant families, consisting of 163 genera and 2798 individuals from the tree plotting inventories (Appendix 11).

Of the higher plant species identified during the assessment (see also 3.2.2), one species was new to East Kalimantan (Aristolochiaceae, *Aristolochia nviculilimba*), and one species was new for Borneo (Orchidaceae, *Plocoglottis quadrifolia*, identified from photograph) and one species was even new for the Malesian region (Celastraceae, *Lophopetalum wallichii*). A Bornean endemic family, which was previously known to be endemic only in Northern Borneo, was also identified (Scyphostegiaceae, *Scyphostegia borneensis*). At least one new species has been discovered, Ficus lumutana C.C. Berg. The team also identified one new fern species for East Kalimantan (*Tectaria inopinnata*), and two new fern species for Borneo (*Asplenium* cf. *subnormale* and *Pneumatopteris brooksii*). Some Bornean endemics identified were: *Pyrrosia platyphylla, Tectaria inopinnata, Selliguea metacoela* and *Pyrrosia kinabaluensis*. Several rare species were also found, i.e., *Goniophlebium mehipitense* and *Pteris holttummii*, and possible new species in the genera *Hymenophyllum, Grammitis* and *Selliguea*. Only a few specific limestone Pteridophytes were found.

Table 7. Overview of Number of Collections by Growth Form

Plant Group	Collections
Trees	111
Treelets	21
Shrubs	18
Climbers	60
Herbs	21
Epiphytes	7
Saprophytes	1
Pteridophytes (ferns)	278

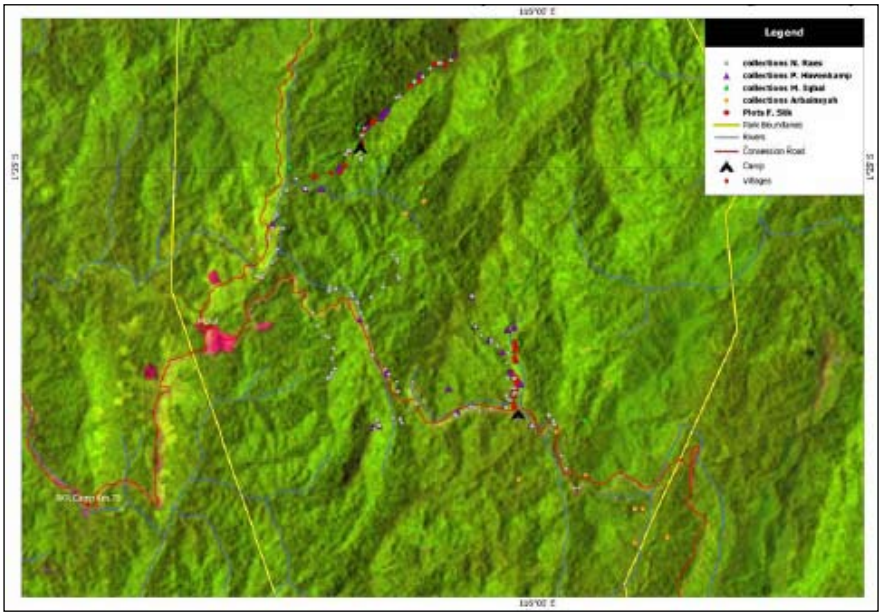

Figure 15. Locations of collections and plots made in the environs of Gunung Lumut (Northern camp) and the base camp (Southern camp)

(Note: Red dots indicate the plots, all others are collections made during the botanical survey)

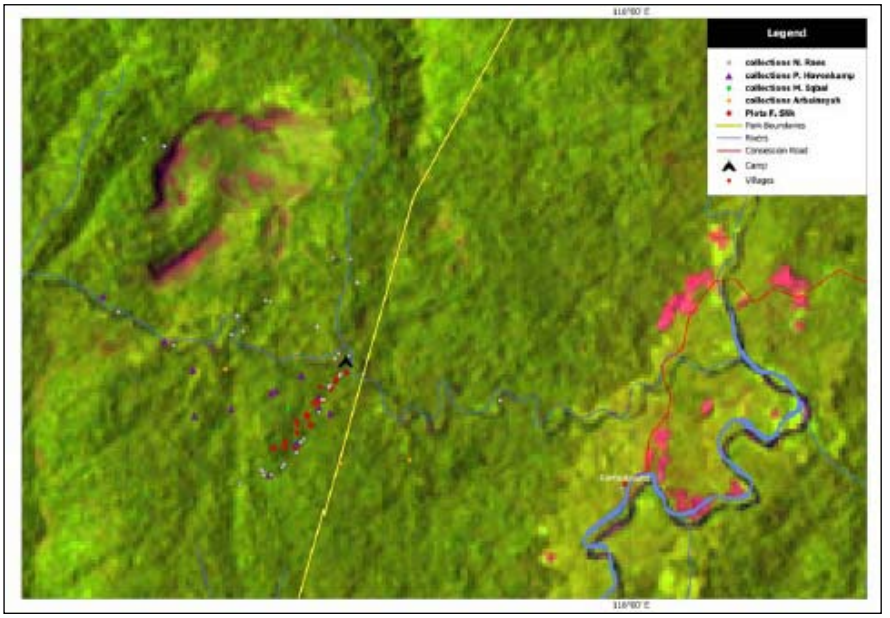

Figure 16. Locations of collections and plots made in the environs of Rantau Layung

(Note: Red dots indicate the plots, all others are collections made during the botanical survey)

3.2.1.1. Forest Structure, Genus Diversity and Environmental Data

Tree density varied significantly between locations, with rather low density in the logged forest around the base camp in Gunung Lumut and Rantau Layung, and very high density in undisturbed coastal forest around Sungai Wain (Table 8).

Table 8. Average Generic Diversity and Tree Densities within the Plots at Each Location, Split up in Several Diameter Classes *

Location	Generic diversity (Fisher's-alpha)	Dbh			
		≤ 2.5 cm (n/100 m²)	2.5 - 5 cm (n/100 m²)	5 - 10 cm (n/100 m²)	>10 cm (n/100 m²)
Base Camp	26.5abc	20.4a	8.2a	5.5a	5.7b
Gunung Lumut	15.6a	56.5b	9.8a	9.6ab	6.7b
Rantau Layung	17.0ab	41.1b	11.8ab	6.9a	4.2ab
Mului	22.2b	39.2b	10.7ab	5.4a	4.1a
Meratus	30.7c	42.0b	11.8b	5.5a	4.9ab
Sungai Wain	26.8bc	86.3c	18.5c	10.3b	4.9ab
P-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.014
Kruss-Wall test	38.4	73.8	39.6	34.1	14.3

* significant differences within each column are indicated with different characters

Forests in Gunung Lumut and around Mului Camp have higher canopy openness and associated diffuse light levels due to low leaf density in these two forests (Table 9).

Table 9. Average Canopy Openness, Direct- and Diffuse-Light, and Leaf Area Index per Plot for the Studied Locations *

Location	Canopy Openness (%)	Direct Light (mol/m²/day)	Diffuse Light (mol/m²/day)	Leaf Area Index (m²/m²)
Base Camp	4.1b	2.8	0.31ab	3.7a
Gunung Lumut	4.4b	2.1	0.35b	3.8a
Rantau Layung	3.3ab	2.0	0.25ab	4.3b
Mului	2.3b	1.9	0.20ab	4.6b
Meratus	2.2a	2.3	0.18a	4.7b
Sungai Wain	2.8ab	3.1	0.26b	4.7b
P-value	< 0.0001	NS	0.0004	< 0.0001
Kruss-Wall test	26.8		22.3	33.9

* Significant differences within each column are indicated with different characters

3.2.1.2. Diversity Curves

The study showed that the undisturbed forests on limestone in Rantau Layung and the undisturbed montane forests on Gunung Lumut had the lowest plant diversity, the undisturbed forests on the foot of Gunung Meratus and the logged forests around the Base Camp had the highest plant diversity (Figure 21), and the undisturbed lowland forest at the foot of Gunung Lumut (Mului) and the undisturbed coastal forest near Balikpapan (Sungai Wain) had the medium diversity.

Fern diversity was rather low in the Rantau Layung forest, medium in the forest around the Base Camp, very high in Gunung Lumut (Figure 23).

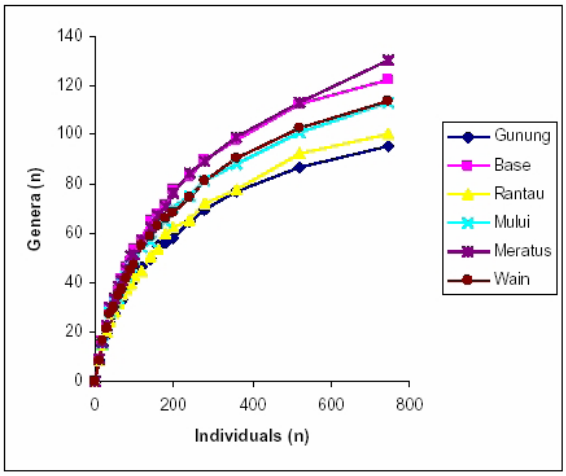

Figure 17. Genus-Individual Curves for the Studied Locations
(Note: Each curve is the average of 10 replicate curves)

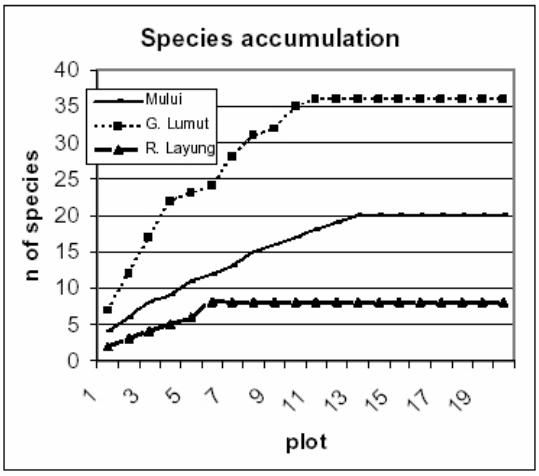

Figure 18. Species-Area Curves for Ferns based on a Single Replicate per Location

3.2.1.3. Plant Composition

Plant composition differs significantly between the coastal Sungai Wain forest and the more inland forests on the Meratus Mountain range (Figure 22). There was a clear geographic plant gradient within Meratus Mountain Range forests, which was indicated by differences in specific plant composition at each geographic level.

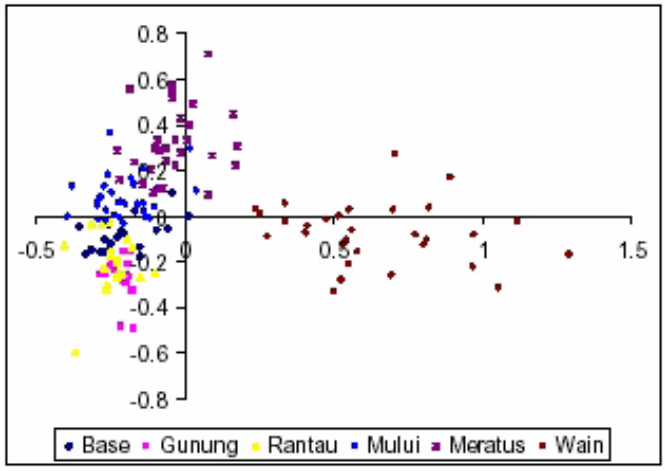

Figure 19. Scores of the Plots on the First Two PCA-Axes based on Number of Individuals per Genus per Plot

(Note: The two axes combined explain 10.2% of data variance, and clearly separate the Sungai Wain plots from all other included plots)

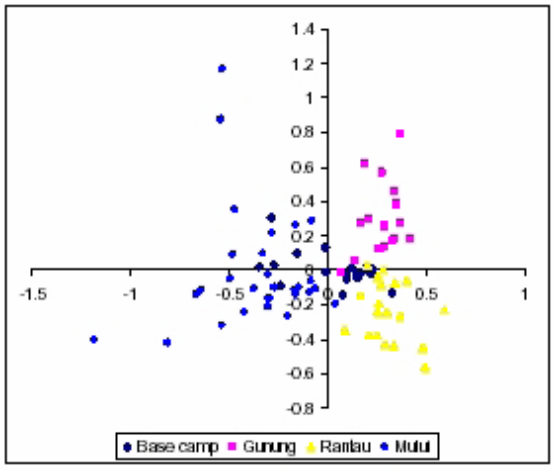

Figure 20. Scores of the Plots on the First Two PCA-Axes based on Number of Individuals per Genus per Plot

(Note: The two axes combined explain 8.5% of data variance, and clearly separate the plots from Mului, Rantau Layung and Gunung Lumut)

The survey locations in Gunung Lumut Protection Forest represented specific plant composition (Figure 22). The undisturbed lowland forest plots in Mului had a more diverse plant composition if compared to the other three forest locations along the second PCA axis, while the plant composition in the logged forests near the Base Camp was quite similar to the one in the undisturbed forests near Mului.

3.2.1.4. Altitudinal Patterns

The number of trees increased significantly with the increase of altitude on Gunung Lumut (Figure 21). This correlation was found strongest among treelets, i.e. trees with a diameter between 5 and 10 cm (Table 10), and weakest/none among saplings (dbh 0-2.5 cm). The study also showed no/weak correlation between environmental and tree diversity and altitude increase, but there was a strong correlation between plant composition and altitude changes (Figure 22).

Table 10. Regression Results for Tree Density against Altitude on Gunung Lumut

Diameter Class	Regression Type	Correlation Coefficient	R^2	P
0-2.5				NS
2.5-5	Linear	0.50	25.0	0.046
5-10	Linear	0.67	45.0	0.004
> 10	Linear	0.51	26.0	0.042
All	Linear	0.57	32.0	0.023

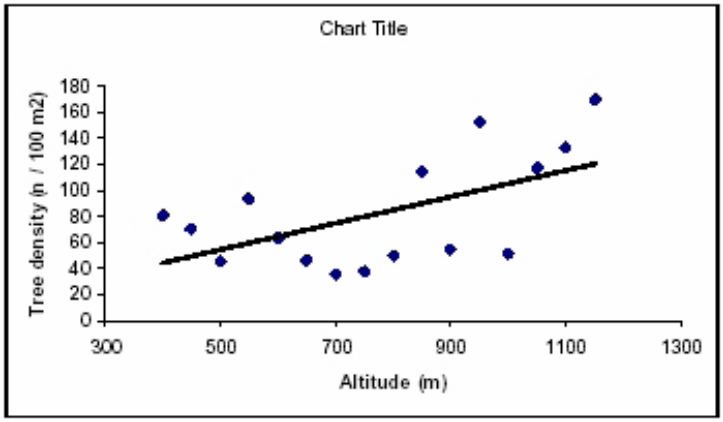

Figure 21. Relationship between Altitude and Tree Density on the Slopes of Gunung Lumut

(Note: Linear relationship with a correlation coefficient of 0.57, and R2 of 0.32, and p = 0.023)

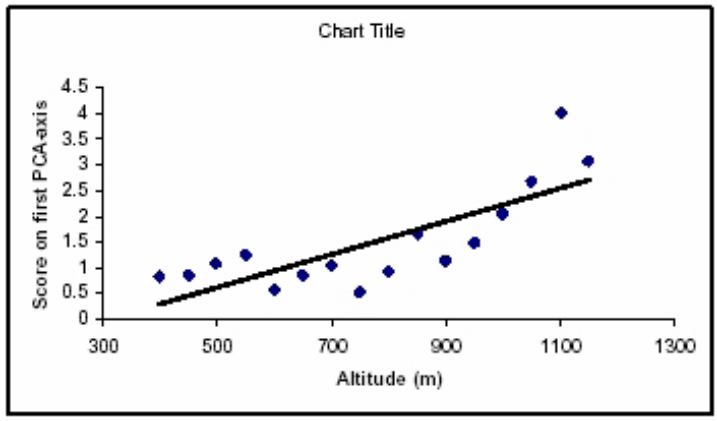

Figure 22. Relationship between Altitude and Generic Tree Composition on Gunung Lumut

(Note: Composition was based on the scores of the plots on the first axis of the PCA (correlation coefficient 0.78, R2 of 60.7% and p = 0.0004))

Fern diversity increased significantly with altitude (Figure 23), which corresponds with observed fern densities with increasing altitude.

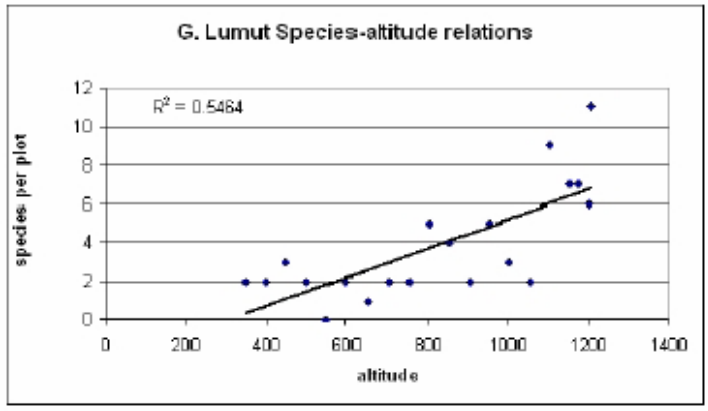

Figure 23. Increase in Fern Diversity with Increasing Altitude on Gunung Lumut

3.2.2. Higher Canopy Plant (Higher Storey Vegetation)

The higher canopy plant diversity includes plants occupying the higher canopy layers in the forest – mainly small to large trees. Higher plants are important because they arethe main components in forest, and determine forest type and composition, as indicators of forest condition in an area.

3.2.2.1. General Vegetation

Several vegetation types were found in Gunung Lumut Protection Forest. The areas along the logging road, which crosses almost diagonally the Northern part of the protection forest, along the skidding trails, and the area surrounding Mului Hamlet are covered by secondary (forest) vegetations. Especially in the vicinity of the Hamlet, the vegetation type varies in some stages depending on their age as a consequence of the implementation of swidden agriculture. Only some small areas of *kebun* (fruit trees garden) at the upperstream of Sungai Mului were observed. The area was the former settlement of local people who are now living in Mului Hamlet.

Although Gunung Lumut area is mostly covered by primary forests, only small parts of the forests are still in good condition, particularly the least accessible forests (areas with very steep slopes and/or located at the top of narrow ridges). The other parts are relatively damaged in various degrees due to illegal logging, particularly in the areas close to settlements such as Rantau Layung Village.

3.2.2.2. Species Diversity

At least 445 higher canopy plant species were observed during the expedition. These species belong to 215 genera and 74 families (did not include lianas, epiphytes and herbs), dominated by the Euphorbiaceae family. Euphorbiaceae was accounted by 46 species, followed by Rubiaceae (by 30 species), Dipterocarpaceae and Annonaceae (each by 27 species), Moraceae (by 20 species) and Lauraceae (19 species). This composition reflects high plant diversity in the area. During the assessment, 310 fertile herbarium specimens were collected. All plant species observed during the expedition are listed in the Appendix 12.

3.2.2.3. Secondary Forests

The structure and species composition of the secondary forests varies widely depending on the habitat type. Only very general and qualitative information can be presented here because no plots were established in these forests. On poor soils (usually sandy and stony) along the ridges and slopes, *Neonauclea gigantea* (Rubiaceae), *Trisnaniopsis obovata* and several species of *Syzygium* (Myrtaceae), *Melastoma* spp. (Melastomataceae), *Leucosyke capitellata* (Urticaceae) were usually dominant. In the other habitats with more fertile (loamy) soils, secondary forests were dominated by *Trema orientalis* (Ulmaceae), *Anthocephalus chinnensis* (Rubiaceae), *Octomeles sumatrana* (Datiscaceae), *Adinandra dumosa* (Theaceae), *Duabanga moluccana* (Sonneratiaceae) and some species of *Macaranga* (Euphorbiaceae).

