





**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**The Development Survey  
on The Forest Resources  
in Brunei Darussalam**

**FINAL REPORT**

**Volume 2**

**(National Park Area)**



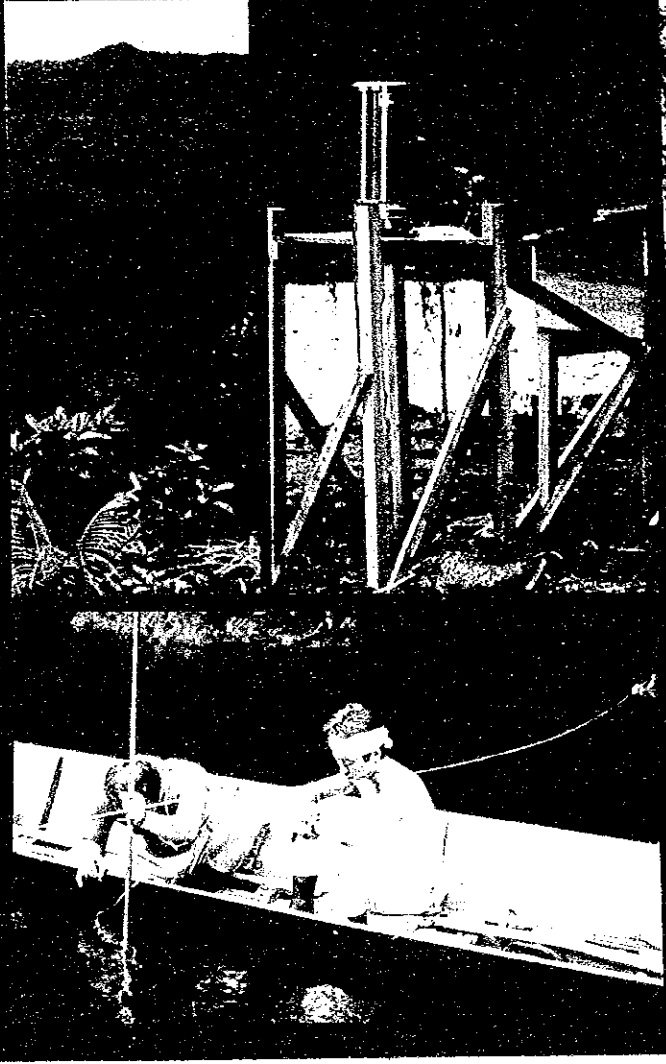
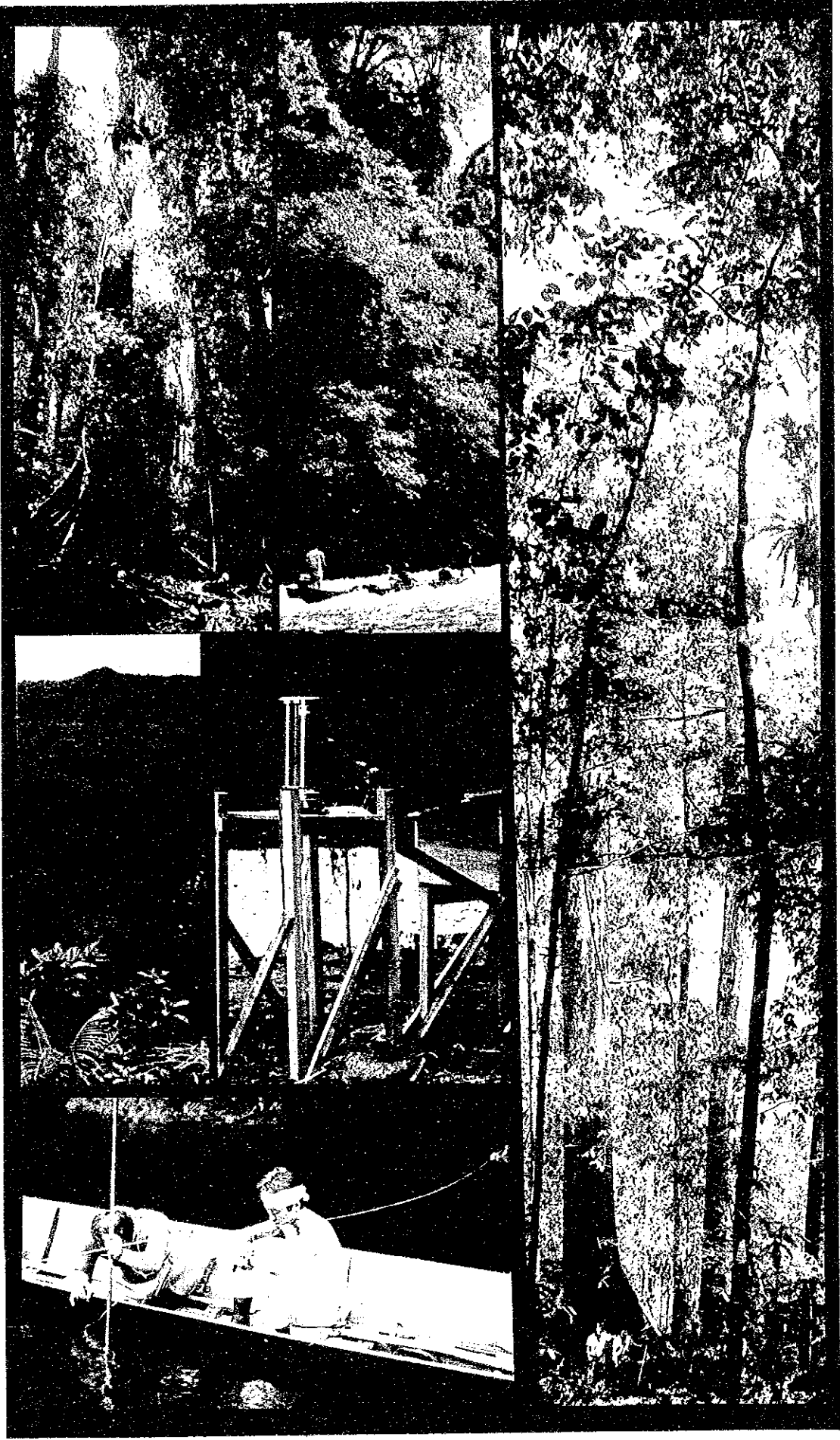
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**MARCH 1994**