A locally common tree species *Bruinsmia styracoides* (Styracaceae) was only found in the areas that are crossed by the main logging road and at the border area between Rantau Layung Village and Mului Hamlet, that have rather poor soils, but was not found around Mului Hamlet and surrounding Gunung Lumut areas.

Another interesting finding was the common presence of *Peronema canescens* (Verbenaceae), mainly in the area close to Rantau Layung Village (along the Sungai Perayan). The species was dominant in the area and grew densely in groups. *Macaranga gigantea* which is usually very

common in heavily disturbed secondary forests was not found in the surrounding areas of Sungai Perayan in Rantau Layung.

Other tree species that were also identified in the secondary forests, were *Ficus* spp. (Moraceae), *Bridelia glauca*, *Mallotus* spp. and *Glochidion* spp. (Euphorbiaceae), *Saurauia* spp. (Actinidiaceae), *Cananga odorata* (Annonaceae), *Litsea garciae* (Lauraceae) and *Geunsia pentandra* (Verbenaceae). The tree species of *Wendlandia burkillii* (Rubiaceae), *Melochia umbellata* (Sterculiaceae) and *Trichospermum* sp. (Tiliaceae) were rarely found, although they might be dominant in some other areas in Kalimantan.

3.2.2.4. Primary Forests

The study showed that the primary forests in Gunung Lumut were still dominated by Dipterocarps. The team identified at least 27 species of this family (see Appendix 12). Most of them could not be documented scientifically through herbarium specimens due to lack of flowers or fruit, especially among the most important group of *Shorea*. In good forest, the Dipterocarp species may reach over 40 m height and over 150 cm diameter (dbh). These trees were observed mainly in the surroundings of Gunung Lumut, where the topography was very steep.

Some other important timber trees species, such as *Agathis borneensis* (Araucariaceae), *Palaquium* spp. (Sapotaceae), *Heritiera symplicifolia* (Sterculiaceae), *Gonystylus macrophyllus* (Thymelaeaceae) and *Peronema canescens* (Verbenaceae), were rarely observed. The most durable timber tree species, Ulin (*Eusideroxylon zwageri*, Lauraceae) was mostly found in the Southern part of the mountain, close to Rantau Layung village, and only a few around Mului Hamlet.

Forest composition tended to vary with locality. For example, at the ridge and slope area just before the border between Rantau Layung village and Mului Hamlet the *Dipterocarpus humeratus, Shorea smithiana and Shorea laevis* (Dipterocarpaceae) and *Artocarpus dadah* (Moraceae) were very common, in comparison to the rarely found *Podocarpus neriifolius* (Podocarpaceae) and *Polyalthia cauliflora* (Annonaceae). *Podocarpus neriifolius* was observed frequently at the upper steep slope along the ridge to the summit of Gunung Lumut. *Dyera costulata* (Apocynaceae), *Bouea oppositifolia* and *Gluta wallichii* (Anacardiaceae), *Engelhardtia serrata* (Juglandaceae), *Sindora leiocarpa* (Leguminosae), *Caralia brachiata* (Rhizophoraceae), *Sloanea javanica* (Elaeocarpaceae) and *Maranthes corymbosa* (Chrysobalanaceae) were observed on the ridge off km 50 of the logging road to Mului.

Seedlings and saplings of a typical mountain tree species, *Podocarpus imbricatus* (Podocarpaceae) were only found at the slightly open ridge (after logging) around km 54 of the logging road to Mului, on the 570 m a.s.l altitude. In this area some large trees of *Agathis borneensis* (Araucariaceae), many *Gluta macrocarpa, Buchanania arborescens* (both Anacardiaceae) and *Syzygium* sp. (Myrtaceae) were also observed.

Forest vegetation around the top of Gunung Lumut (1,200 m a.s.l.) and at the ridges surroundings was characterized by the common presence of *Lithocarpus* and *Quercus* species (Fagaceae),

Syzygium spp., *Adinandra* sp. and *Schima wallichii* (Theaceae), *Xerospermum* sp. (Sapindaceae), and *Calopyllum* (Guttiferae). It was observed that a lot of Annonaceae, mainly belonging to the genera of *Enicosanthum, Neouvaria, Miliusa, Mitrella* and *Orophea*, grew together with *Diopyros* spp. (Ebenaceae), *Pterospermum javanicum* (Sterculiaceae), *Homalium* sp. (Flacourtiaceae) and *Paranephelium* sp. (Sapindaceae) at the slope and stony habitat of about 650 m altitude, down South of the mountain. On the ridges (mostly narrow) *Swintonia glauca* (Anacardiaceae), Lithocarpus, *Shorea* spp. (mostly belonging to the group of yellow meranti) and *Fordia splendidissima* (Leguminosae) (usually only occupied the lower forest canopy layers) were also commonly found.

The pioneer trees of *Macaranga pearsonii* (Euphorbiaceae), *Duabanga moluccana* (Sonneratiaceae) and *Bruinsmia styracoides* (Styracaceae) were also sometimes found together in the previously disturbed primary forests, and could reach over 35 m height, and over 80 cm diameter.

3.2.2.5. Riparian Forests

Vegetation that grew along rivers was dominated by *Saraca declinata* and *Endertia spectabilis* (Leguminosae), *Dracontomelon dao* and *Pentaspadon motleyi* (Anacardiaceae), *Pometia pinnata* (Sapindaceae), and some species of *Syzygium* (Myrtaceae). The other commonly found species were *Elmerrillia tsiampacca* (Magnoliaceae), *Koompassia excelsa*, *Dialium indum* (leguminosae), *Pterospermum diversifolium* (Sterculiaceae) and *Dysoxylum* sp. (Meliaceae).

Each species has a specific distribution and adaptation patterns. *Endertia spectabilis* was commonly found along the wider rivers, while *Saraca declinata, Pometia pinnata, Koompassia excelsa, Pterospermum javanicum, Paranephelium* sp. (Sapindaceae), *Dipterocarpus tempehes, Archidendron havillandii* (Leguminosae) and *Baccaurea lanceolata* (Euphorbiaceae) were commonly found along small rivers and streams (the latter three were commonly found in the Northern part). There was no *Dipterocarpus oblongifolius* found in this area. This species may possibly occur only along rivers with harder stream and wider than Sungai Perayan. The rooting system of the tree found in this habitat is seemingly very strong and may have an irregular net-like form (Figure 24).

3.2.2.6. Fruit Trees

These tree species are characterized by their edible fruits, which can be consumed either fresh or cooked. The most important fruit tree species identified in the area were *Durio dulcis, Durio kutejensis, Durio oxleyanus, Durio zibethinus* (all belong to the family of Bombacaceae), *Mangifera* spp. (Anacardiaceae), *Garcinia* spp. (Guttiferae), *Litsea garciae* (Lauraceae), *Dialium indum* and *Parkia timoriana* (Leguminosae), *Sandoricum koetjape* (Meliaceae), *Artocarpus integer* and *Artocarpus lanceoifolius* (Moraceae), *Dimocarpus longan* and *Nephelium* spp. (Sapindaceae).

All these fruit tree species are economically important for local communities. They are distributed widely in the area, especially at the lower altitudes. During the fruiting season, these fruit can be easily found in the area, but transportation problem made only a few of them can be sold to the outside market, and local people only sell them to passing through visitors.

Figure 24. The rooting system of Saraca declinata (leguminosae) along perayan river (Photo by Sidiyasa)

Traditional laws and regulations only allow people to collect the fruits without cutting the trees, but recently, many of them have started cutting the trees to avoid the fruit to fall on the ground. This, of course, may significantly contribute to the degradation of forest and plant species diversity.

3.2.2.7. Endemic and Protected Tree Species

Not all of the plant species observed or collected during the expedition could be identified down to the species level. It is therefore difficult to completely identify the endemic and (by Indonesian Law) protected tree species. Table 11 lists only part of these tree species. The Table doesn't include some of the protected palm trees and ferns, that were collected during the expedition such as *Caryota no* (Palmae) and *Cyathea* spp. (Cyatheaceae), species that are traditionally protected by local communities due to their local economic importance such as *Koompassia excelsa* (Leguminosae, for honey production) and other fruit tree species (see 3.3).

Table 11. List of Identified Endemic and Protected Tree Species in Gunung Lumut Protection Forest.

Family	Species	Endemic	Protected
Anacardiaceae	Mangifera pajang	v	
Annonaceae	Monocarpia kalimantanensis	v	
Apocynaceae	Dyera costulata		v
Bombacaceae	Durio acutifolius	v	
Bombacaceae	Durio dulcis	v	
Bombacaceae	Durio kutejensis	v	
Bombacaceae	Durio lanceolatus	v	
Bombacaceae	Durio zibethinus		v
Clethraceae	Clethra canescens	v	
Dipterocarpaceae	Anisoptera reticulata	v	
Dipterocarpaceae	Dipterocarpus tempehes	v	
Dipterocarpaceae	Dryobalanops lanceolata	v	
Dipterocarpaceae	Hopea rudiformis	v	
Dipterocarpaceae	Shorea ferruginea	v	
Dipterocarpaceae	Shorea parvistipulata	v	
Dipterocarpaceae	Shorea smithiana	v	
Dipterocarpaceae	Vatica parvifolia	v	
Euphorbiaceae	Macaranga pearsonii	v	
Euphorbiaceae	Macaranga winkleri	v	
Lauraceae	Euideroxylon zwageri		v
Leguminosae	Archidendron havillandii	v	
Leguminosae	Endertia spectabilis	v	
Magnoliaceae	Magnolia candollii		v
Moraceae	Artocarpus lanceifolious	v	
Moraceae	Artocarpus tamaran	v	
Myristicaceae	Knema cinerea	v	
Olacaceae	Scorodocarpus borneensis		v
Sapotaceae	Payena microphylla	v	
Sonneratiaceae	Duabanga moluccana		v
Thymelaeaceae	Gonystylus macrophyllus		v

3.2.2.8. New Records and New Species Discovered

Identification of new species requires a long validity process through in-depth literature study and cross-checking. Therefore, some of the potential new species collected during the expedition are not discussed in the report. Indications of potentially new species were only based on the scientists' assumption.

A herbarium specimen labeled as Sidiyasa et al. 3548 has very interesting characters that differ from those of other plants, similar to a species collected by Ambriansyah (AA. 2512) in Gunung Beratus. Both species look like or are closely related to *Cassia fistula* (Leguminosae) (Ding Hou et al., 1996), by their similar fruit, although the formers' have more leaflets (14-22 pairs) in a single rachis if compared to 3-7 pairs in *Cassia fistula*. The formers' leaflets are also much smaller (up to 7.5 cm long) if compared to the latter's leaflets that are 7-12 cm long (Figure 25).

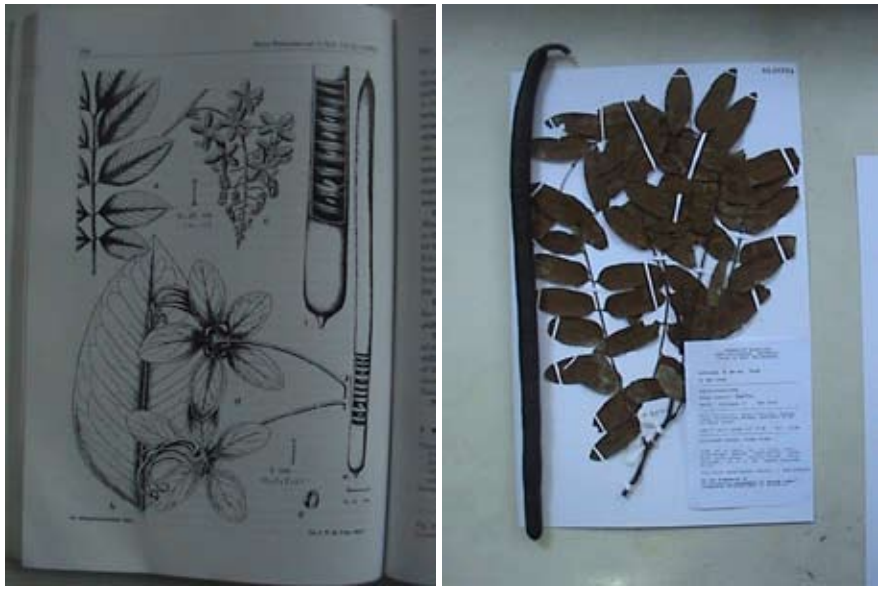

Figure 25. The species assumed new for science (left) compared with Cassia fistula (right) (Photo by Sidiyasa)

The team also discovered another tree species that is assumed to be a new species from the family Annonaceae. Unfortunately, the species could not be identified even to genus level. The specimen collected for this species was labelled as Sidiyasa et al. 3596. The species was characterized by its hard, big, rounded and whitish fruit, which looks very different from other members of the family Annonaceae (Figure 25). Another potentially new species was labelled Sidiyasa et al. 3522, which is most likely a *Calophyllum* (family Guttiferae), collected from the ridge at 375 m altitude, along the foot trail to Gunung Lumut. A character that distinguishes the specimen from other *Calophyllum* species is its narrowly ovoid fruit.

3.2.2.9. Fruits Eaten by Animals

At least 149 plant species (representing 69 genera and 32 families) collected during the expedition have fruit that are edible for wild animals. Most edible fruit tree species collected were members of the family Moraceae (18), followed by Annonaceae (14 species), Myrtaceae (10 species), Anacardiaceae (9 species), Sapindaceae and Euphorbiaceae (each 8 species). Most of the species collected were members of genus *Ficus* (11 species), followed by *Syzygium* (10 species), *Artocarpus* and *Diospyros* (each 7 species) and *Durio* (6 species) (see Appendix 12).

Figure 26. Unrecognized genus of Annonaceae, collected in Rantau Layung area (Photo by Arbainsyah)

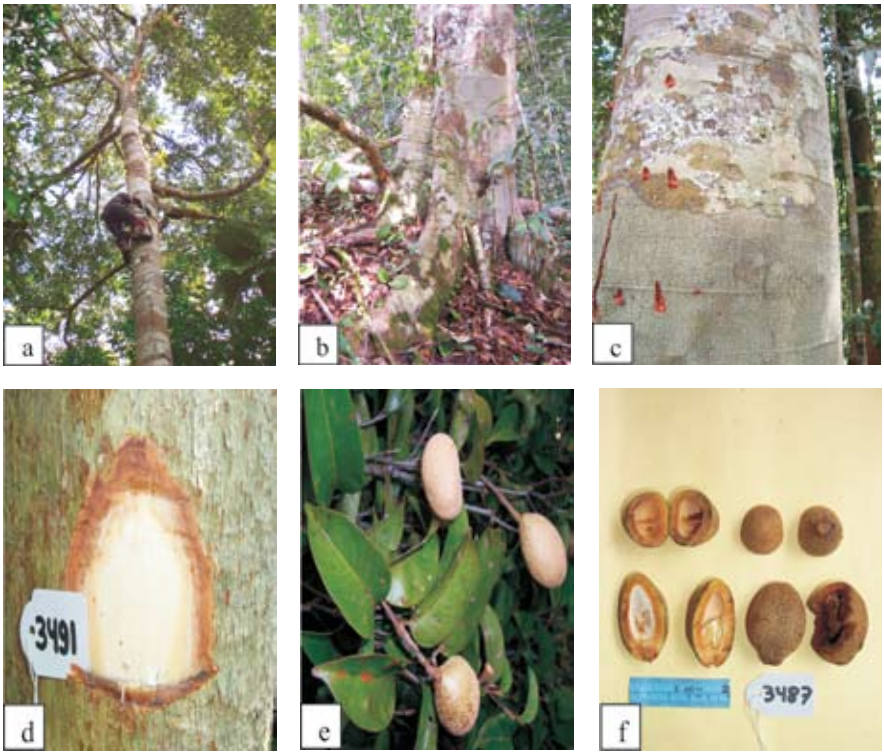

Figure 27. The characters of plant species that observed and collected in the field (Photo by Arbainsyah)

(Note: a. tree crown, b. buttresses (when present), c. tree bole and outer bark, d. slashed bark, e. fruits, f. laterally and horizontally cut fruit and seeds)

3.2.3. Understorey Species

The survey on understorey vegetation indicated a high plant diversity in Gunung Lumut Protection Forest shown by the discovery of some new species, records of new plant distribution and absence of rare species.

A total of 252 specimens from the forest understorey were collected during the expedition (Appendix 13). The study didn't include ferns, mosses, lichens, algae and fungi. Below is further explanation on plant species collected in each locality:

3.2.3.1. Forest around Mului Camp (400-600 m a.s.l.)

The area is situated between 400 and 600 m above sea level (a.s.l.). About 160 specimens were collected within 10 days of exploration, including trees, climbers, shrubs and herbs. Forest in this area is still quite good, with some places dominated by Dipterocarps. In this condition, the understorey vegetation is usually very poor, and only few herbs and shrubs were found. Most commonly found species in this layer were *Ixora cf. javanica*, *Lasianthus oculus-cati, Urophyllum* sp., *Saurauia* sp., and *Vitex vestita*.

Because herbs and shrubs usually need more humid condition, the data (and specimens) were collected along slopes around the riverside. Species of families Zingiberaceae, Begoniaceae, Gesneriaceae and Araceae were abundant in the area. More than 10 species of genus *Begonia* were found, and some of them are new to the science and need further study. The species of Gesneriaceae, such as *Cyrtandra* spp., and Zingiberaceae like *Costus speciosus*, *Etlingera* spp., have potential uses for ornamental as well as medicinal purposes. Only one species of genus Impatiens from the family Balsaminaceae was found.

The road side habitats were covered by secondary vegetation with pioneer species, some of which were identified as the common giant grass, *Sorghum propingiuun*, the *Melastoma malabahtricum* and *Piper aduncum*.

3.2.3.2. Forest around the Peak of Gunung Lumut (700-1200 m a.s.l.)

In this area of 700-1200 m altitude, about 28 plants have been collected within 2 days. The area near the foot trail to climb the Gunung Lumut along Sungai Mului, was covered by secondary vegetation. Some big trees along the roadside were identified as *Octomeles sumatrana*, *Duabanga moluccana, Antocephalus chinensis* and *Ficus* spp. Some open areas were dominated by *Melastoma malabathricum*. Some climbers species were also found, such as *Mucuna biplicata,* with trifoliate leaves and violet flowers, *Uncaria ferrea* with opposite leaves, tri-nerval venation and head-like inflorescences, and *Nepenthes albomarginata*, the pitcher plant. The species that were commonly found along the old tractor road were *Rubus moluccanus*, a species that usually cover the whole area with its spiny stems, white flower and red fruit, *Lea aculeate*, a medium shrub about 2-3 m tall which has spiny stem and compound leaves, and *Tetrastigma papilosum* that has many small papils along its stems.

The team also identified *Saurauia* sp., *Melastoma decemfidum*, and *Fagraea racemosa* were identified along the trail from the camp at 700 m a.s.l. to the top of the mountain (1,200 m a.s.l.), as well as herbs (*Labisia pumila, Globba pendula,* the *Begonia* spp., *Arisaema* cf. *filiformis, Sarcandra glabra*), some terrestrial orchids, and a few palm species such as *Pinanga* sp., and rattan as *Daemonorops* sp., *Calamus* spp.