**Forest Civil Engineering Consultants Foundation  
Pasco International Inc.**

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NATIONAL PARK AREA

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- 3: Mt. Belalong
- 4: Rain gauge at Kuala Belalong
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## **EXECUTIVE SUMMARY**

### **NATIONAL PARK AREA**

#### **1. Purpose and Items of the Survey**

In order to use the National Park for tourism and educational purposes, while at the same time paying attention to conservative management of the forest, the survey produced descriptions of forest types and forest stand structure over the 10,000ha area in the watershed of the Temburong River. In addition, information on rainfall, water levels, flow rates, collapsed land, and details of mammals and birds within the National Park area were collected. Proposals are included relating to the design of nature trail routes and the planning of facilities for the Park, together with their possible environmental impacts. By combining the results of all the surveys, we have produced guidelines for the conservation and management of forests within the area of the National Park.

#### **2. General Description of the Temburong River Watershed and its Forests**

The survey area is in the watershed of the Temburong River, having Bt. Pagon (1,850m) as its highest point. The landscape consists of steep slopes of sandstone, and shale from the Paleocene period, and shallow soil containing gravel covers the slopes. The average annual temperature is high, 27 -28 °C. The average annual rainfall is over 4,000mm and the average rainfall for each month exceeds 250mm.

From the upstream area to the river-mouth of the Temburong River, which includes areas outside the survey area, various kinds of natural forests such as Montane Forest, Mixed Dipterocarp, Kerangas, Peat Swamp and other types of forests such as secondary forests are distributed.

#### **3. Forests in the National Park**

In order to clarify the types and structure of the forest comprising the National Park, interpretation of aerial photographs and field surveys of forest structure was carried out.

Two main forest types can be identified by interpretation of the aerial photographs. One has relatively continuous and smooth crowns distributed on the ridges, and the other has crowns of tall trees uneven in height distributed below the middle parts of the slopes.

The survey of the forest structure was carried out by the two methods, one by the Belt-transect method of 18 plots of 50 x 5m and the other by the Line transect method, shown in Figure-1. The result of these surveys were the same as the interpretation of the aerial photographs, with two forest types being identified. One is "Mixed Dipterocarp Forest, which has even and dense crowns, few emergents, and with a tree height of less than 50m" distributed in the upper parts of ridges, and the other "Mixed Dipterocarp Forest which has dense crowns, uneven crown heights, with many emergents of more than 50m in tree height" distributed below the middle parts of the slopes.

During the field survey, more than 80 species were identified, 26 of them being Dipterocarp. Emergents higher than 41m were found in 19 of these species, with 13 species of emergents being identified as Dipterocarp.

#### **4. Forest Land Conservation**

Rainfall, which has an influence on forest land conservation, was measured for about 9 months from September 1992 by a data logger type of rain gauge situated close to the entrance to the National Park. This is the lowest part of the river in the survey area as shown in Figure-1.

During this period, the highest rainfall in one day was 142.0mm, and the the highest rainfall in one month was 621.5mm. Rain often falls from early evening to night time, and 80% of the total rainfall was measured during this period. The highest rainfall in one hour was 69.5mm.

The water level, which is vital for boat transportation, since the only access to the National Park is by the Temburong River, was measured for about a year from September 1992 at a point on the Temburong River slightly upstream from the National Park entrance, as shown in Figure-1. The highest and lowest average water level in one month differ from each other by about 1m. The water level at night time is 10cm higher than during day time, reflecting the characteristic of rainfall time described before. The highest and the lowest water level in one year differ from each other by 4.12m.