The peak of Gunung Lumut is covered by humid mossy forest. Only one shrub of *Rhododendron* (sterile) was found as epiphyte. Other small plants that are commonly found in the area were *Medinella crassifolia, Sonerilla* sp., and *Schismatoglottis* sp. Interesting climbers were *Smilax laevis* and *Dischidia cf nummularifolia.*

3.2.3.3. Forest around Perayan River Camp, Rantau Layung (100-300 m a.s.l.)

Within 4 days of survey, about 62 plants were collected in this area. The forests were mostly in disturbed condition. Among the emerging trees there were a number of 50 m tall and 70 cm in diameter *Koompassia excelsa.* Other trees found were *Dillenia excelsa* with its yellow flowers and *Arenga undulatifolia* (family Arecaceae), which grows in many places, as well as members of families Burseraceae and Meliaceae. Among the climbers, the team identified *Alsomitra macrocarpa*, which has big fruits with thin skin and many winged seeds, *Mucuna biplicata* with its violet flowers and pods that have wings along margins, and a commonly found medium-sized *Uvaria* sp, that looks very attractive with its yellow flowers. Some rattans like *Calamus* spp. were also found in the area.

The team also found many families of understorey plants, such as Rubiaceae, Araceae, Zingiberaceae, Begoniaceae, Cyperaceae, and Gesneriaceae. The family Rubiaceae was represented by *Lasianthus* sp. and *Urophyllum* sp., , family Araceae by *Amorphophalus* sp. and *Homalomena confuse*, family Zingiberaceae by *Etlingera* sp., *Globba* sp., *Elettariopsis* sp. and *Alpinia* sp, family Begoniaceae by four species that usually grow at river banks, and a probably new species that grows on the rock and has peltate leaves, family Cyperaceae by *Mapania longiflora* that was abundant and locally common, as well as *Elatostoma* sp., *Curanga* sp., *Phrynium* sp., and *Donax cannaeformis* that are commonly found along the river banks, and family Gesneriaceae by *Cyrtandra* sp.

3.2.4. Mushrooms

The team found various mushroom species in the three forest locations around Mului, Gunung Lumut and Rantau Layung Camps, some of which were found in all three locations.

The highest number of mushroom species was found in Mului, followed by Gunung Lumut and Rantau Layung forests (Appendix 14). Mushrooms can be an indicator of forest condition. The team found more mushroom species in undisturbed habitat than in disturbed forests. Undisturbed habitat was indicated by the presence of many big-diameter Dipterocarp trees. Big trees are the main habitat for mushrooms; hence their lesser existence in disturbed forests.

The growth of mushrooms is also determined by several climatic factors, mainly temperature, humidity and rainfall, and their fruitbodies which can not be formed in unappropriate climate.

In Mului forest, 76 species of mushroom were found, of which 45 species were growing in the soil, 29 species in dead wood, 1 species in the root of a dead tree in soil and 1 species in plant debris. Most of the mushrooms growing in the soil were mycorrhizal, in which *Russula foetens* that usually grows in small groups was the most commonly found. Of the edible mushrooms, 18 species were growing in soil, 9 species in dead woods and 1 species in plant debris. Among the edible mushrooms, 2 species (*Auricularia auricula* and *Pleurotus ostreatus*) can be used for medicinal purposes. There were also 47 unedible species, of which 6 species were poisonous.

In Lumut forest, 55 species of mushrooms were found, of which 20 species were growing in the soil, 32 species in dead wood, 1 species in the root of a dead tree in soil, 1 species in plant debris and 1 species in the soil above a termite nest. Most of the mushrooms growing in soil were mycorrhizal, with *Laccaria laccata* the most frequently found one, growing in small groups. *Amauroderma* sp., which is associated to root of dead trees, was the most frequently found in the area, growing solitary or in small groups. Of the edible mushrooms 8 species were growing in soil, 7 species in dead woods and 1 species in plant debris. There were also 40 species of unedible mushrooms, of which 1 species was poisonous.

In Rantau Layung forest, 52 species of mushrooms were found: 15 species were growing in the soil, 32 species in dead wood, 2 species in living trees as parasites, 1 species in root of a dead tree in soil, 1 species in plant debris and 1 species in soil above a termite nest. Most of the mushrooms growing in the soil were mycorrhizal and occurred in about the same abundance. *Ganoderma applanatum,* growing in dead wood, was frequently found in small groups or solitary in logs, stumps or in dead standing trees. From the edible mushrooms 8 species were growing in the soil, 4 species in dead woods and 1 species in plant debris. The inedible mushrooms were 39 species, of which 2 species were parasitic on living plants and 1 species was associated with termite nests.

At the three locations, nearly all mushrooms growing in soil were mycorrhizal. Mului forest (44 species) recorded the highest number of mycorrhizal species, followed by Lumut forest (20 species) and Rantau Layung forest (14 species). In these three locations, *Russula* spp. was the most frequent species. *Polyporus* spp. that was commonly found on dead wood in Lumut and Rantau Layung forests.

The results indicated that the habitat condition of Mului forest (for mushrooms) was better than the other two locations. In Mului forest, there were still a lot of big Dipterocarps trees with over 50 cm diameter, while in Rantau Layung forest, such trees were very rare. This indicated that the condition of Rantau Layung forest was heavily disturbed. Mushroom fruitbodies cannot be formed on unsuitable host plant, and Dipterocarp trees are important because they are suitable host for many mycorrhizal fungi. But better forest condition in Gunung Lumut if compared to Mului does not necessarily mean that it is a better habitat for mushrooms, since the growth of mushrooms is also determined by weather conditions. In Gunung Lumut area the rainfall is higher, air temperature is lower and air humidity is higher than in the two other locations (Figure

18 and 19). If there is too much rainfall, is difficult for the fruitbodies of mushrooms to form and only their mycelia will grow. According to Pace (1998), the growth of fungal mycelium requires water. In contrast, the fruitbodies start forming when the conditions are unfavorable (in the scarcity of water supply as solvent for nutrients) for the growth of mycelium.

Jülich (1988) reported, that there are more than 60 species of mycorrhizal fungi in East Kalimantan (Bukit Soeharto, Wanariset in Samboja and International Timber Cooperation of Indonesia or ITCI in Kenangan), some of which have very narrow ecological requirements, and others with a wide host range and well-adapted to wet as well as dry habitats.

Mushrooms were found distributed in various types of habitat. Some of them are distributed from the foot of the mountain and still found on the top, like *Amauroderma* sp., *Cantharellus cibarius*, *Ganoderma* spp., *Laccaria laccata* and *Russula cyanoxantha*, indicating that they are well-adapted to a variety of substrats, symbionts and climatic factors. Some species can only adapt to specific habitats such as in soil under trees with big diameter, and some are even host-specific such as *Ganoderma carnosum,* that was found only on dead wood of *Octomeles sumatrana*. Most of the dead woods could not be identified, because they had no leaf, bark, resin or other identification marks.

There are some edible mushrooms which are cultivated on a large scale, such as *Auricularia auricula* and *Pleurotus ostreatus*, while others are used incidentally by people when they find them in the forest.

The team collected some poisonous mushrooms such as *Amanita gemmata*, *A. virosa*, *Lactarius helvus*, *Phylloporus pelletieri*, *Russula luteotacta* and *Russula mairei*, and also some non-toxic but inedible species (due to their tough, woody or non tasty fruitbodies), that are only consumed by insects, beetles, ants, snails etc. According to Bigelow (1979), Pace (1998), *Amanita virosa* is also called "destroying angel" or "death angel" because it can cause death when swallowed. Some species can also be used for medicinal purposes, such as *Auricularia auricula* and *Pleurotus ostreatus*.

According to Suriawiria (1993), poisonous mushrooms are usually characterized by the following physical appearances although there are also non-poisonous mushrooms that have such characteristics:

a. Distinctive or eye-catching colours such as blood-red, dark black, dark blue or other colors.
b. Unpleasant smel, such as like rotten egg or ammonia.
c. Presence of ring (annulus) and or cup (volva).
d. Grow in the dirty places such as in rubbish, animal dung, but in cultivating some compost mushrooms are often used animal dung.
e. When contact with metal (steel or silver), the metal will turn to blue or black colours.
f. The colour can change rapidly from white to dark colour when cooked or heated.
g. When they are cooked with rice, they will change the rice colour into dark colour.

The descriptions of each mushroom are presented alphabetically in Appendix 15.

3.3. Socio-Economy

3.3.1. Research Site

3.3.1.1. Location

The socio-economic study was conducted in two settlements around and within the protection forests in Rantau Layung village and Mului sub-village (Swan Slutung village).

Rantau Layung village is surrounded by forest, fallow and upland rice fields with a steep topography, and is administratively managed under the Batu Sopang sub District, in the Paser District. The village covers a total area of 18,913 ha or 17% of the total sub district area (Batu Sopang Sub District in Figures, 2004). The village is located about 150 km or four hour-ground transportation from Tanah Grogot (Capital of Paser District) by double traction (4 WD) vehicle or six hours from Balikpapan City.

The main transportation infrastructure in Rantau Layung is water and a dirt road. From Rantau Layung to Batu Kajang, the capital city of Batu Sopang sub District, villagers should take six hours by motorboat through the Kesunge River. Besides for transportation medium, the rivers are also important supplies for drinking water, bathing and washing. The dirt road was built in 2003 with support from a small scale logging company (PT. Telaga Mas). The road (which is actually a logging road) is the only ground access from Rantau Layung to the main road, and is frequently used by villagers as access for trading activities, such as selling their products such as fruit, rattan and honey, and buying household tools, as well as for finding medical treatment.

Mului is part of the Swan Slutung village and is administatively managed under the Muara Komam Sub District, in the Paser District. Mului people live inside the Gunung Lumut Protection Forest, separated from the other villagers. The settlement can be reached in six hours by car from Balikpapan city. The Swan Slutung village covers a total area of 12,636 ha (Anonimous, 2002) and it takes about half an hour by motorbike from Mului settlement.

There is a logging road that lies towards the Northern part of Gunung Lumut that connects Mului to the nearest town in Simpang Lombok. In the period of 1999 – 2000, Social District Services of Paser had built 50 stilt houses made of wood blocks, planks and zinc on the left and right side of the road.

Home gardens with fruit and rattan plantations can bee seen around the village and surroundings. Mului is mostly surrounded by forests and agriculture fields including fallows in the Southern part. Mului and Lelam rivers flow about two kilometers away from the settlement and are the main supply for drinking water.

Figure 28. Mului hamlet in Gunung Lumut Protection Forest (Photo by Basuki)

Figure 29. Logging road across Mului hamlet (Photo by Basuki)

3.3.1.2. Settlement History

a. Rantau Layung

Rantau Layung people originally lived in Long Sai, which is located at the upperstream area of Sungai Perayan in the early 1800s (Table 12). After living in the area for more than a century, the Dutch Colonial Authority conducted a resettlement program in the 1940s and pushed them to move from Long Sai to another settlement in Old Rantau Layung village, which was a bit further downstream from the current location.

A few years after the country's independence, there was some chaos in various regions around the country, including in Paser District. In 1957, the situation was worsened by a separatist movement by local people in the old Rantau Layung village (see also CIFOR, 2001). The rebellion drove people's exodus to Temborong area nearby Batu Kajang. The situation was back to normal after several years, and in 1969, people abandoned Temborong and moved to a new settlement in Rantau Layung which is not so far from the old village.

b. Mului

Mului people originally lived in Utok Mului at the highlands of Sungai Kuaro and Mului, before moving to Lenong Lomu in Gunung Berani area (Table 13). The ancestors of the Mului used to live separately one of the other, and each household lived close to their agricultural field. The villagers often moved to a new place to find a better agricultural land and forest products. They kept moving around this area until Indonesia' independence when they moved again to the downstream area of Sungai Kuaro.

Table 12. History of Settlement of Rantau Layung People

Place	Location	Year abandoned	Reason to move from the place
Long Sai	Mouth of Perayan River	1940s	Resettlement program conducted by Dutch Colonial Government
Old Rantau Layung	Kesunge River	1957	chaos; rebellion
Batu Kajang	Temborong (mouth of Kesunge River)	1969	back to the previous village as the situation was under control
Rantau Layung	Kesunge River	Until today	

Table 13. History of Settlement of Mului People

Place	Location	Year of moving	Reason to move from the place
Utok Mului	Upper area of Kuaro and Mului River	Before 1900	Suggested by old people
Lenong Lomu, Gunung Berani	Mount Penempa (later known as Trans HTI location)	1900-1945	Suggested by old people
Swan Slutung	Mouth of Slutung River in Kuaro River	About 1945	To find land for agriculture
Tanjung Teleng	Near the upperstream of Mului River in Kuaro River	1971	For road facilities; to protect Gn. Lumut area (old village); to find area for rice field
Lolo Pangan	Mouth of Serari River	1993	To join HTI project; to make rice field on Gn. Janas; for road facilities
Gunung Janas	Mount Janas	1999	In response to suggestion from the Governor and Bupati; Social District Service built houses and other village facilities. They moved to current settlement in Tanah Rian, Lelam River.
Mului Hamlet	Tanah Rian		

They joined with Swan Slutung people and lived in the area for a long time and conducted agriculture, horticulture and rattan garden. Many fruit trees were planted, which according to Mului people, can still be found in their old village. In 1945 they moved together to Tanjung Teleng where they found better agricultural land.

Following a conflict between Mului people and Slutung people and the development of a logging road by a logging company, Mului people moved to Lolo Pangan, which is located at the riverbank of Serari River, nearby the current Mului settlement.

Only a few people stayed in Lolo Pangan due to severe water scarcity (because the village is located far from rivers or springs). In 1993, most people moved from Lolo Pangan to two different places. Some of them joined the Indonesian transmigration project to live in Swan Slutung area where they then started to develop industrial forest plantations (or *HTI = Hutan Tanaman Industri*). The others moved to Gunung Janas area to find new agricultural fields and better road facilities.

In 1999, Paser District government initiated reconciliation between Mului people in Swan Slutung and Gunung Janas since it would be easier for the local government to manage the people if they lived in one area. Soon after the Social District Service of Paser built houses and other facilities, the Mului people decided to move to the current Mului village.

3.3.1.3. Socio-culture

a. Rantau Layung

There are 50 households or 217 people living in Rantau Layung, with a population density of ± 1 people/km^2 (Daftar Isian Potensi Desa, 2005), and in the last five years (2000 to 2004), the population increased by an average of 2.34% annually (Batu Sopang Sub district in Figures, 2004). The area is dominated by Paser ethnic who are mostly indigenous people. It is reported that there are six Rantau Layung people who have been married to people from other ethnicities, i.e. Banjar and Kapuas.

Public facilities in the village are a *masjid* (Islamic praying building) and an elementary school. There are 30 villagers who have completed their elementary school (SD), 10 villagers have completed secondary school (SMP) and 3 people have accomplished high school (SMU). The others have not finished elementary school and some of them never went to school at all. There is no *Puskesmas* (Centre for Public Health) available in the settlement. Local people still depend on their customary leaders for medical treatment when they are sick.

Figure 30. Customary Leader of Rantau Layung during Ritual of Belian (Photo by Padmanaba)

Most Paser people in Rantau Layung are still cult prayers they inherited from their ancestors. Although some have turned to be Moslem in 1970s, cult practices are still widely used. A customary leader (*kepala adat*) plays an important role in maintaining cultural harmony, and some traditional rituals are still practiced, such as *belian* for a newly born baby (Figure 30), and for healing sick people.

Besides Indonesian modern law, local people still apply customary law in their community livelihood. In managing natural resources, customary law is used to classify forest (*alas*) into categories according to its function i.e. *Alas Tuo, Alas Adat, Alas Nareng and Alas Mori.* Definitions of these forest categories are explained later in the report, in a discussion on landscape.

b. Mului

There are 121 people from 18 households in Mului, which is almost one sixth of the total population in Swan Slutung Village (Anonymous, 2002). Most of them are Paser Mului ethnic group and only a few are non Paser ethnic who are married to local people. The team found many un-married 40 year old people among the younger generation, which is uncommon phenomenon in the District. The population is dominated by children and young people, and old people are usually highly respected persons, such as customary leaders and village head.

Figure 31. Wooden bike is an alternative transport used by Mului people (Photo by Basuki)

Parents just started to send their children to school less than two years ago, because previously, there were no formal schools in the area. Most of the older people never went to school except the outsiders who are married to local people. Currently, there are two primary school teachers who were hired by the local government and stay with local people.

Mului people interact with outsiders through the logging road using motorbikes or sometimes public cars. People sometimes also use the logging trucks to go to and return from the nearest town e.g. Simpang Lombok. People go to Swan Slutung or Simpang Lombok at least once a month for grinding paddy, shopping etc. Rivers in the area have many rapids and big stones, hence are not the main transportation infrastructures. People used to travel by boat when they lived at the downstream area, but there is no more boat available in Mului at this moment.

Mului people enthusiatically welcomed Tropenbos International and other researchers, and they, especially the young and old men, actively contributed to the research, through assisting the research work in both the forests and village. So far, they have interacted with many outsiders e.g. employees of HTI (*Hutan Tanaman Industri* = industrial forest plantation), the logging company, social and forestry district services, NGOs and researchers. They hope to be able to improve their livelihood by cooperating with outsiders.

Figure 32. Rite ceremony in Mului after some villagers survive from an accident (Photo by Basuki)

Supervised by some NGOs, the local people used their experience to develop and document their village customs and rules. This document will later be used as a guideline for natural resources management in the area, for example, local people and outsiders are not allowed to cut and sell timber from the forest.

People in Mului, including the outsiders, speak one common Paser language. Only some of the younger generation speak Bahasa Indonesia that they learnt from their teachers and NGOs.

Mului people are all Moslem but traditional rituals are still widely practiced, for healing sick people, delivering babies, agricultural activities, cutting big trees and collecting honey. *Belian* is the biggest ritual ceremony, which is most frequently applied in any customary occasions and characterized by very long magical spells. *Timbu* and *babas* are only conducted for healing purposes. *Besoyong* is also conducted in various customary occasions but characterized by short magical spells. Recently, there are only a few younger generation that practice these rituals.

The customary law in Mului does not allow people to cut down timber and honey trees (*Koompassia excelsa Becc. Taub*) from forests in Gunung Lumut and Pulau Ulin (iron wood area). Only Mului people can harvest forest products from Mului forest, and it should be based on the community agreement. Tanah Mori and Tukok Sipumori are strictly forbidden for timber harvest but is still allowed for animal huntings. Outsiders are also not allowed to disturb Suong Bosa (gold mine area) and the old villages' graveyards.

Local people believe if customary laws are violated, it will result in negative consequence to the lawbreakers, and hence they should be punished, e.g. by paying a penalty of money or goods.

3.3.1.4. People and Livelihoods

a. Rantau Layung

Most villagers cultivate upland rice fields using shifting cultivation systems. They also live by hunting, fishing and collecting non timber forest products (NTFP), such as rattan, fruits, vegetables and honey and usually sell them to Batu Kajang town. Among the NTFP products, fruit and rattan are the main income source in Rantau Layung. Rattans can be easily found along Kesunge River.

Another important income source is small-scale logging timber. During 1995 to June 2005, most were still cutting trees in the surrounding forest and sometimes even inside the Gunung Lumut Protection Forest. Currently, about 20 people in Rantau Layung own a chainsaw. The villagers usually did logging in groups, which consisted of 4 to 5 people, although some did it alone. Each group could produce 8 to 12 cubic meter a month and dragged them to the river. People mainly cut meranti (*Shorea* spp.) and kapur (*Dryobalanops* spp.). Market prices vary between Rp. 300,000 and 400,000 per cubic meter of sawn timber; and Rp. 200,000 for round logs. However, since the Wana Lestari operation to combat illegal logging took place in this area in July 2005, small-scale timber extraction activities were halted. This ban caused a lot of frustration among

villagers, and some children in Rantau Layung could not continue with their formal education due to lack of money. Table 14 describes types of income generating activities and number of households involved in each activity, coverage area, distance from the village, the period when each activity was started.

Table 14. Activities of Rantau Layung Community in Forest Area

No.	Activities	No. of Households	Coverage area (ha)	Distance from the village (km)	Starting time	Remark
1.	Shifting cultivation	43	56	0.5 to 4	ancient time (1800s)	The cycle is 6 to 10 years
2.	Gathering NTFP	48	not applicable	2 to 15	ancient time (1800s)	-
3.	Hunting	14	not applicable	2 to 20	ancient time (1800s)	Since 1990's starting using spear, arrow, snare, dogs
4.	Timber production	17	not applicable	1 to 8	1987	Until 1995 it was only sold in the village, after that it was also sold outside

b. Mului

Most of the Mului people cultivate rice in a relatively small paddy field area that cannot provide sufficient yield to sustain their livelihood. Each household has approximately one hectare of paddy field and apply, at least, herbicide and weeding treatment (Table 15). People also plant vegetables and fruit trees as intercrop plants, which can potentially be developed into fruit garden or agro-forestry areas when the paddy field is abandoned.

Supervised by local government and some NGOs, each household in Mului has planted one hectare of mixed fruit trees in its house yard and three hectares of rattan plantation in a garden located a bit further from the settlement. The people go hunting at least once a month usually with snare and a few air-rifles. During hunting, they also collect young sprouts and mushrooms to be used as vegetables. Fish are also an important protein source for local people.

Selling fruit, animals, and honey are the main income sources for Mului people, but these resources can only be harvested seasonally. *Gaharu* (eagle wood) and gold mining were also main income sources, but both are becoming scarce recently. Only one family is recorded to own retail shop that sells basic commodities such as instant noodle, candies, soap, sugar, etc.

Table 15. Activities of Mului Community in Forest Areas

No.	Activities	Number of households	Coverage area (ha)	Distance from the village (walking hours)	Starting time	Remark
1.	Shifting cultivation	16	16	0.5	1999	Move each year, two years at most
2.	Home garden	21	4.2		1999	Fruit trees
3.	Rattan garden	21	50	0.5	2004	50 people
4.	Hunting	21	not applicable	6	Ancient time	Deer, barking deer and birds
5.	NTFP Gathering	21	not applicable	6	Ancient time	Fruits, Honey, Young leaves, etc.
6.	Timber harvest	21	not applicable	1	Ancient time	Not for sale

c. Seasonal Calendar

Communities in Rantau Layung and Mului distribute their activities throughout the year. The main activities are shifting cultivation, collection of non timber forest products, hunting, timber production, fishing, rattan harvesting and other activities (gold mining, rubber tapping). Shifting cultivation is time consuming and labour intensive. In Rantau Layung, the activities usually start in July and continue until January the next year. They rest for three months from February until April before they harvest in May and June. Other activities such as hunting, timber production, fishing and rattan harvesting are usually conducted throughout the year (Table 16).

In Mului, villagers spend most of their time in their paddy field. The villagers usually have a group meeting in May to define which field they should work on before they start cultivating and slashing the shrubs (Table 16). After cultivating and slashing, the next activities are cutting trees, burning, building huts and planting until November. After a long rest during December, people continue working on weeding and, finally, harvesting in March and April.

Other activities such as hunting, collecting NTFP, and gold mining are only conducted during their spare time between agricultural activities. During the fruit season (especially durian), most people go to the forest almost everyday to collect durian fruit. Gold mining is carried out only during the dry season (June to August) using inadequate traditional tools. Most men do hunting and gold mining activities, as well as working together with women in fishing and collecting fruit and honey.

Villagers' activities that potentially bring negative impacts on Gunung Lumut Protection Forest are shifting cultivation and hunting. Key informants explain that shifting cultivation system in Mului is carried out for 2 years in one field area, before moving to another field area. This means that every 2 years, people will clear the land by cutting the trees in either primary or secondary forest including those inside the Gunung Lumut Protection Forest. Hence, it needs to be taken into account and anticipated by the working group/board of the Gunung Lumut Protection Forest, in order to minimize potential negative impact to the forest.

Table 16. Seasonal Calendar of Rantau Layung Community Activities

Activities	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shifting cultivation:												
• slashing							xxx	xxx				
• tree cutting									xxx			
• burning										xxx		
• clearing/collect waste material											xxx	xxx
• crop planting/dibble with a pointed stick in order to sow seeds	xxx											
• weeding					xxx	xxx						
• harvesting												
Hunting	xxx	xxx	xxx	xxx	xx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Timber production	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Fruits gathering	xxx											
Honey gathering	xxx	xxx										
Fishing	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Rattan harvesting	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Other activities (gold mining, eaglewood gathering, rubber tapping)	xxx	xxx	xxx	xxx	xxx	xxx						

Mului people frequently go for hunting during the whole year (Table 17). They usually use snare and gum to catch animals, particularly mammals and birds. Since they live inside the protection forest, this activity will directly affect animal abundance and diversity. Conservation awareness needs to be built continuously in Mului, and people need to be involved in the management of hunting activities within the Gunung Lumut Protection Forest.

Table 17. Seasonal Calendar of Mului Community Activities

Activities	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shifting Cultivation:												
• selecting rice field					xxx							
• slashing					xxx	xxx	xxx					
• tree cutting								xxx				
• burning									xxx	xxx		
• building hut										xxx		
• rite on planting; a day before planting											xxx	
										xxx		
• crop planting/dibble with a pointed stick in order to sow seeds											xxx	
• weeding												
• harvesting	xxx	xxx										
			xxx	xxx								
Hunting	Xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Fruits gathering	Villagers only do this activity on the fruit seasons (no exact timing)											
Honey gathering; once in three years						xxx	xxx	xxx	xxx			
Gold mining						xxx	xxx	xxx				
Fishing	Xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx

3.3.1.5. Biodiversity and Distribution of Natural Resources

Participatory mapping of land-types and natural resources started during the first few days of the village assessment and continued throughout the research period. Before going to the field, a 1:50,000 scale base map was printed out from an already existing digital layer of rivers and village locations, provided by TBI Indonesia. Besides showing boundaries, topography and some other attributes, this map also describes biodiversity distribution in the two villages (the occurrence and number of encounters in each landscape). In many cases, discussion on village boundaries is sensitive to raise horizontal conflicts; hence it was not discussed during the activity.

After drawing the main river and its tributaries, several local key informants provided information on natural resources, such as important trees and animals, cultural sites, potential sites for ecotourism etc (Table 18).

a. Rantau Layung

In Rantau Layung, although most informants have good knowledge on key natural resources, only a few, including the customary leaders and hunters, could accurately identify resources that

are usually found and put them on the map. The main resources and special features drawn in the map (Figure 33) were: honey trees, eaglewood, cave, waterfall, salt spring, fallow, rattan garden, and old villages. Hunters are experts mainly in wildlife resources such as deer, sun bear, monkey, snake, birds and fish.

Table 18. List of Features Drawn on the Map by Local People in Rantau Layung and Mului

Land type/special feature		Resource	
Rt. Layung	Mului	Rt. Layung	Mului
Village	Village/Settlement	Honey trees	Big trees
Former village	Old village	Rattan garden	Agathis
Mountain	Mountain top	Iron wood	Iron wood
River/tributary	River	Sun bear	Sungkai/Peronema
Rice field	Rice field	Clouded leopard	Albizzia
Salt spring	Salt spring	Monkey/gibbon	Eaglewood
Spring	Water spring	Porcupine	Rattan
Cave	Cave (with bats)	Birds	Plant shoot
Water fall	Waterfall	Snake	Honey tree
Logging road	Small stream	Fish	Sun bear
	Old fallow	Deer, barking deer, mouse deer	Gold
	Wild games area		Mushroom
	Birds area		
	Garden		
	Road		
	Big stone		

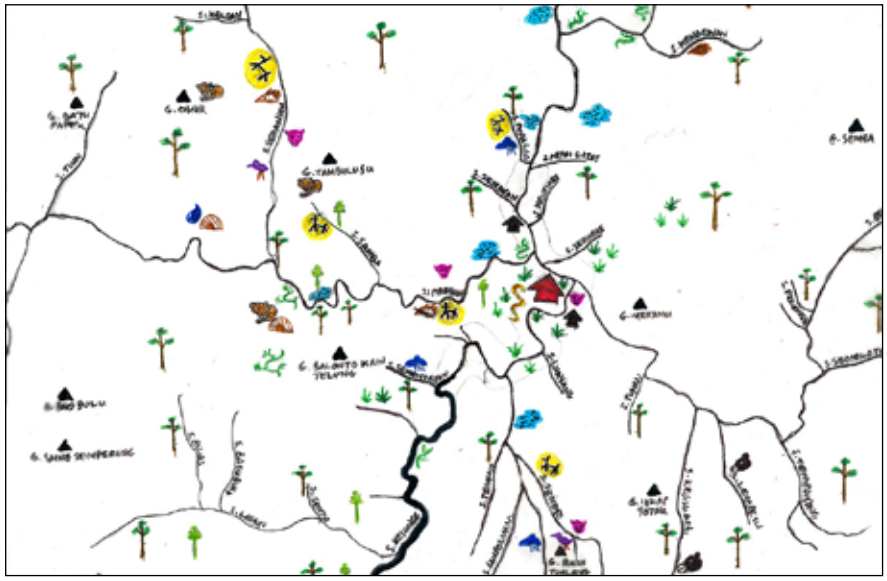

Figure 33. Part of biodiversity and natural resources map of Rantau Layung village

b. Mului

In Mului, people were familiar with maps and very helpful in showing information on their territory. Young informants were knowledgeable on hunting sites and natural resources. The old informants were helpful in contributing their knowledge on cultural and historical sites.

They started by providing names for the main tributaries of the Mului, Kuaro, Sempangen and Payang rivers (already included on the base map), and drew many additional tributaries as well as their names. Young informants were surprisingly knowledgeable about this; they obtained the knowledge from their parents and from their hunting experiences.

After most of the main river tributaries were added to the map, it stimulated other people to subsequently complete with other information, such as important trees (honey tree, *Agathis, Shorea*), hunted animals, birds, bear, mountains, lakes, agriculture fields, fruit garden etc, until the biodiversity map was completed.

Villagers also recognized some specific sites that may be the habitats for endangered species of wildlife e.g. sun bear, deer, and horn bills, as well as springs, mountains and riverbanks in Gunung Lumut Protection Forest that should be considered by the Authority as key biodiversity areas.

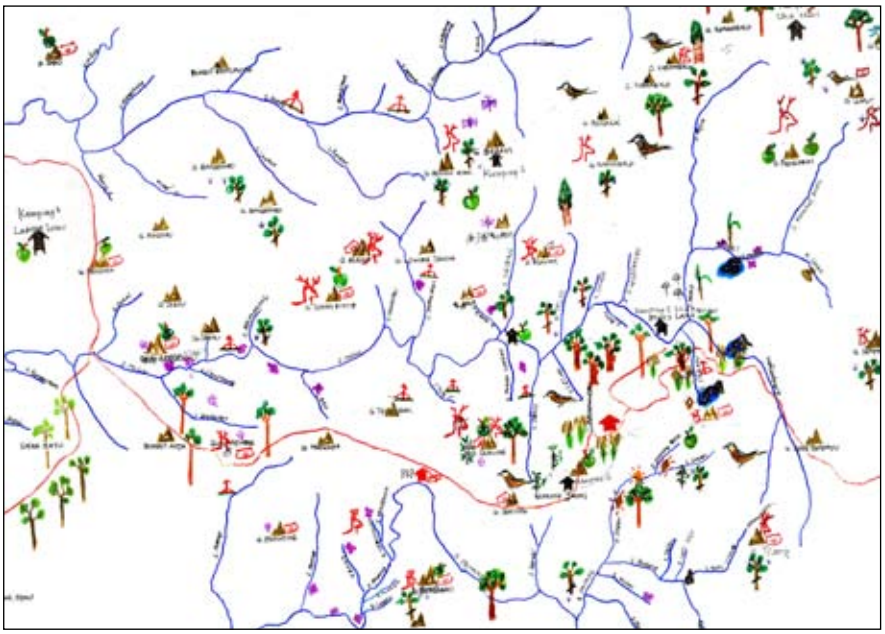

Figure 34. Part of the final Mului community resource and biodiversity drawing

3.3.2. Community Perceptions

3.3.2.1. Perceptions of Forest and Conservation

The respondents were asked directly about their view on forest protection and conservation. The questions were repeated carefully –at least twice– to make sure that they were clearly understood.

Respondents had choices: 'agree'; 'disagree'; and 'don't know'. The responses were scored as 'correct' if they confirmed conservation principles: i.e. 'agree' for confirming statement and 'disagree' for a contradictory statement. Score 1 was given to every 'correct' answer and score 0 was given to every 'don't know' or 'incorrect' answer. The total score was then divided by the maximum possible score and expressed as a percentage, representing our 'measure of agreement' (Figure 35). This term refers to the number of 'agreements' or 'disagreements', which were correct according to the common principles of conservation.

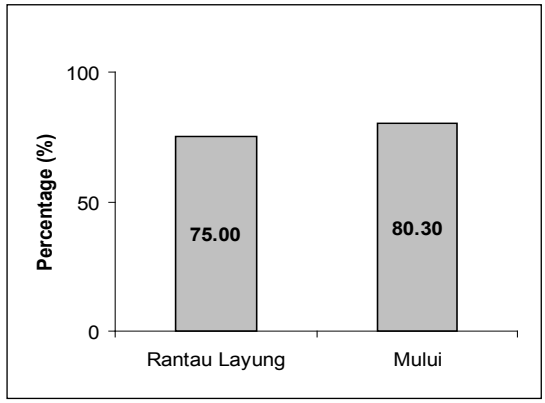

Figure 35. Measure of agreement showing local perception on forest and conservation

In general, the 'approval' of local community was high and the difference between two villages was relatively small (80.3% vs. 75%). People in Rantau Layung and Mului agreed that they are heavily dependent on forest that provides many resources for their daily livelihoods (see 3.3). Therefore, they were convinced that forest needs to be conserved.

All (100%) respondents in Mului and 67% respondents in Rantau Layung agreed with forest conservation, although it is also interesting to note that more than half, 63% in Mului and 53% in Rantau Layung, respondents did not think that their hunting activity will lead to animal extinction.

According to all respondents in both villages, investors such as logging and plantation companies have to highly consider local views on important plants and animals that may be impacted by their operation. As many as 82% respondents in Mului and 60% in Rantau Layung suggested

that most of the lands in Gunung Lumut Protection Forest are not suitable for permanent and commercial crops including oil palm. In addition, 81% respondents in Mului and only 47% respondents in Rantau Layung considered that logging and plantation companies are threats for the sustainability of Gunung Lumut Protection Forest.

3.3.2.2. Perception on Legal Status of the Gunung Lumut Protection Forest

Local knowledge and community perception on the legal status of Gunung Lumut Protection Forest were recorded from the same respondents representing households in Rantau Layung and Mului. In Rantau Layung, only four (27%) respondents knew about the decree that mentions Gunung Lumut as a protection forest and only two respondents (13%) knew about borders of the forest. Those who did not know either the decree or the borders were given the actual information concerning those issues and were asked for their opinion. Most of the respondents (87%) agreed with the decree but just three respondents (20%) agreed with the borders. Most respondents could not answer whether they agreed with the borders of the protection forest or not since they did not clearly know where the borders are. In Mului, four (36%) respondents knew about the decree and 9 respondents (82%) knew about borders of the forest. Seven (64%) respondents agreed with both the decree and the border.

By calculating positive responses in each research site and dividing them with the total positive answers of all questions, the relative level of knowledge and perception of the respondent on the legal status of the Gunung Lumut Protection Forest was obtained (Figure 36).

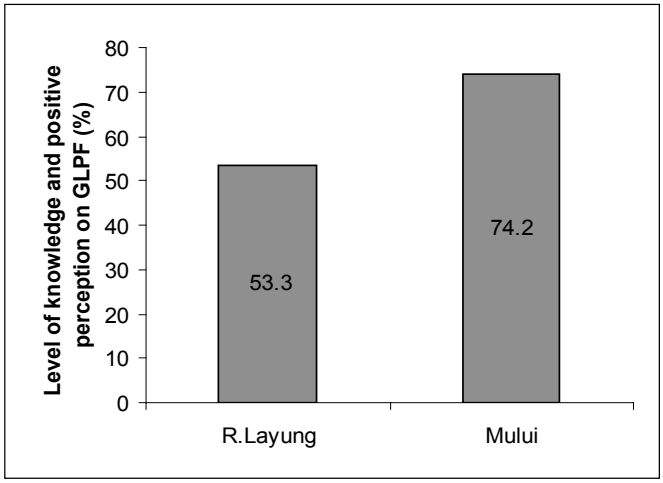

Figure 36. Level of knowledge and positive perception about the Gunung Lumut Protection Forest of the community at Rantau Layung and Mului villages

The community in Mului had better knowledge and more positive perception towards the legal status of Gunung Lumut Protection Forest, if compared with the community in Rantau Layung. This might be caused by the difference in level of dependency on nature resources and

of accessibility to external information. Mului people, who live inside the protection area, spend most of their time in the forest to collect forest products for their daily needs. With their higher dependency on natural resources, they have a better informal (customary) knowledge on forest protection.

In addition, there is a logging road connecting Mului to other places, so that Mului villagers have better opportunity to interact with outsiders and obtain knowledge on any issues concerning protection forest. In contrast, Rantau Layung village is connected to outsiders only by a poor road, hence has very limited access to external information.

Discussing the socialization of the extension of the legal status of Gunung Lumut Protection Forest by the relevant government institution, four respondents (27%) in Rantau Layung mentioned that they rarely obtained information, 11 respondents (73%) stated never and none of the respondent got information frequently. In Mului, five respondents (45%) stated that they got information rarely, six respondents (55%) answered never and none of the respondent obtained the information frequently. From the results, it can be concluded that the Rantau Layung community was much lesser exposed to external information than the Mului community. Involvement of both communities in the determination of the protection forest boundaries was also low. There were only three respondents (20%) in Rantau Layung and one respondent (9%) in Mului that were involved in the activity.

3.3.3. Natural Resources and Local Utilization

Since the Mului and Rantau Layung settlements are located inside and near the Gunung Lumut Protection Forest, communities in both villages have a high dependency on the surrounding forest resources, including timber and non timber forest products including animals. Forest uses can be direct (home consumption) and indirect (cash earning) which can be calculated using the market price approach at the community level.

3.3.3.1. Plant Resources

The types of plants used by the local community in Rantau Layung and Mului are classified into four groups: timber, non timber (rattan, *gaharu*, and bamboo), fruit and vegetables such as young sprout of bamboo, ferns, etc. Timber is important for some uses such as heavy construction including houses, light construction and fire wood. In Rantau Layung, timber is also used as the main income source, which was sold either inside or outside the village during the period of 1995 to mid 2005.