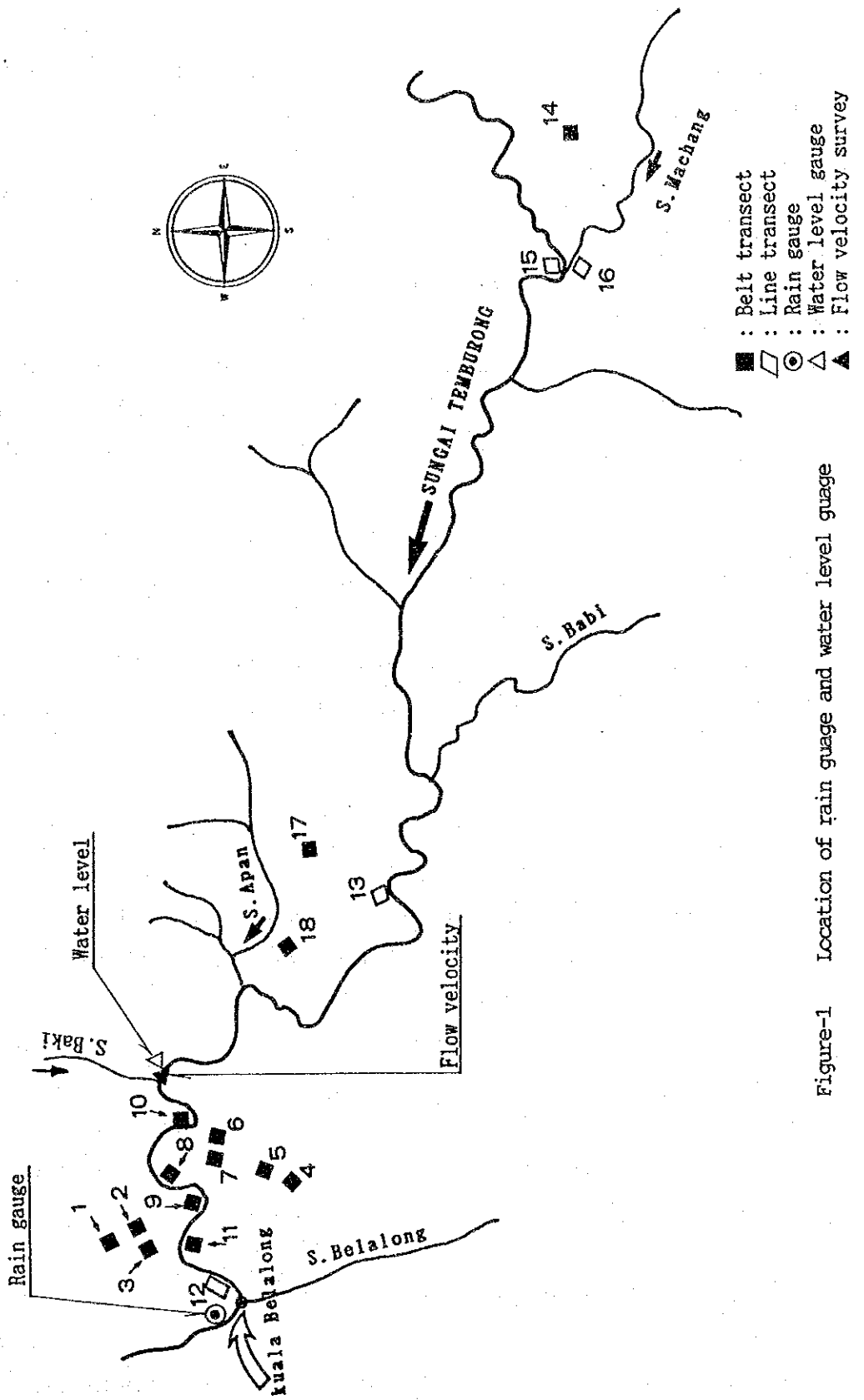


Figure-1 Location of rain gauge and water level guage

The maximum rise in the water level after rainfall was 3.4m after one hour. The water level fell 1.0m in three to four hours, returning to the stable level after falling slowly for 20 to 30 hours thereafter.

The specific drought water discharge rate was very small, 12.9 liters/s/km<sup>2</sup>. This rate is very close to the rate in Japan's Tertiary region, and given that the rainfall here is high, this could be due to the soil having a low permeability to water.

The survey of collapsed land was carried out by interpretation of aerial photographs, together with a field survey by boat and on foot. Twenty hillside landslides totalling 12.22ha in area, and 25 bank collapses totalling 0.86ha were measured.

There were 511 fallen trees, and driftwood was found in 203 places between Batang Duri which is the departure point for the National Park, and Sg. Machang in the Park.

Sedimentary earth on stream beds did not vary greatly as long as the water level increases remained at two to three metres, as was the case during the survey period.

## **5. Animals in the National Park**

A survey conducted by perusing and checking literature showed that 55 species of mammals existed in the area including the National Park. As a result of interviewing the FD staff and workers at the site, we added an additional 17 mammal species.

A total of 239 bird species, including Helmeted Hornbills, could be found. Most of the bird species were those inhabiting in crowns. The number of bird species living in undergrowth communities was 55. A total of 124 species were inhabiting close to the waterside, 132 species on slopes less than 460m in altitude, and 83 species on slopes higher than 460m.