Non timber forest products, particularly rattan and bamboo are used for light construction, furniture and tools and also as a source of household income. Most of the forest fruits such as durian (*Durio zibethinus*), *cempedak* (*Artocarpus integer*) and *lei* (*Durio kutejensis*) are sold to the nearest market (Batu Sopang for Rantau Layung and Swan Slutung for Mului). Vegetables are only used for household consumption in both villages. The average value of the plants used by community in Rantau Layung and Mului can be seen in Table 19.

Table 19. Average Value of the Forest Flora used by Community in Rantau Layung and Mului

Community	Average value of flora used per household per year					Total (Rp.)
	Wood		Non wood (Rp.)	Fruits (Rp.)	Vegetables (Rp.)	
	Volume (m^3)	Value (Rp.)				
Rantau Layung (n=14)	8.3	1,888,214	411,786	2,621,714	216,861	5,138,536
Mului (n=11)	na	na	74,432	5,159,864	na	5,234,295

The community in Mului does not sell forest timber, but rather use them for maintaining their house that were built with support from the social district services in 1999 (see history of Mului), and a small volume for light construction such as huts in their fields. Therefore, Mului people do not have idea about the timber price. Communities in both settlement areas also consumed vegetables that they collect from the forest, but because they don't sell them, they have no idea on volume and price.

One of the most valuable non-timber forest products consumed by the communities in both villages is fruit. Mului people consume more forest fruit and recognize more plant species than people in Rantau Layung. This may be because Mului has better access to NTFP market than Rantau Layung.

Besides daily consumption, forest products are also used for other purposes, such as traditional medicine, tools, basketry, ornaments, ritual use, hunting place and hunting tools. A detailed description of these useful plants including species, category of use, habitat preference, parts being used and availability in the nature is important information for the conservation of plant species. The habitat of certain species is indicated by the specific place from where the species was collected by the community. Availability is influenced by the harvesting method used, and regeneration as well as growth rate of the species. Destructive fruit harvesting methods, such as branch and even tree cutting may destroy the species population.

List of useful plants, uses, preference sites, parts being used, and availability in nature from both Rantau Layung and Mului, is presented in Appendix 16 and 17. Appendix 16 shows that 104 identified plant species (out of total 126 species), which represents 44 families and 6 flora types, are widely used by the community in Rantau Layung. Members of the family Palmae are the most commonly used (20 species), followed by Moraceae (10 species) and Leguminosae (7 species). The plants are used mostly for food, medicine and construction including heavy, light and boat construction, either for subsistence uses or commercial (as source of income). Parts of the plants that are most frequently used are the stem, fruit and root, and there are many species that have two or more useful parts, such as *walor* or *Nauclea subdita* (the root, the bark, the leave and the sap).

The data indicates that populations of several species tend to decrease, e.g. *bekokal* (*Saraca declinata*), *gaharu* (*Aquilaria malaccensis*), *kapur/sintuk* (*Dryobalanops lanceolata*), *keramu* (*Dacryodes rostrata*), *keranji* (*Dialium spp.*), *perari* (*Neolitsea sp.*), and *suro/ulin* (*Eusideroxylon*

zwageri). The population decrease of *gaharu* and *keranji* is closely related to the local harvesting system. So far, a traditional way of collecting *gaharu*/eagle wood is by cutting down the stump whenever people find the tree since none of them knows exactly which tree contains the *gaharu*. *Keranji* fruit are small and abundant, therefore villagers usually cut the whole tree to make fruit gathering easier. However, the villagers are aware of the impact of such destructive harvesting methods and try to stop the practices, which will also be regulated in the customary law. The sanctions will range from sharing 1/2 of the yield to the community through the customary leader (for first time violation), sharing 2/3 to the community (for second time violation), to giving the whole harvest to the community through customary leader. There are many species of plants identified and used by Mului people. Most of them are edible and the others are used for medicine, construction, hunting tools, cash income etc. Many of them have more than one uses. The team recorded 511 plant species that have been used by local community for their daily livelihood, 162 specimens of which were also collected and identified. People collect those plants and animals mainly from the forest, a few from garden, agricultural field, rattan garden and bushes.

Most of the flora species used by Mului people were reported to be numerous.There were only some flora species in small quantity. *Botung* (bamboo), *jombu* and *luyan* trees, for example, were reported as decreasing recently but were predicted to increase again. Local people believed that the number of new domesticated flora species e.g. *we* (rattan) and *balo* (bamboo) will increase.

3.3.3.2. Animal Resources

Forest animals or their products utilized by the community in Rantau Layung and Mului villages can be distinguished into four categories, i.e. mammal, bird, fish and others (mainly honey as a product of bees). Species of mammals frequently utilized by most villagers are *payau* (*Cervus unicolor*), *kijang* (*Muntiacus muntjak*), *kancil* (*Tragulus napu*) and *trenggiling* (*Manis javanica*), while species of birds are *sakan* (*Lophura ignita*), *lembukon* (*Chalcophaps indica*), *merak/jue* (*Argusianus argus*) and lensio (*Rollulus rouloul*). River fish are caught by most villagers in Rantau Layung since the settlement area is very close to the river. Some species of mammals, birds and honey are used for daily household consumption and some others are sold to the nearest market as a source of household income. Most of fishes are only used for food and rarely sold. The average value of fauna used by community in Rantau Layung and Mului can be seen in Table 20.

Most people in Mului are good hunters and they catch more mammals and birds than Rantau Layung people. Each household uses 10 individual mammals and 30.5 birds in average per year or almost one mammal and 2.5 birds per month. Again, this can be understood as the Mului people are living inside the protection forest area so that they can easily obtain animal resources. However, they only collect approximately five liters of honey in a year, which is much lower than the amount collected by Rantau Layung people.

Table 20. Average Value of the Forest Fauna Used by Community in Rantau Layung and Mului

Community	Average value of fauna used per household per year								Total (xRp. 1000)
	mammal		bird		fish		honey		
	Volume (ind.)	Value (x Rp. 1000)	Volume (ind.)	Value (xRp. 1000)	Volume (kg)	Value (xRp. 1000)	Volume (L)	Value (xRp. 1000)	
Rantau Layung (n=14)	5.6	1,105.3	1.3	37.6	180.3	786.9	21.2	828	2,619.2
Mului (n=11)	10	573.8	30.5	943.5	141.5	367.9	0.45	22.7	1,902.4

Note: ind. = individu

Besides daily consumption, forest animals and their products are also used for other purposes, such as traditional medicine, tools, basketry, ornaments, ritual use, hunting place and hunting tools. The species information, including species name, uses, parts being used, capturing method, and availability in nature is very important baseline data for conserving the animal species. Animal habitat is usually correlated with animal habits and is indicated by a specific place where the animals are often caught by the community. The availability is influenced by method and number of harvesting and breeding rate of the species. Exploitation of forest animals may lead to the species extinction. A list of useful animals, uses, parts being used, prefered habitat, and dynamic of abundance for both Rantau Layung and Mului, is presented in Appendix 18 and 15, each for Rantau Layung and Mului.

Appendix 18 shows the dynamics of abundance of several animals in Rantau Layung that are predicted to decrease in the next few years. Some local people explained that fish population in Kasungai River has decreased if compared to 10 years ago and it is predicted to be decreasing even more in the future. This may be affected by the harvesting method used such as net and electric fish catcher, which catch not only mature or big-sized fish but also the juvenile ones.

Honey production was also reported to have decreased if compared to the production from 10 years ago and it is predicted to continue decreasing. Production of honey is related to the availability of flower bearing trees as sources of food for the honey bees, which have been greatly reduced by rampant logging activities, such as a small-scale concession (IUPHHK) around Rantau Layung village in the period of 2001 to 2003 and other logging activities by local people in Rantau Layung in the period of 1995 to 2005. Other animal species, which populations were reported to have also decreased are pelanuk/mouse deer (*Tragulus* sp.) and rusa/sambar deer (*Cervus unicolor*).

People in Mului identified 90 animal species which they used in their daily livelihood. The animal species were mostly birds and mammals although reptiles and fishes were also recorded. People eat most of them except reptiles and sell big mammals such as payau (*Cervus unicolor)* and birds e.g. Tiong (*Gracula religiosa*) (Appendix 19). Some animals are used as ornament e.g. munin/ *Arctictis binturong* and medicine e.g. biwang (*Helarctos malayanus*) and pawing (bats).

Mului villagers hunt mammals, birds and reptiles in the forest, specifically at salt springs, and shrubs near their settlement. Fish and mollusk are caught in Suong Bosa and Mului Rivers. Specific animal such as pawing/bats are collected in few caves of Mount Tekedey.

Mului people are known as good hunters and they live inside Gunung Lumut Protection Forest. The protection forest authority should socialize to the people about endangered and protected species, so that their hunting activities will be conducted in a way that may not destroy the sustainability of the species. A good example is the sun bear (*Helarctos malayanus*), which isclassified as an endangered animal (Saleh, 2003), but is also utilized by Mului people for their livelihood.

Total value of flora and fauna utilized by communities in Rantau Layung and Mului per household per year is presented in Figure 37

Figure 36 shows that Rantau Layung people who live around Gunung Lumut Protection Forest collect forest resources as much as 7.7 million rupiahs per household per year. This is higher, although not too significant, than in Mului (7.1 million rupiahs) where the people live inside the protection forest. In both settlements, flora is valued higher than fauna. These amounts (almost 2 million rupiahs per capita in Rantau Layung and 1.2 million rupiahs per capita in Mului) are considered as the value of forests' economic contribution to the local communities' livelihood. This economic figure has not included intangible benefits, such as clean water supply, fresh air, and other ecological functions. The authority of Gunung Lumut Protection Forest should consider these economic and ecological benefits in the development of the protection forest management strategy, since some of the losses may be irreversible. Categories of fauna used by community in Rantau Layung and Mului including number of useful fauna of each category are described in Table 21.

3.3.4. Importance of the Source of Products

a. Rantau Layung

A scoring exercise using Pebble Distribution Methods (PDM) among sources of products aims at comparing the importance of the wild, cultivated/farmed and bought products. Figure 37 show that in general, local communities in Rantau Layung rank plants as more important than animals. People also consider that products from wild resources are more important than those from cultivated, farmed and bought resource. Wild plants (score 32) are important as a source of food (vegetables, fruits) and provide valuable products as a source of income and other daily needs (basketry, construction, etc.).

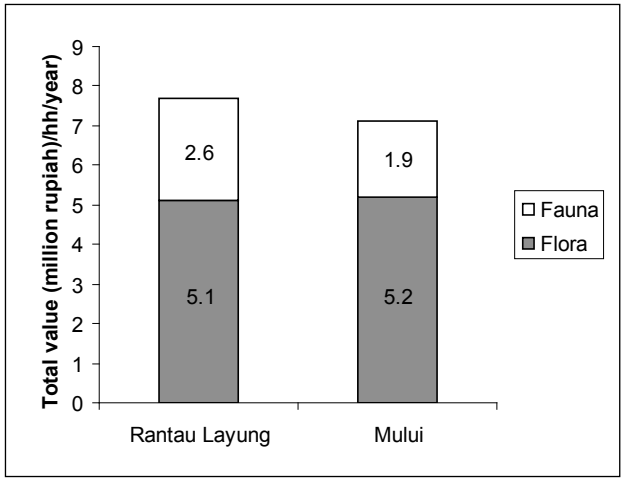

Figure 37. Total value of flora and fauna utilized by the communities in Rantau Layung and Mului per household per year

Table 21. Categories of Natural Resource Used by Community in Rantau Layung and Mului, including Number of Useful Flora and Fauna of Each Category

Category of uses	Rantau Layung		Mului	
	Number of flora	Number of fauna	Number of flora	Number of fauna
Food	44	14	133	59
Medicine	26	5	37	14
Light construction	16	-	23	-
Heavy construction	22	-	14	-
Boat construction	9	-	5	-
Firewood	4	-	26	-
Basketry	7	-	15	-
Ornament/Ritual	5	7	37	21
Hunting place	8	-	14	-
Hunting tools	4	-	23	-
Tools	12	3	18	2
Source of income	27	14	29	25
Future	n.a.	n.a.	10	n.a.

Note: n.a. = not available

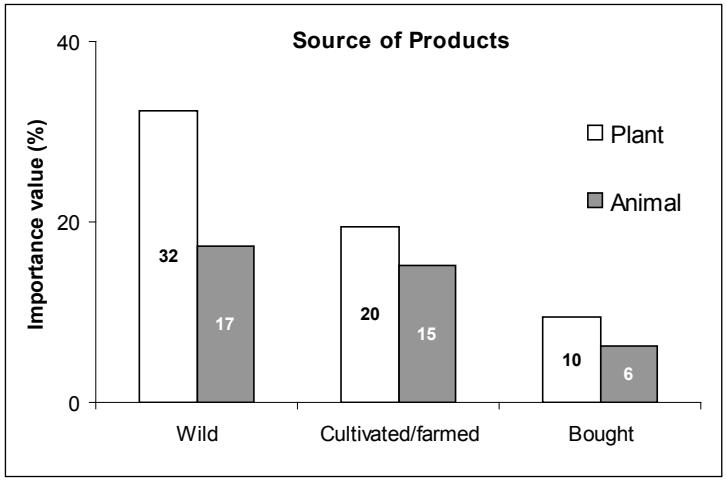

Figure 38. Product sources importance (mean value) for plant and animal by all groups in Rantau Layung village

The second most important category is cultivated/farmed products especially rice as the main source of food and rattan as the major source of income. Bought resources are considered less important since people prefer to fulfill their need with resources they collect from nature or those they cultivate.

b. Mului

People in Mului perceive forest plants as the most important source of food and they are usually more abundant and cheaper than the cultivated crops (Figure 39).

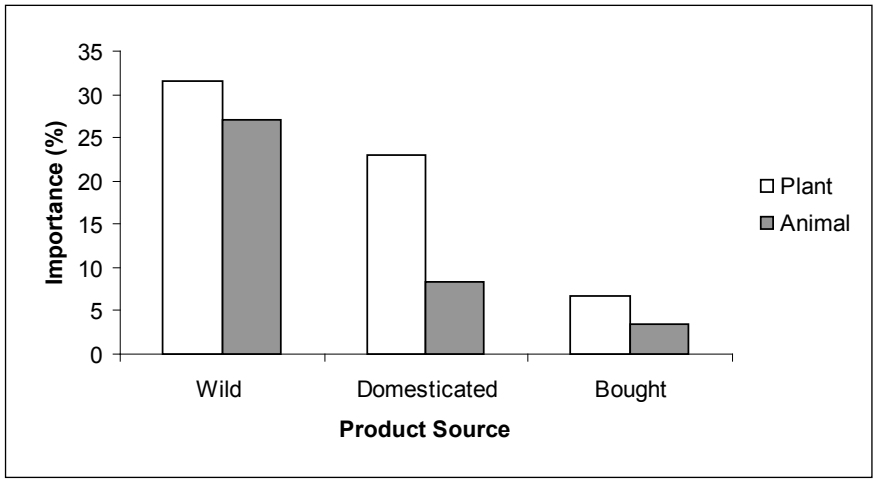

Figure 39. Product sources importance (mean value) for plant and animal by all groups in Mului

3.3.5. Household Income and Expenditure Pattern

Data on household income should be calculated from both major and minor income sources. But income-based approach is usually less accurate since respondents often underestimate their income. Another approach that can be used is household expenditure-based approach. Household expenditures are classified into three groups, i.e. food, non-food and production. Income figure can be estimated by adding household expenditure with saving. Average household expenditures and savings at Rantau Layung and Mului are described in Table 22.

Table 22. Household Expenditures, Savings and an Estimated Income (Mean Value) per Year

Community	Expenditures (Rp./year)			Saving (Rp./year)	Estimated income (Rp./year)
	food	non-food	production means		
Rantau Layung (n=14)	6,040,854	5,248,185	289,538	273,846	11,852,423
Mului (n=11)	3,715,164	2,487,295	34,091	472,727	6,709,277

In general, household expenditures in Rantau Layung village are significantly higher than in Mului sub-village. However, households in Mului save much more money than households in Rantau Layung. This indicates that households in Rantau Layung are more consumptive than in Mului. In both communities, food is the highest expenditure and production means is the lowest expenditure. Even in Mului, expenditure for production means is less than for savings. It explains that the shifting cultivation system carried out in these two areas use very low input. Farmers never buy, for example, good quality seeds or seedlings, fertilizer and/or pesticide except a small volume of herbicide, since they still heavily rely on soil fertility to sustain their agricultural crops.

Both communities have similar level of expenditures for both food and non-food. People spend slightly less money on non-food than on food. This indicates that they have considered and allocated a proportional amount of money to buy non-food items, such as clothes, medicines, tolls, etc.

In addition, the two communities mostly generate their cash income from selling forest products, mainly non timber forest products. In Rantau Layung, community's estimated cash income is much higher than the value of total forest product collected, while in Mului it is slightly lower (Figure 40). Although the total value of forest product gathered by the communities comprises of direct (the material used directly) and indirect use (the material sold for cash income), this figure shows that community in Rantau Layung have other important sources of income such as rattan, rubber and timber.

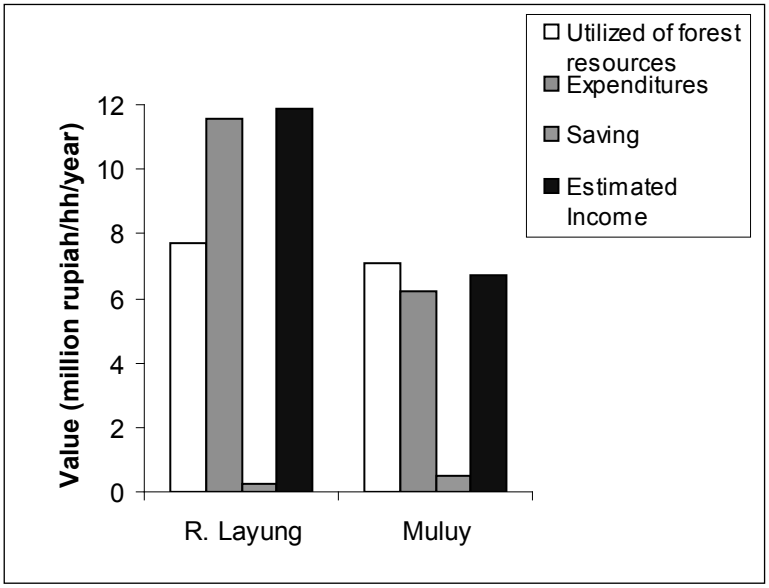

Figure 40. Comparison between values of forest product utilized and cash income of communities in Rantau Layung and Mului

Table 22 shows that the estimated community income in Rantau Layung and Mului are 11.85 and 6.71 million rupiahs per household per year, respectively. Each household in Rantau Layung and Mului consists of approximately four and six people so that it is assumed that the average income per capita of Rantau Layung people is 2.96 million rupiahs and 1.12 million rupiahs for Mului people. The income per capita is lower than GDRP (Gross Domestic Regional Product) per capita of Paser District 2004 based on a constant price, which is Rp. 4.5 million (Paser Regency in Figures, 2004).

Community income in both Rantau Layung and Mului can be increased through value improvement of various non timber forest products (NTFP) such as fruit, rattan and honey. The value improvement can be done through the application of post harvesting technologies, by which the NTFP raw materials are processed into half products or finished products. Rattan can be made and sold as mats while honey should be sold in a desired package. Durian and *lei*, for example should be processed to become *lempo* and sold in a nice package. This improvement requires training local communities in order to improve their skills. Sardjono, et al (2005) also suggest to improve the NTFP gathering method and to develop the post harvesting technology.

Although many villagers are interested in oil palm plantation, this commodity is not suitable in these areas because they are mountaineous, steep, and are for forestry commodities.

3.3.6. Landscape

There are several types of landscape in Rantau Layung and Mului where communities conduct their daily activities and collect products as sources of revenue. The identified landscape in Rantau Layung and Mului including their characteristics, management and utilization as well as existing constraints are described in Table 23 and Table 24.

Seven types of landscape are identified by the Rantau Layung community. Cultivation is carried out in rice fields *(ladang)* and gardens *(kebon)* by planting seeds or seedlings with limited input and technology. Fruit gardens *(sipung bua)* are traditionally planted by throwing fruit seeds around the field when the *ladang* is still cultivated. Fallow (lati) is abandoned rice field, invaded by abundant pioneer plants that can be used as fire wood. In Rantau Layung, forest (*Alas*) is classified into four sub types of landscape, i.e. *Alas Tuo, Alas Adat, Alas Nareng and Alas Mori. Alas tuo* is a forest for which usage is not yet arranged by customary law, and is usually located far from the settlement with a steep topography. *Alas Adat* (customary forest) is a forest area for which usage has been arranged according to customary law, it is located far from the village with a steep topography and it can not be exploited neither converted to rice fields (*ladang*). *Alas nareng* is a forest reserved for *ladang* area, located close to the village with gentle slope. *Alas mori* is a forest that is believed to be a dangerous place or haunted area, hence can not be utilized.

Trees in customary forest can only be cut for subsistence or self-usage. When people cut the tree for income sources (sell the wood), the logger has to contribute to the community through the customary leader by paying tax: Rp. 25,000,- per cubic meter for meranti (*Shorea* spp.) and kapur (*Dryobalanops* spp.); Rp. 50,000,- for iron wood (*Eusideroxylon zwageri*) and Rp. 15,000,- for other species. But this customary regulation is no longer implemented since the timber production activity has stopped.

Mului area is surrounded by hills and mountain slopes. People use their land for agriculture, horticulture and small scale mining activities. There is almost no flat area available for these activities, therefore rice fields, rattan and coffee gardens are all developed on the slopes.

People in Mului recognize eight land types from where they collect various resources for their daily livelihood (Table 24). These resources are important for fourteen categories of uses. Mului people spend time mostly in their agricultural field but most resources are taken from forests. They believe that surrounding forests are theirs and highly important to support their livelihoods.

People divide forest (Alas) landscape into old and young. Old forest means an area dominated by big trees of which the condition is still relatively intact while young forest means a re-grown area consisting of naturally regenerated trees. Suong Bosa is a site along a river where people used to gather gold and fish. Village is defined as the settlement where people live, including gardens surrounding their houses. Rice field is a land type where people cultivate paddy mixed with corn, cassava, vegetables and fruits. Fallow is abandoned rice field and usually full of small trees and bushes.

All landscapes in Mului are mainly characterized by a steep topography; only a few parts of the settlement including garden and coffee garden are flat or have a gentle slope. People believe that the total area of all landscapes they develop will increase as a result of population growth. Both old and young forest will also increase naturally with time. It means that young forest will grow and become the old forest and there will be more logged land that will become young forest.

Table 23. Identified Land Types in Rantau Layung, Characteristics, Management and Utilization as well as Constraints

No	Land type	Landscape characteristics		Management and utilization	Constraints
		Topography	Main vegetation		
1	Umo/ladang (rice field)	flat, gently slope, steep	paddy, maize, rubber, oil palm	shifting cultivation, no tillage, no technology, use of herbicide, self seedlings	pig attack, monkey
2	Strat (Kampong/ Village)	flat, undulating	fruit trees, coconut	settlement, village maintenance by means of gotong royong, managed by Village's Head and Adat's Head, structured organization	very limited transportation facilities to outside of settlement
3	Kebon (Garden)	flat to steep, undulating	rubber, rattan, coffee, coconut	no tillage, directly planted from the seed and/or natural seedlings, and for few cases nursery seedlings, herbicide application	drop of coffee price, marketing products from garden is difficult (very limited transport facilities), pig attack and rats, no skill in sap tapping
4	Lati (fallow)	flat to gently slope	Trees of Peronema, Vitex, Arthocarpus, and bamboo	abandoned, shifting cultivation area (fallow), will be back after 10 years	none
5	Alas (forest)	slope to steep and undulating	Mixed of dipterocarps trees	the forest product can be gathered with permission and deliberation to customary leader, subsistence-wise, by selective cutting, and contributing to the village	the government prohibit to cut the trees; the regulation is not properly applied
6	Sunge (River)	gently slope to steep	Ferns, trees of Ficus, Litsea, and Kleinhovia	used for bathing, washing, toilet and drinking water, place to gather fish and transportation facility, keep the function as it is	the water become turbid after rain
7	Sipung bua (fruits garden)	flat to steep	fruit trees and rattan	former village or cultivation, private owner, traditionally planting, the fruits are free for the village community	none

Table 24. Identified Land Types in Mului, Characteristics, Management, Utilization and Constraints

No	Landscape	Characteristics	Management	Constraints
1	Kampong (Village)	Vegetation: banana, rambutan, coconut, durian, jack fruit; Topography: Gentle.	Weeding for home garden	-
2	Umo (Rice field)	Vegetation: paddy, banana, cassava, sugarcane, corn, vegetables, durian, lai, tudak; Topography: steep	Weeding	Scarcity of plain area and many disturbances from pest (pigs, monkeys, rats)
3	Lati burok (Young Fallow)	Vegetation: Trees, Shrubs; Topography: steep	-	-
4	Lati tuo (Old Fallow)	Vegetation: Trees, Shrubs; Topography: steep	-	-
5	Kebon (Garden)	Vegetation: Rattan, Coffee, rambutan, durian, other fruit trees; Topography: Flat – steep	Weeding	-
6	Suong Bosa (River/ gold mine)	Vegetation: Trees Topography: steep	-	-
7	Alas Burok (young forest)	Vegetation: Shorea, Peronema Topography: steep	-	-
8	Alas Tuo (Old Forest)	Vegetation: Shorea, iron wood ; Topography: steep	Checking for the forests condition and violation	-

Figure 41. Mului people working together in a rice field on slope (Photo by Basuki)

3.3.6.1. Landscape Dynamic

Knowledge about landscape dynamics is important to predict the trends in landscapes in the future. Change of landscape in Rantau Layung, in terms of area and distance, is described in three periods: at present (2005), 10 years ago (1995) and projected landscape within 10 years from now (2015). In Mului, landscapes have changed as a result of several activities such as shifting cultivation and small scale gold mining at Suong Bosa River. A similar description was also made for Mului, but using different timeline: at present (2005), 6 years ago (1999) and 10 years from now (2015). Different timeline was used because people in Mului explained that significant landscape changes in the area have just started since six years ago (1999), when Mului people moved from Mount Janas area to the current settlement.

The description of changes in landscape and land tenure in Rantau Layung and Mului are summarized in Table 25 and 26.

In Rantau Layung, the total area of the village, rice fields, gardens, fallows, fruit gardens have been increasing with the increase of population density in the village. In contrast, *alas* (forest) area tends to decrease due to its conversion into rice fields and gardens. The conversions have broadened the distance from the village to the forest, which will affect the villagers' capacity to collect forest products, and consequently will decrease the volume of forest products that can be collected.

Table 26 shows that tenure of village, rice fields, gardens, fallows, fruit gardens, rivers and forest(s) belong to the community (collective property tenure), which are managed by a customary leader, and can only be utilized with permission of the customary leader and community agreement. Besides collective property, each household is permitted to have their own property of home-lands, fruit garden areas, and rice field.

People in Mului believe that the current forest area is much smaller than 6 years ago, due to rampant logging activities that started 6 years ago. Usually, the logged over area will grow again to form a new forest after years.

3.3.6.2. Landscape Importance by Use Categories

People's perspectives on the importance of each landscape were recorded through the Pebble Distribution Method (PDM). These perspectives cover overall benefit and type of individual use on each land type. Based on the data, we can classify various land use categories.

Analysis on PDM was conducted as an exercise involving all community groups (old men, old women, young men and young women) in Rantau Layung and Mului. The results were average of the importance values for all land use categories, which then were ranked to see what people perceive as the most towards the least important categories (Figure 42 and Table 27).

The results show that both forest ('alas') (perceived by old women as the most important) and rice fields ('*ladang*') (perceived by the rest as the most important) were at the highest rank (25%),

might be because people perceived them as the most important sources of food. Gardens were considered as the second most important land use category (17%), might be because most villagers plant rattan in their gardens as an alternative source of income. Table 27 shows all land use categories and forest types in Rantau Layung village, as well as their importance values.

Forest provides resources for various uses i.e. medicine, house/building as well as boat materials, tools, ornament/ritual, hunting tools and hunting place, hence it is considered as the most important land types in both Rantau Layung and Mului (Figure 43 and 44). In Rantau Layung, old forest is considered as the most important forest type (Figure 43). In Mului, rice field is perceived as the second most important source of food, customary, firewood and income.

Table 25. Landscape Dynamic and Land Tenure in Rantau Layung

Land type	Area (ha)			Land tenure			Distance from settlement		
	10 years ago	At present	10 years from present	State	Custom-ary/ collective	Private	10 years ago	At present	10 years from present
Strat/ village	Smaller	10-20	bigger	-	-	50 hh	0	0	0
Umo/ rice field	Smaller	30-45	bigger	-	-	35-49 hh	nearer	0.5-4km	same
Kebon/ Garden	Smaller	49-150	bigger	-	-	42-50 hh	nearer	0.5-10 km	same
Sunge/ River	Same	Do not know	same	-	Village	-	same	10-50 m	same
Alas/ forest	Bigger	600-1630	smaller	-	Village	-	nearer	1-4 km	same with or farther
Lati/ fallow	Smaller	90-350	bigger	-	Village	-	nearer	0.5-3km	farther
Sipung Bua/ fruit garden	Smaller	90-100	bigger	-	-	50 hh	nearer	0.5-10km	same with or farther

Note: hh = household

Table 26. Dynamic of Landscapes around Mului Settlement by Area and Distance

Land type	Area (ha)			Distance from settlement		
	6 years ago	At present	10 years later	6 years ago	At present	10 years later
Settlement	Less	± 20 ha	fixed	2 km	0	fixed
Garden	5 - 18 ha	50 - 54 ha	50 ha - increase	2 - 4 km	1 - 1.5 km	0.5 - 1.5 km
Rice field	16 - 18 ha	16 - 21 ha	increase	1.5 - 12 km	1 - 2 km	3 - 4 km
Young fallow	18 - 30 ha	16 - 84 ha	increase	1 - 1.5 km	1 - 2 km	3 km
Old Fallow	0 - 16 ha	16 - 18 ha	increase	0 - 12 km	1 - 10 km	1 - 3 km
Young forest	Less	fixed - 8000 ha	fixed - increase	100 m - 1 km	100 m - 1.5 km	fixed - further
Old forest	Less	> 8000 ha	increase	0 - 12 km	100 m - 12 km	300 m - 12 km
River/gold mine	same	84 - 168 ha	fixed - increase	500 m - 3 km	500 m - 3 km	500 m - 3 km

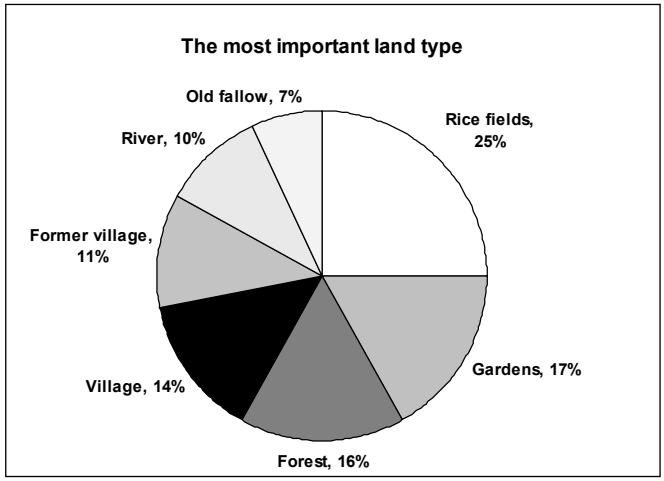

Figure 42. Land Types Importance (Mean Value) for All Groups in Rantau Layung

Table 27. PDM Exercise Summary of Land and Forest Type Importance (mean value) by Use Categories for All Groups in Rantau Layung

Land type	Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry/cordage	Ornament/ritual	Source of income	Hunting tools	Hunting places	Future
Village	6	8	2	2	3	0	1	0	16	1	1	0	3
River	15	6	4	7	10	1	2	1	0	12	1	8	2
Rice fields	29	23	3	2	1	3	15	0	1	14	0	0	10
Forest	19	35	30	54	61	50	16	25	26	20	42	53	32
Fallow	3	11	41	20	12	25	41	37	23	1	41	17	8
Fruits garden	14	8	5	4	2	3	17	3	10	23	8	20	17
Gardens	14	9	15	11	11	18	8	34	24	29	7	2	28
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
Forest type													
Sacred forest	8	7	3	1	1	1	0	0	1	0	1	1	5
Customary forest	25	26	23	21	20	21	25	28	35	22	20	22	38
Old forest	32	42	38	56	54	42	36	33	39	46	50	48	28
Reserved forest	35	25	36	22	25	36	39	39	25	32	29	29	29
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

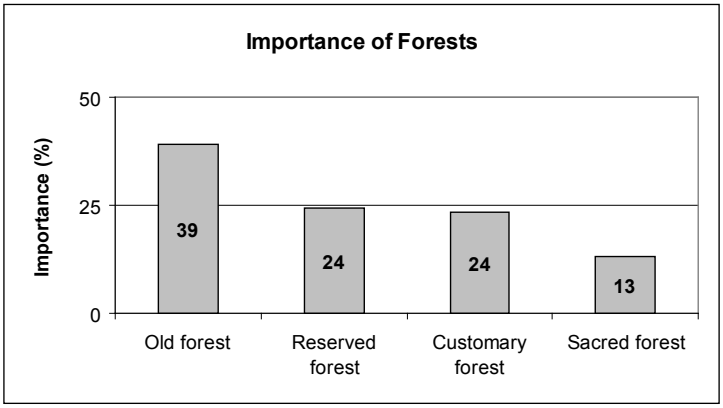

Figure 43. Forest Types Importance (Mean Value) for All Groups in Rantau Layung

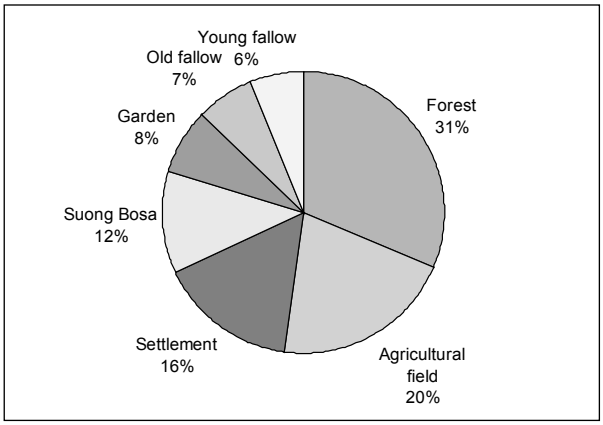

Figure 44. Forest Importance (Mean Value) Among Other Landscapes by Mului People

Table 28 shows that in Mului, settlement is perceived as an important landscape because its function as a place for people to rest and socialize with others. Garden is also perceived as important for the future because its function as a place to plant various commodities that can provide important alternative source of income, such as rattan and coffee. Young fallow is perceived as the least important landscape since it was seen as providing lowest benefits than the other landscapes.

Forests are divided by the villagers into two categories, e.g. old and young forests. Old forest is perceived as more important than the young one by both men (70%) and women (67.5%) groups, see Figure 31. This might be because old forest is perceived as a more secure source of food and income for today and in the future.

Young forest is perceived as less important (30% by men and 32.5% by women) because it is perceived to provide fewer products at present, but it is considered to be more important in the future. Young forest is an important source of several materials, such as light construction, bike construction and tools that are not available in the old forest (Table 28).

Table 28. PDM Exercise Summary of Land and Forest Type Importance (Mean Value) by Use Categories for All Groups in Mului

Landscape	Category of use													
	Food	Medicine	Light construction	Heavy construction	Bike construction	Tools	Firewood	Basketry	Ornament	Income source	Hunting material	Hunting place	Customary	Future
Settlement	9.0	6.3	0.5	0.0	0.0	0.0	2.5	0.0	1.0	2.7	2.5	0.0	8.0	7.5
Garden	11.5	8.7	2.0	0.0	0.0	2.2	4.5	0.0	1.5	10.0	0.0	5.0	12.5	11.5
Rice field	23.2	9.5	2.5	4.7	3.7	6.3	36.2	0.0	2.5	13.3	0.0	0.0	14.3	16.3
Young fallow	6.3	11.0	5.0	5.3	0.0	2.7	6.0	8.0	3.7	5.2	5.0	6.2	8.7	8.0
Old fallow	10.0	13.3	23.7	10.0	13.8	13.8	12.8	26.2	20.0	9.8	21.2	12.5	10.5	9.3
Forest	31.7	45.5	59.3	80.0	82.5	75.0	38.0	65.8	67.5	43.0	70.0	65.0	37.0	32.5
Suong Bosa	8.3	5.7	7.0	0.0	0.0	0.0	0.0	0.0	3.8	16.0	1.3	11.3	9.0	15.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

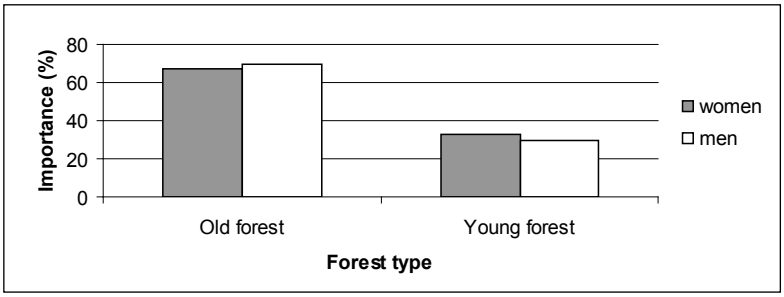

Figure 45. Men and Women Group Perceptions (Mean Value) on Forest Type Importance in Mului

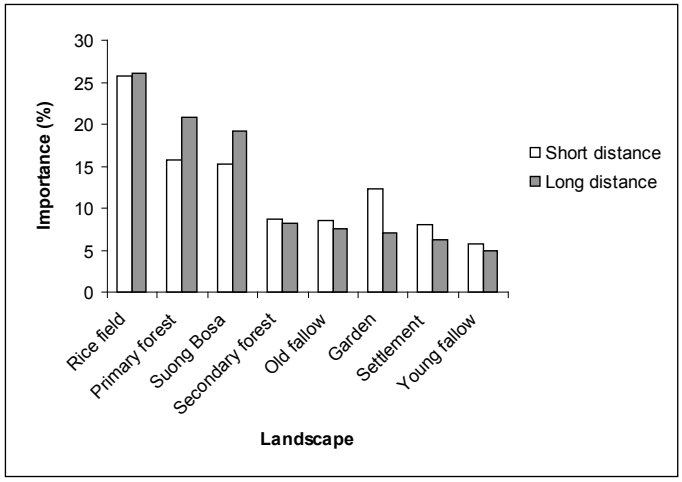

Figure 46. Importance of Landscapes (Mean Value) by Distance Categories for All Groups in Rantau Layung

Table 29. Forest Types Importance (Mean Value) by Category of Uses (Four Groups by Age and Gender) in Mului

Forest type	Category of use													
	Food	Medicines	Light construction	Heavy construction	Bike construction	Tools	Firewood	Basketry	Ornament	Marketable items	Hunting function	Hunting place	Recreation	The future
Old forest	64.5	55.0	47.7	55.3	46.5	45.0	37.5	54.7	58.7	57.5	56.2	51.2	52.5	47.5
Young forest	35.5	45.0	52.3	44.7	53.5	55.0	62.5	45.3	41.3	42.5	43.8	48.8	47.5	52.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

3.3.6.3. Landscape Importance by Distance

a. Rantau Layung

The scoring exercises also assessed the relationship between distance from each landscape to the village and the importance level of the landscape. Figure 30 shows rice fields are considered as the most important land type as they provide the main source of food for the community, regardless their distance from the village (near (half an hour walk) or far (more than 2 hours walk).