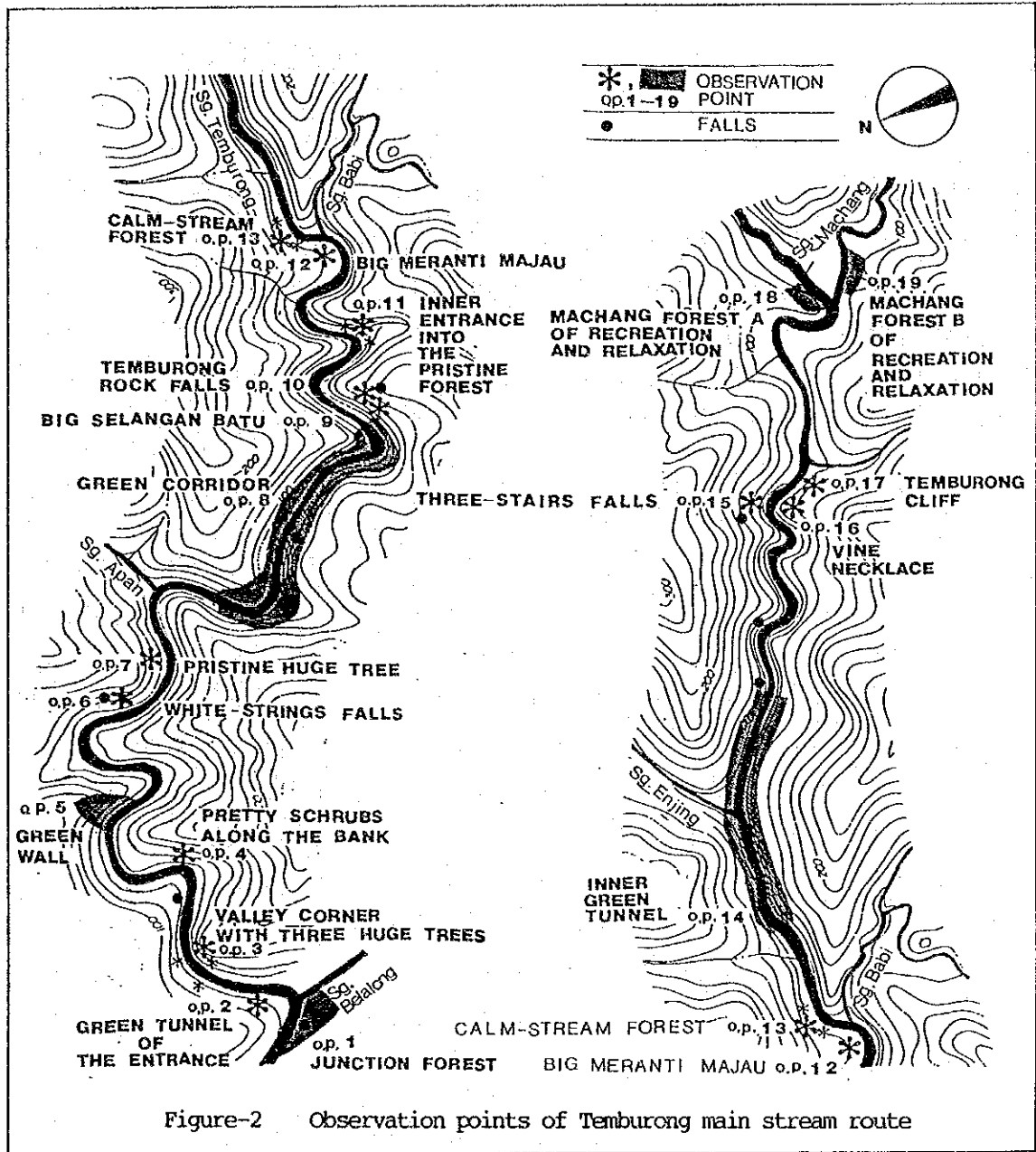
## **6. National Park Development Plan**

The concept of ecotourism to minimize impacts to the ecosystem was employed in the design of the utilisation plan for ordinary users.

The area downstream of the confluence of Sg. Machang was selected as an area allowing day trips during the high-water level season.



Three routes were selected as nature observation courses, allowing users to observe the forests within a walking distance of less than two hours. The first route is the Temburong Main Stream Route, shown in Figure-2, to observe



forest landscapes on a large scale along the main stream of the Temburong River. The second route is the Apan Tropical Rain Forest Observation Route spread over a distance of about 2km allowing viewing of trees in tropical rain forests over 360° from the confluence of Sg. Apan. The third route is the Kuala

Belalong Forest Observation Route which is suitable when the water level is low or for short-time observation.

### **7. Development Facilities Plan**

The basic policies in drawing up the plan was to have the minimum facilities required for safety and convenience of the users, while avoiding the cutting of trees for the sake of installing these facilities as much as possible. Although the plan for management facilities, observation facilities, resting facilities, public toilets and jetties all require new installations, the plan for nature trails is only to improve existing footpaths in line with the policy described above. The installation of signboards, information boards, etc., was also mentioned, together with recommendations regarding the appropriate location of facilities, their structure and size. Notes on using and managing of these facilities are also included.

### **8. Harmonisation of Park Utilisation with the Ecosystem**

Possible impacts from Park development on the natural ecosystem were checked by the flow chart shown in Figure-3, and a study undertaken on conservation of the natural environment.

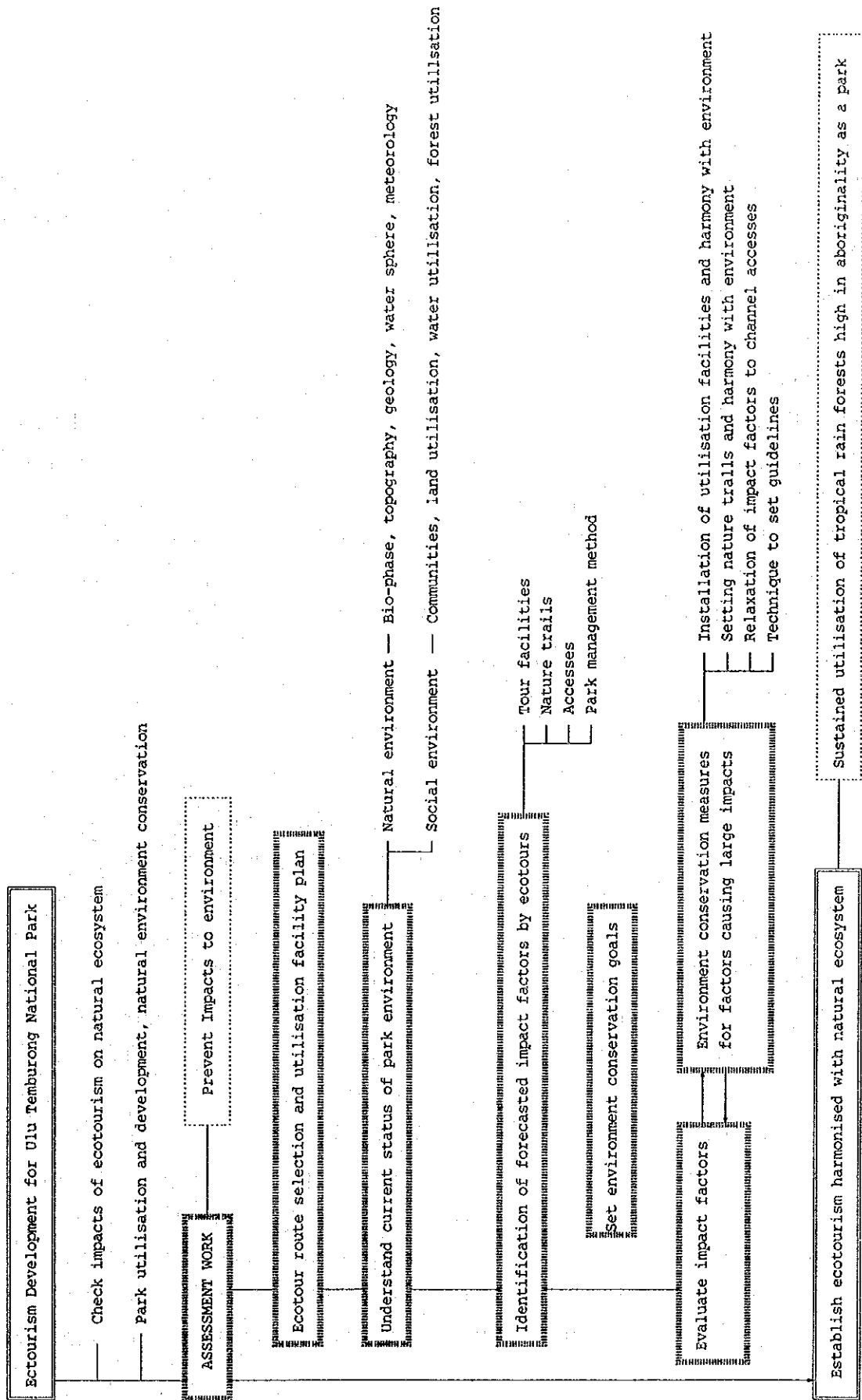
The relationship between four environmental factors, namely, development facilities, nature trails, accesses and park management method, and three environmental elements, namely, natural environment, social and cultural environment and psychological environment affected by these factors, was studied. Recommendations were also made on the following matters: Park facilities and nature trails harmonising with the environment, reduction of impact factors due to channel access, how to deal with the area surrounding the Park as a buffer zone, and the relationship with U.B.D/Kuala Belalong Field Studies Centre.