Gardens or forests are perceived as the second most important when they are located nearby the village. If gardens are closer, they are perceived to be more feasible as the source of income through cultivation of fruit or rattan which later can be sold. If forests are closer, they are perceived to be the main source of commercial items, such as materials for houses, building, and boat construction.

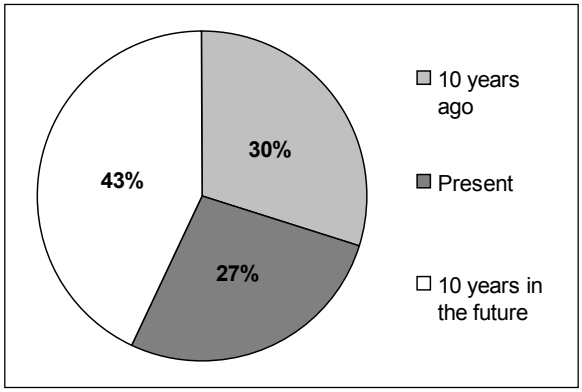

Figure 47. Importance of local landscapes (mean value) by distance categories for all groups in Mului

b. Mului

Rice fields are perceived as the most important landscape for most people in Mului, regardless their distance from the village, might be because they can collect more food from rice fields than from the forest (Figure 46). They provide the daily needs for food e.g. cassava, vegetables, etc.

However, it is interesting to know that only young men perceived forest as the most important landscape. They argued that regardless its distance from the village, forest is the main source of food and income such as fruit, meat and honey. This age group might not consider distance as an obstacle, since they are still strong enough to walk further and work harder in the forest than the other age groups.

3.3.7. Forest

3.3.7.1. Forest Importance: Past-Present-Future

a. Rantau Layung

Scoring exercise helps to compare the relative importance of the forest 10 years ago, at present, and in the next 10 years. For all land uses categories, local people perceived forest as the most important source to provide various needs for their livelihood, in the past, at present and in the future – also see Figure 49.

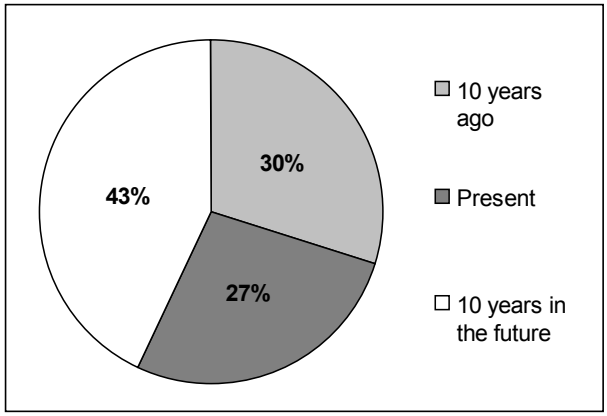

Figure 48. Importance of forest (mean value) for all groups in Rantau Layung

In the next ten years, the people see forest as an important source of food, medicine, heavy construction, ornament/ritual and source of income, while ten years ago, it was an important source of materials for boat, tools, basketry, hunting tools and hunting places (Table 30).

Table 30. Local perspective in Rantau Layung on forest importance (mean value) by use category in the past, present and future

Category of use	10 years ago	At present	10 years in the future	Total
All uses	30	27	43	100
Food	26	32	42	100
Medicine	28	35	37	100
Light construction	27	37	36	100
Heavy construction	35	29	36	100
Boat construction	37	30	33	100
Tools	41	31	28	100
Firewood	32	34	34	100
Basketry/cordage	40	27	33	100
Ornament/ritual	26	36	38	100
Source of income	33	31	36	100
Hunting tools	44	33	23	100
Hunting places	41	34	25	100
Future	28	32	40	100

People argued that in the future when roads have been well developed, they will be less dependent on boat and other river transportation means. In the future, people prefer to use plastic-based household equipment/tools, hence forest is seen less important as source of those materials. The people also believed their hunting resource will greatly decrease due to decrease of animal habitats in the forest, hence they prefer to rely more on farmed animals.

b. Mului

For Mului people, six years ago (1999) was an important momentum when they started to move from Mount Janas to the current settlement in Tana Rian.

Forest is the most important landscape in Mului (see previous chapter on landscape importance) and it will be more important in the future (49% vs. 33%; Figure 49). People described that in the future there will be more benefits from the forest. People believed that if their forest was not destroyed by illegal logging, it may have grown larger in the future and they will have more secure stocks and better access to sustain their livelihood. Forest that is developed from the old fallow that is planted with fruit trees are also perceived important as a major source of food and income.

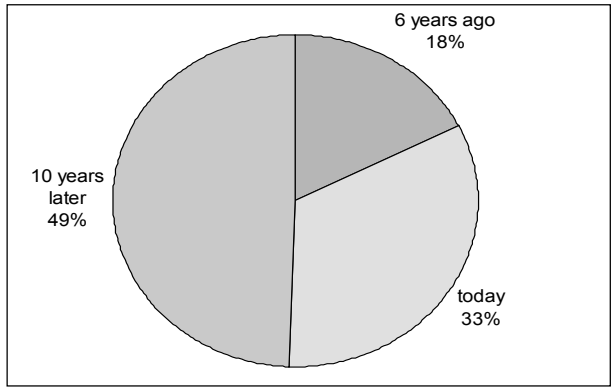

Figure 49. Forest importance (mean value) on the past, present and future by Mului people

Table 31. Forest importance (mean value) by use category on the past, present and future in Mului (four groups by age and gender)

Category of use	6 years ago	At present	10 years later	Total
Food	17.50	36.25	46.25	100.00
Medicine	17.50	31.25	51.25	100.00
Light construction	19.50	34.50	46.00	100.00
Heavy construction	30.00	33.75	36.25	100.00
Bike construction	43.75	30.00	26.25	100.00
Tools	32.50	28.75	38.75	100.00
Firewood	33.25	33.75	33.00	100.00
Basketry	36.25	33.75	30.00	100.00
Ornament	27.50	30.00	42.50	100.00
Income source	28.75	31.25	40.00	100.00
Hunting materials	33.25	30.75	36.00	100.00
Customary	34.50	30.75	34.75	100.00
Hunting place	33.75	27.50	38.75	100.00

Table 31 shows that forest will provide the people with more food, medicine, construction material, tools, ornament and income in the future. In the past villagers had limited access to forest products because of restrictions from the logging company. At present, with no logging company in their territory they have more access to forest and to manage forest products.

3.3.7.2. The Most Important Plants and Animals

a. Rantau Layung

Working with 4 groups of local people (old men, old women, young men and young women) in Rantau Layung, the PDM exercise was used to score 13 use categories of forest recognized by people and to determine the level of importance of each category against the others, the result is presented in Figure 50.

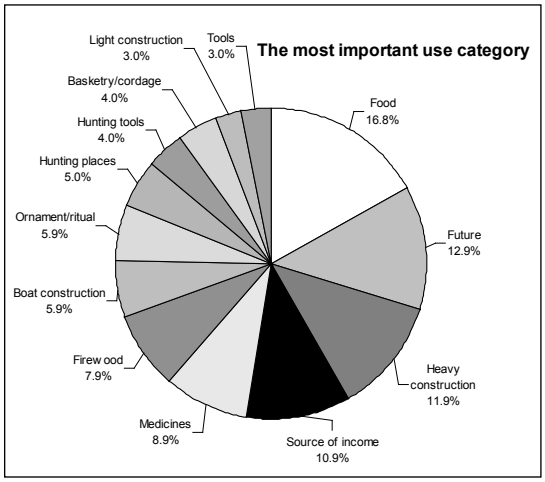

Figure 50. Importance of forest (mean value) per use category for all groups in Rantau Layung

The figure shows that local community in Rantau Layung considered 'source of food' (16.8%) as the most important use of forest since it is a basic need for people's livelihood. The second most important use is 'future reserve' for the next generation (12.9%). 'Source of materials for heavy construction' (11.9%) is considered as the third most important forest since forest is an important source of wood for houses and other buildings. 'Source of materials for tools light construction' (both are 3%) are considered as the least important forest use since people thought that such materials can also be obtained from other landscapes.

For each use, people prepared a list of the 10 most important plants and, if applicable, animals. Similarly, they ranked the importance of each species within each forest use category. The results are presented in Table 32 and 33.

Local people in Rantau Layung ranked Sungkai (*Peronema canescens*) and Telion (*Eusideroxylon zwageri*) as the two most important plants (Table 32) and are usually used as materials for construction and tools. Among the ten species, Sambu (*Vitex vestita*) is considered as the least important plant, which is usually used as materials for light construction and tools.

Local people in Rantau Layung ranked Payau (*Cervus unicolor*) and Telaus (*Muntiacus muntjak*) as the two most important animals (Table 33), and are usually used as resources of food or source of income – by selling it. Among those ten species, Sakan (*Lophura ignita*) is the least important animal, which is usually used for food and ornament.

Table 32. Most important species of plant for all use categories (averaged over four groups by age and gender) in Rantau Layung

Local Name (Plant)	Scientific Name	Category of use												
		Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry	Ornament/ritual	Income source	Hunting tools	Hunting place	Future
Sungkai	Peronema canescens			■	■		■	■						■
Ulin/telion	Eusideroxylon zwageri				■		■				■	■		■
Rotan	Calamus sp.			■			■		■	■	■			■
Meranti/putang	Shorea spp.				■	■					■	■		■
Durian	Durio zibethinus	■									■			■
Kapur/sintuk	Dryobalanops sp.				■	■	■				■			■
Perari	Neolitsea sp.			■		■	■				■	■		■
Nyarau	Elmerrillia tsiampacca				■	■					■	■		■
Bambu	Fam. Poaceae			■			■		■					
Sambu/mahlaban	Vitex vestita			■			■							

Table 33. Most important species of animal for all use categories (averaged over four groups by age and gender) in Rantau Layung

Local Name (Animal)	Scientific Name	Category of use												
		Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry	Ornament/ritual	Income source	Hunting tools	Hunting place	Future
Rusa/payau	Cervus unicolor	■	■				■			■	■			■
Kijang/telaus	Muntiacus muntjak	■					■			■	■			■
Lebah	Fam. Apidae	■									■			■
Ikan	Ichthyofauna	■												■
Pelanduk/kancil	Tragulus sp.	■									■			■

Local Name (Animal)	Scientific Name	Category of use												
		Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry	Ornament/ritual	Income source	Hunting tools	Hunting place	Future
Trenggiling/ayom	Manis javanica	■	■								■			■
Merak/jue	Argusianus argus	■								■				■
Beruang	Helarctos malayanus		■								■			■
Landak/tetung	Hystrix brachyura	■	■				■			■				■
Ayam hutan/sakan	Lophura ignita	■								■				

b. Mului

Figure 35 shows that for people in Mului, the forest is perceived as the most important to provide better future (15%), cash income (11%), food (10%), heavy construction (9%) and customary uses (9%) for the people.

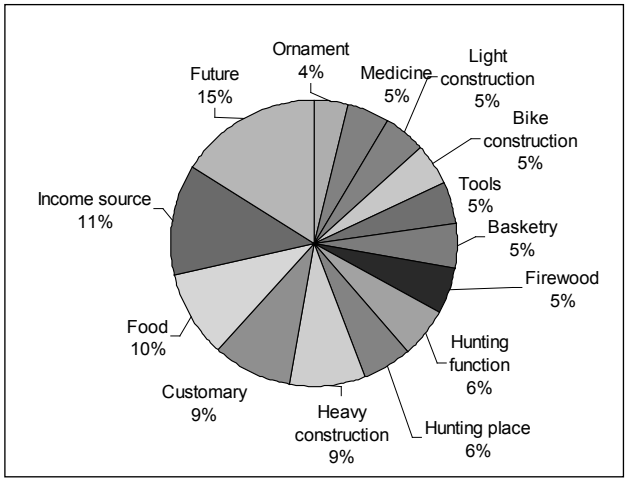

Figure 51. Forest importance (mean value) by use categories (average of four groups by age and gender) in Mului

People listed and scored the most important plant and animal species of each forest use category and then analyzed across all 14 categories to find ten most important plants and animals collected and used by the people. The summary result is shown in Table 34.

Table 34. Most important species of plant and animal (four groups by age and gender) in Mului

No	Plant		Animal	
	Local name	Scientific name	Local name	Scientific name
1	Sungkai	Peronema canescens	Payau	Cervus unicolor
2	Teliyen	Eusideroxylon zwageri	Telaus	Muntiacus muntjak and M. atherodes
3	Putang	Dipterocarpaceae	Juwe	Argusianus argus
4	We	Korthalsia sp.	Bilaomban	Copsychus malabaricus
5	Lomu	Canarium littorale	Pelanuk	Tragulus javanicus
6	Durian	Durio zibethinus	Sakan	Lophura ignita
7	Nyarau	Elmerrillia tsiampacca	Biwang	Helarctos malayanus
8	Puti	Koompassia excelsa	Lisio	Rollulus rouloul
9	Nunuk	Ficus sp.	Tetung	Hystrix brachyura and H. crassispinis
10	Perari	Litsea sp.	Pengulor	Aves

Sungkai (*Peronema canescens Jack*) and Teliyen (*Eusideroxylon zwageri*) are perceived as the two most important plant species in Mului (Table 35) and used by people as resources for medicine, construction, tool, firewood etc. Among those ten species, Perari (*Litsea sp.*) is the least important plant which is only used for construction and tool.

Table 35. Most important plant for Mului people by use categories (four groups by age and gender)

No.	Plant	Category of use													
		Food	Medicine	Light construction	Heavy construction	Bike construction	Tools	Firewood	Basketry	Ornament	Income source	Hunting material	Hunting place	Customary	Future
1	Sungkai		■	■	■	■	■	■		■		■			
2	Teliyen				■	■	■			■		■			■
3	Putang			■	■	■	■	■					■		■
4	We			■					■	■		■			■
5	Lomu						■				■		■		■
6	Durian	■									■		■		■
7	Nyarau				■	■	■								
8	Puti						■			■				■	■
9	Nunuk												■		■
10	Perari				■	■	■								

Payau (*Cervus unicolor*) and Telaus (*Muntiacus muntjak* and *M. atherodes)* are perceived as the most important animal species in Mului (Table 36). They are used by people for many uses mainly for food and cash income by selling it to others.

Table 36. Most important animal for Mului people by use categories (four groups by age and gender)

No.	Animal	Category of use													
		Food	Medicine	Light construction	Heavy construction	Bike construction	Tools	Firewood	Basketry	Ornament	Income source	Hunting material	Hunting place	Customary	Future
1	Payau	■	■				■			■	■	■			■
2	Telaus	■					■			■	■	■			■
3	Juwe	■								■	■				
4	Bilaomban										■				■
5	Sakan	■								■	■				■
6	Pelanuk	■									■				■
7	Biwang		■							■	■				
8	Lisio	■								■	■				■
9	Tetung	■	■				■			■				■	■
10	Pengulor										■				

3.3.8. Specific Resources

Forests in Rantau Layung and Mului are very important. The local informants showed several locations in the forests that are potential to be further developed and managed for generating income without destroying their ecological functions, such as source for mineral drinking water, electric generator and ecotourism (Table 37 and 38).

There are three natural objects that are highly potential for ecotourism attractions, i.e. waterfall, *bengenget* stone and cave. Besides being located relatively close to the settlement and are safely and easily accessible, the objects offer some interesting features to visitors such as beautiful waterfall scenery, natural swimming pool area, and underground caving adventure to observe thousands of bats in their natural habitat.

Besides natural attractions, cultural performances, such as traditional dances and customary ceremonies, are also potential attractions for visitors. *Selendang Mului* is the most commonly practiced cultural dance and music, which is considered to be very potential for tourist attraction (Figure 52).

There are four natural objects in Rantau Layung that are potential for ecotourism attractions, i.e water falls, *Riam (Lumbang)*, and *Batu utok uwok*. They are located relatively close from the village, but the path-ways need to be repaired immediately to make them more accessible for tourists.

There are also several natural objects that are potential as sources of clean water and electricity for local community, such as waterfalls (Kuaro River and *Kepala Luayang*), *Riam* and cave or spring.

3.3.9. Threats and Opportunities to Gunung Lumut Protection Forest

Gunung Lumut Protection Forest provides many benefits both for surrounding communities and outsiders, either tangible or intangible. To guarantee the sustainability of the benefits, the conservation area has to be maintained. In order to manage Gunung Lumut Protection Forest sustainably, it is important to first identify actual and potential threats as well as opportunities to the conservation area.

3.3.9.1. Threats

Several big concessions (*HPH = Hak Pengusahaan Hutan*) around the Gunung Lumut Protection Forest could be considered as a potential threat to the sustainability of the protection area. Past experiences showed that many HPHs have illegally expanded their operations outside their concessions and neighbouring areas. If the existing HPHs are not properly monitored and controlled, they may illegally expand their logging activities to Gunung Lumut Protection Forest.

Small-scale loggings by the local community as well as outsiders are also potential threats to the protection area. As an example, small-scale logging has been conducted by the Rantau Layung community during the period of 1995 to mid of 2005 with capacity 8 to 12 cubic meter per team per month (there were about 20 teams). Assuming that the logging operated for 10 months in a year, the volume of the wood collected would have reached 2,000 cubic meters per year. If the volume of one tree is equivalent to 4 cubic meter of wood, means they have cut 500 trees in a year or 5,000 trees in 10 years. As more villages around Gunung Lumut Protection Forest carry out similar activity, the negative impacts to resources will be magnified, and become serious threats that should be immediately addressed by the Protection Forest authority.

Shifting cultivation can be a sustainable traditional agriculture system if population growth is controlled to avoid excessive forest clearings that may exceed forest's regeneration capacity. In fact, population growth in villages around Gunung Lumut Protection Forest is relatively high that makes shifting cultivation as another potential threat to the sustainability of the forest if it is continuously implemented.