### **9. Recommendations for Development and Management of Temburong National Park**

The following matters arising from the overall results of the survey should be noted for the future management of the National Park.

1. The fundamental premises for Park development is that the nature of the

Figure-3 Flowchart for National Park environment assessment



existing precious tropical rainforest in the Park should not be disturbed. To secure the primitive state of the forest is important.

2. One aspect of the Park development would be for educational and/or research purposes, requiring minimal facilities such as walking paths etc.. However, for all types of development, it is essential that efforts are directed to ensure that impacts on the Park are minimal.

Only supervised use of the Park should be allowed, and non-disturbance of the ecosystem should be the first priority. Also the forest surrounding the National Park should be managed in the same way as the Park, and any clear cutting of the outer edges of the forest surrounding Park should be avoided.

3. A careful study has been undertaken for the use of the Park by the general public. It is advisable for ecotour participants to learn the attitude, "enjoy nature without disturbing it". To achieve this, ecotour participants should be led by a guide who has sufficient scientific knowledge, and in such a way as to understand the joy of observing nature and the importance of nature.

4. The principle is to be employed that where the construction of facilities requires cutting down trees, these should be outside the National Park.

5. To carry out ecotours, transport should be improved. The access, from the capital Bandar Seri Begawan to Bangar by boat, from Bangar to Batang Duri by car, and from Batang Duri to Kuala Belalong by small boat, needs to be improved, so that the public can make travel arrangements more easily.

6. Danger might occur when the water level rises during the rainy season, and when shallow banks appear during the dry season in the river from Batang Duri to Kuala Belalong. Safety countermeasure should be planned.

7. Three ecotour routes for return day tours from the capital Bandar Seri Begawan, have been set by this survey. With the possibility of tours of 2-3 days in mind, promotion could be by way of day tours, which would draw people's attention to the rare forest ecology and scenery of the National Park. After raising national and international awareness, tours of 2 - 3 days should be planned gradually afterwards. Facilities should also be improved gradually. In order to enhance the reputation of the National Park, a brochure or leaflet should be compiled, which includes research data on forest ecology, animals and fish.

8. Clarify the roles of the Forest Department, District Office and local guides.

It is necessary to establish a management structure for development and management of the National Park, including the expected role of the University of Brunei Darussalam. The possible roles of each group are shown in Figure- 5.