Table 37. Potential objects for ecotourism in Mului (four groups by age and gender)

Special object	Accessibility from settlement	Current use	Strength of Object
Waterfall of Sempangen River	Two hours walk	Recreation, bath	Plain walking trail; high waterfall
Waterfall of Une River	5 km away or one hour walk	Recreation, bath	Beautiful waterfall with many pools for bathing
Mount Lumut	Six hours walk	Recreation, hiking	Beautiful scenery from the top
Bengenget stone of Mului River	Half an hour by motorbike	Hunting for animal and fruit, customary ceremonies	Human like stone
Traditional dances and ceremonies	-	Anytime when there is need	Unique dances e.g. Selendang Mului; most of villagers are able to dance
Caves with stalactite and bats	One hour walk	Hunting for animal and fruit	Caves with beautiful stalactite/ stalagmite and thousands of bats
Legendary place of payo dale bale	Ten hours walk	-	Legendary place

Table 38. Special resources of the Rantau Layung village

Object	Location	Distance from the village and accessibilities	Strength	Opportunities
Water fall	Sai River	1 km to the North, by water or pathway	Nice panorama, cold water	Potential for an ecotourism object
Water fall	Kepala Luayang, Semantayan	1 to 3 km through village path	beautiful site	Potential for an ecotourism object and a source of clean or drinking water
Water fall	Kuaro River	14 km	Near to the road	An electric generator
Riam	Near the village	1 km	The water resource is sustainable	A resource for drinking water
Riam	Lumbang, Ipu	8 km through forestpath	Beautiful panorama	Potential for a new tourism object
Cave and spring	Perayan and Nango Rivers	3 km through forest path	stalactite/ stalagmite, a water resource inside the cave	A resource for drinking water
Batu utok uwok	Sungai Perayan	4 km through forestpath	Beautiful stone, beautiful panorama	A tourism object

Phenomena in growing oil palm has become the big threat for Gunung Lumut Protection Forest. It has been attract the most villagers in Rantau Layung and communities in other villages around Gunung Lumut Protection Forest to develope oil palm plantation as a promising source of income. Community in Rantau Layung have proposed to develop oil palm plantation to the Estate Crop District Services. The proposal was rejected by the Forestry District Services because the proposed area is close to Gunung Lumut Protection Forest, which is classified as a forestry plantation area (*Kawasan Budidaya Kehutanan*), and because the experience says that once it is approved, it has a tendency to illegally expand to the protection area.

Figure 52. Traditional dance called Selendang Mului is practiced on many occasions (Photo by Basuki)

Despite the facts that hunting is one the most income generating activities for local communities in the research sites, and there are many endangered species in Gunung Lumut Protection Forest and the surrounding forest, there has not been a hunting regulation to control the activities. Hunting can be a serious threat to animal biodiversity, hence hunting policy should be urgently addressed by the Protection Forest authority.

Most of the local people believe that forest areas next to settlements is their customary land. Lack of knowledge on status and the role of people in managing the Protection Forest may potentially raise conflicts among stakeholders, which in turn will adverse the forest.

The logging road is an important access to outside areas for local people, but at the same time, it could be potentially harmful for the Protection Forest. The main road has created an open access to Gunung Lumut Protection Forest, through which anyone including outsiders may have access to extract forest resources. Therefore, the use of this logging road should be well monitored in order to minimize access for illegal forest extraction.

3.3.9.2. Opportunities

There are some nature conservation-related customary rules that are still followed by people in both villages. In Rantau Layung, for example, people recognize one forest category i.e. *Alas Mori* which is believed to be sacred area where the spirit of their ancients live. If anybody disturbs this area, they may get a negative consequence, such as getting sick, etc. In Mului, people are not

allowed to cut and sell trees from their forest. Forest wood can only be used for small construction (house repairing, etc.). This sort of local wisdom needs to be maintained and can be integrated into the management plan of the protection area.

Natural resources in Rantau Layung and Mului are potentially high from which some alternatives of livelihoods can be developed to support local source of income. Apart from rattan, some people in Rantau Layung are trying to establish rubber plantation in their garden. Some others are collecting and selling honey in traditional ways. Local government and other related institutions should provide trainings for local people in order to get an added value of their products.

In addition, the customary leader in Rantau Layung suggested that a potential spring near the mouth of Perayan River can be developed, if there is support, to provide clean and clear water for local people. In Mului, nature resources and local culture are considered as potential tourism attractions.

4. Conclusions and Recommendations

4.1. Conclusion

The Gunung Lumut Protection Forest is very diverse in terms of geological conditions (with both granite and limestone), and climatic conditions and altitude (with lowland in the Southern part and sub-montane upland up to 1,200 m a.s.l. in the Northern part) that have formed quite diverse habitats for a highly diverse flora and fauna.

While the surrounding area has been heavily disturbed or converted to oil-palm plantations, most area of the Gunung Lumut Protection Forest is still covered by primary and old secondary vegetations. Above ca. 600 m the vegetation is largely undisturbed and is still in very good condition. Some areas below that altitude are covered by secondary vegetations, particularly in the former shifting-cultivation areas surrounding the villages, along the former logging roads, and skid trails used for selective logging about 30 years ago.

The forest plays a pivotal role for local communities' livelihood, by providing food, raw materials, and income for people living inside (Mului Hamlet) and outside (Rantau Layung Village) of the Protection Forest. Observations during the assessment revealed that local people also used part the forest for agricultural purposes, such as 'shifting-cultivation'. Even though the intensity is still limited, this activity affects the condition of the protection forest and in the long-term, might become a serious threat to the existence of Gunung Lumut Protection Forest. These threats may be caused by limited involvement of local community in the management of the protection forest, lack of alternative sources for livelihood, and poor awareness on the importance of forest for various vital ecological functions (water and soil protection).

The Gunung Lumut Protection Forest is also very important for its hydrological and soil protection functions. It is the upper watershed area of the Sungai Telake water catchment in the Northwest and Sungai Kendilo water catchment in the West, South, and East of the Protection Forest. These rivers are vital water sources for 68 settlements surrounding the area including the relatively big towns on the downstream, including Tanah Grogot, Batusopang, Muara Koman and Long Ikis.

4.1.1. Fauna

Results of the assessment show that Gunung Lumut Protection Forest is the home and the last shelter for typical Bornean forest fauna, including insects, birds and primates as well as large and small mammals. It is of importance especially because the surrounding areas have been disturbed or converted to oil palm plantations. Many endemic as well as rare species were found in Gunung Lumut, which indicate the Protection Forest is in a relatively good condition.

Insects

The number of butterfly species encountered is more than 160. The knowledge of leave-mining moth-families, such as the Nepticulidae, in Southeast Asia is still poorly developed, and significant new observations were made. Dragonfly diversity was less than expected as both the number of species and the number of specimens was lower than usually encountered in other parts of Borneo. It is not clearly known whether this was influenced by seasonal effect, effects of logging, or by the geological history of the area.

Birds

Gunung Lumut was proven to be the home for most of Borneo's lowland bird families. During the three-week field assessment, 137 bird species were identified, including certain rare and endemic species, such as White-crowned Hornbill, Great Argus, and Laughing-thrush.

The structure of the bird community can be used as an indicator for changes of habitat structure and certain aspects of the forest micro-climate. There are differences in bird community structure between virgin forest, secondary forest and disturbed forest area. Apart from typical virgin forest species, many bird species identified in Gunung Lumut area can also be found in other areas in East Kalimantan, such as in Meratus or Mentoko in Kutai National Park, where vegetations are categorized as old secondary forest. Bird species composition is also influenced by feeding guild which depends on the forest structure. The birds in Gunung Lumut area are mostly insectivores or generalists.

There are significant relationships between altitude and bird species composition. Generally, as was found in Gunung Lumut area, the bird diversity decreases with increasing altitude, i.e. with the changes from lowland to sub-montane.

Primates and Large Mammals

The area of Gunung Lumut Protection Forest is a good habitat for primate and large mammals, since most of primate and large mammal species known to occur in East Kalimantan could be found in that protection forest. Although only a small number of individuals for each species was found, the abundance of the fauna, its representativeness and species diversity seemed relatively high.

At least 9 primate and 14 large mammal species could be identified in the three main study areas. Footprints of several other mammals were also found in these areas, but they couldn't yet be identified. Together with data obtained from the interviews with local people, there were total of 11 primate species and 26 large mammal species identified in Gunung Lumut Protection Forest. About half of them are protected species, either by Indonesian Law and/or listed on CITES Appendix and Red Data Book of IUCN.

In addition to the primates and large mammals, there were also at least 5 species of squirrel found in Gunung Lumut area.

Small Mammals

Data obtained from the assessment show that Gunung Lumut area is also a good home for small mammal species. There were 110 specimens and 18 species of small mammals consisting of 14 species of bats and 4 species of rats. None of them is endemic to Kalimantan. On the other hand, compared to the number of small mammal species occurring in the whole island of Kalimantan, the number of species collected was only 9.3 %. It is assumed that the species number in Gunung Lumut could be increased by increasing the duration of the survey, the kind and number of tools for catching small mammals, the human resources and the number of study sites.

The occurrence of fruitbats and rodents is very important for ecosystem functioning. Both are prey for carnivorous birds, mammals and reptiles. Moreover, both play an important role as seed dispersers.

4.1.2. Flora

Results of the assessment indicated that Gunung Lumut Protection Forest is extremely rich in plant diversity. It is believed that several of the plant species are new species, either newly recorded in East Kalimantan or even new to science (as new species).

Plant Diversity

At least 445 higher canopy plant species were identified during the expedition, which belong to 215 genera and 74 families, where Euphorbiaceae is the most dominant family. Some of those plant species are characteristic to disturbed or secondary forest, to undisturbed or primary forest, and some could be found in both secondary and primary forests. Some of the typical riparian tree species, such as ***Saraca declinata*** (Leguminosae) was very common along the rivers and

streams in the area. Of the identified tree species, 23 species are endemic to Borneo and 7 species are protected by law. Some species are considered to be new to science, one of them belonging to the genus ***Cassia*** of the family Leguminosae.

The surveys of understorey vegetation disclosed large diversity in Gunung Lumut Protection Forest, represented by some new species and newly recorded plants. A total of 252 specimens from the understorey forest were collected, consisting of 194 herbs and shrubs, 33 trees, 21 lianas and 4 orchids. Many herb and shrub species, such as ***Ixora*** (Rubiaceae), ***Cyrtandra*** (Gesneriaceae), ***Begonia*** (Begoniaceae) have potential as ornamental plant. About 13 species of ***Begonia*** were collected and some of them are potentially new species. The species richness of Begoniaceae, Zingiberaceae, Araceae that still occur in abundance within this area shows that the past logging has a little effect on the population of the ***Begonia*** spp. and ***Zingiber*** spp. These species usually can only grow near water such as head river bank in shade and good forest.

Diversity of mushrooms is also very high. During the expedition, at least 119 species of mushrooms were collected, and most of them are mycorrhizal mushrooms growing on the ground. Their distribution is very much depending on the habitat (forest) condition and climatic factors (temperature, humidity and rainfall). Forest without or with little disturbance is usually a better habitat for the mushrooms than a heavily disturbed forest. Most of the mushrooms were found in Mului, followed by Gunung Lumut and Rantau Layung.

Many of the plant species are important for the local community as they provide food and materials as well as income opportunity. From the higher plant species, there are many trees that produce edible fruit and moreover, some of them can be sold and provide income for local community. From this group, the most important species belong to the genus ***Mangifera*** (Anacardiaceae), ***Durio*** spp. (Bombacaceae), ***Nephelium*** spp. and ***Dimocarpus longan*** (Sapindaceae). Some herbs, such as ***Cyrtandra*** spp. (Gesneriaceae), ***Costus speciosus*** and ***Etlingera*** spp. (Zingiberaceae) have also economic value since they can be used as ornamental plants and medicinal purposes. From the mushrooms, 57 species are edible and 2 are used as a medicine by local communities.

Variation within the Gunung Lumut Protection Forest

Species composition within the Gunung Lumut Protection Forest varies considerably, i.e. lowland forest (Mului) is different from montane (Gunung Lumut) and limestone (Rantau Layung) forest. This means that these different locations complement one another to compose flora diversity in the whole Gunung Lumut Protection Forest area. The most deviating locations in the Gunung Lumut Protection Forest, both in terms of plant diversity and structure, are Rantau Layung and Gunung Lumut itself. This is probably related to soil characteristics (Rantau Layung) and altitude (Gunung Lumut). Habitat diversity in the Gunung Lumut Protection Forest is the main factor for plant diversity in the area. This effect is even stronger for fern composition and diversity, both of which were closely linked with altitude (which is probably a proxy for air humidity). Another finding of this study is that the logged forest (Base Camp) was still very diverse and not very different in terms of flora diversity from undisturbed forest nearby

(Mului), even though compositional variance between plots in the logged forest was much lower than in undisturbed forest. This means that although large parts of the Gunung Lumut area have been logged in the past, this has probably had only limited impact on species diversity and composition. Both logged forests and the undisturbed forests are valuable conservation areas in Gunung Lumut Protection Forest.

Relation to other Bornean forests

Results of the assessment show that the forests of the Gunung Lumut Protection Forest are floristically very similar to the forests at the foot of Gunung Meratus. This is perhaps not so surprising since both Gunung Meratus and Gunung Lumut are parts of the Northern extension of the Meratus Mountain Range. Floristically, the forests on this mountain range differ considerably from the coastal lowland forests near Balikpapan. This difference is even larger than the difference between undisturbed, logged, montane and limestone forests that were studied in the Gunung Lumut Protection Forest. Since plant diversity in the coastal Sungai Wain forest and the interior Meratus Range forests complement each other, it justifies the importance for conserving both forests.

Earlier studies have shown that both Sungai Wain and Meratus form part of a large floristic region of Kalimantan (Slik et al. 2003). The plant diversity in Gunung Lumut Protection Forest was comparable to that of Meratus and Sungai Wain, indicating that Gunung Lumut area forms a typical example for the region, which according to Slik et al. (2003) harbours the largest tree diversity in Borneo. Structurally the forests in the Gunung Lumut area are very similar to the forests at the foot of Gunung Meratus, which in turn differ significantly from the coastal forest near Balikpapan which has much higher stem densities.

It can be concluded that:
Gunung Lumut Protection Forest is floristically similar to Meratus Mountain Range; plant diversity is high, as might be expected for a forest in Southeast Borneo; the environmental heterogeneity of the area (soils and altitude range) is major factor that determines its flora and structural diversity; and the logged forests within the area are as diverse as the undisturbed forests.

Gunung Lumut Protection Forest can be seen as one of the last remaining large tracts of relatively undisturbed forest in Southeast Borneo, and is very important as a representative sample of the forests in this region. If protected effectively, the Gunung Lumut Protection Forest (as a typical example of the Meratus Mountain Range forest) could, together with the Sungai Wain forest (as a typical example of lowland coastal forest), conserve much of the plant diversity in this region for the future.

4.1.3. Socio-Economy

Results of the socio-economy assessment through community meetings, interviews and focus group discussion in Mului Hamlet and Rantau Layung Village concluded the following:

1. The designation of the Gunung Lumut Protection Forest has not sufficiently involved participation from the local community. Their involvement in the current management of the protection forest is also very limited. This, combined with lack of extension on utilization and conservation of natural resources by relevant government agencies led to limited understanding of and resistance against the status of Gunung Lumut as a Protection Forest. Many local people don't know the border of the protection forest and even are not aware about the status of the protection forest.
2. The resettlement of Mului people to its current location inside the Gunung Lumut Protection Forest – organised and carried out solely by the Social Agency without involvement of the Forest Agency of the Paser District – shows that there was lack of good coordination between the responsible government agencies in the management of the protection forest.
3. The education level of the local people is very low. Most of them did not yet complete elementary school or even never went to school. A combination of poor education, lack of infrastructure and lack of income sources lead to a major poverty in both settlements.
4. The protection forest plays a pivotal role for local communities' livelihood. Many plants, such as hardwood (Sungkai (***Peronema canescens***), Telien (***Eusideroxylon zwageri)***), and fruit trees of ***Mangifera*** (Fam. Anacardiaceae), ***Durio*** spp. (Fam. Bombacaceae), and ***Nephelium*** spp. (Fam. Sapindaceae) as well as wildlife, including payau (***Cervus unicolor***) and telaus (***Muntiacus muntjak***), provide food and raw materials. Moreover, various kinds of non-timber forest products contribute significantly to local economy. Most of them are sold as raw materials as there is no post-harvesting technology applied to gain an added value of the products. NTFPs contribute significantly to the income of the local community up to seven to eight million rupiahs per household per year. Plant resources contribute two to three times than animal resources.
5. The importance of the forest for local communities' livelihood was also confirmed by the local community. From seven and eight landscape types identified by Rantau Layung and Mului people respectively, they identified 13 to 14 land use categories. They consider the forest as an important landscape now and in the future. This is particularly obvious with Mului people, who have a more positive perception of forest and conservation as well as on the legal status of Gunung Lumut Protection Forest than the Rantau Layung people, who live outside the protection area.
6. The forest land is also important for local people for agriculture purposes. Part of the forest is used for 'shifting-cultivation', which is managed with very low input and minimum technology. This confirmed the finding that more than 50% of expenditures of Rantau Layung and Mului people are allocated for food, while investment for production means is only 1.5% of the total expenditure.
7. Several identified potential threats to the sustainability of Gunung Lumut Protection Forest were: illegal logging within and around the protection area, extensive development of oil palm plantations, and shifting cultivation practices as well as hunting activities.
8. Natural resources in Rantau Layung and Mului such as plants and animals resources including culture and local wisdom can be potentially developed to support local livelihoods.

4.2. Recommendations

Realising the critical roles of the Gunung Lumut Protection Forest, which is one of the last remaining large tracts of relatively undisturbed forest in Southeast Borneo, as supporting life system for the local community and home of a highly diverse flora and fauna, it is very important to conserve and sustainably manage the protection forest. In doing so, it is very important to:

- develop a new management model or improve the existing model involving, in particular, the local community, local government and private companies (forest concessionaires and palmoil producers) operating around the protection forest, while conserving the protection forest; and
- impose consistent policy and regulations that guarantee fair benefit sharing to all relevant stakeholders as mentioned above as well as rewards and incentives for those who support the conservation and sustainable management of the protection forest and tough punishment for those who violates the law.
- Particularly important in the conservation and management of the Gunung Lumut Protection Forest is the role of the local community, since they are – from the conservation point of view – directly in the 'front-line' to defend and ensure the sustainability of the protection forest. Their support can only be guaranteed if they receive benefits from the protection forest, and moreover, if they have options to do so. Since the local communities have very limited resources (human, skills, money) it is therefore very important that other stakeholders, particularly the local government, support the local communities to:
- reduce the overwhelming poverty in the area by increasing skills and creating alternative income sources, including:
  - » increase agriculture yields and/or improving farming system, where more input have to be invested and suitable technology should be implemented;
  - » better use of non-timber forest products, e.g. by introducing post harvesting technologies and packing systems; and
  - » develop potential resources that are available in the area, e.g. tourism development and utilization of other unutilized (yet) non-timber forest products such as edible mushrooms, fruit trees, and honey bees.
- increase awareness of and understanding of the role and importance of Gunung Lumut Protection Forest by:
  - » carry out intensive extension on the utilization and conservation of natural resources;
  - » socialization of the border and status of Gunung Lumut Protection Forest
- Finally, it is recommended to use the findings, data, and information gathered from this assessment to improve the current management plan and system of the Gunung Lumut Protection Forest. In this respect, a more detailed and comprehensive follow-up study, research and assessment on flora, fauna, and socio-economy aspects of Gunung Lumut Protection Forest should be carried out in order to have more accurate and complete information and data needed for sustainable management of Gunung Lumut Protection Forest while improving the welfare of local community.

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