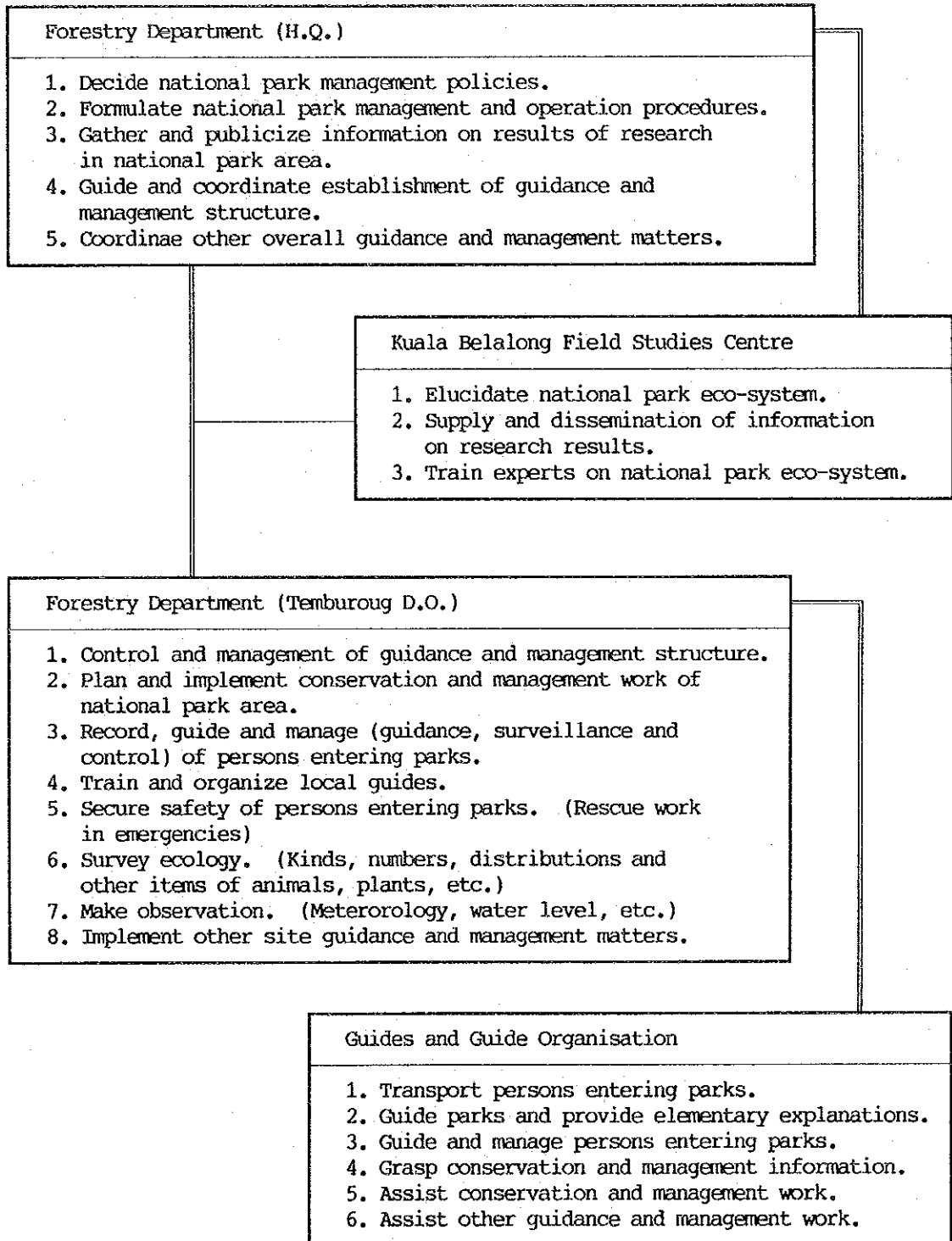


Figure-4 Suggested approach to establishing guidance and management structure for National Park



III NATIONAL PARK AREA





## **1. Objectives and Contents of the Survey**

### **1.1. Objectives and Area of the Survey**

#### **1.1.1. Objectives of the Survey**

The whole area of the Ulu Temburong National Park is covered by tropical rain forest in perfect condition, untouched by man. The object of this survey is to clarify the basic information for the people of Brunei as well as those overseas, in order that they may take an interest in the wonders of nature provided by this forest, without spoiling it.

The objectives of the survey of the National Park area can be divided broadly into three parts:

- 1) To analyse and provide descriptions of the forests in the survey area, and to prepare corresponding vegetation maps.
- 2) To outline the various factors required to conserve the forests and to identify precautions which should be taken for good forest management.
- 3) To prepare plans for National Park development and for National Park facilities. Pautilisationnal  
Park facilities.

#### **1.1.2. Area of the survey**

11,100 ha of the 48,857 ha total area of the Ulu Temburong National Park, upriver from the confluence of the Temburong River and Sg. Belalong. (See Figure-6.)

### **1.2. Contents of the Survey**

Figure-5 "Outline of Survey in National Park Area", summarises the survey items.

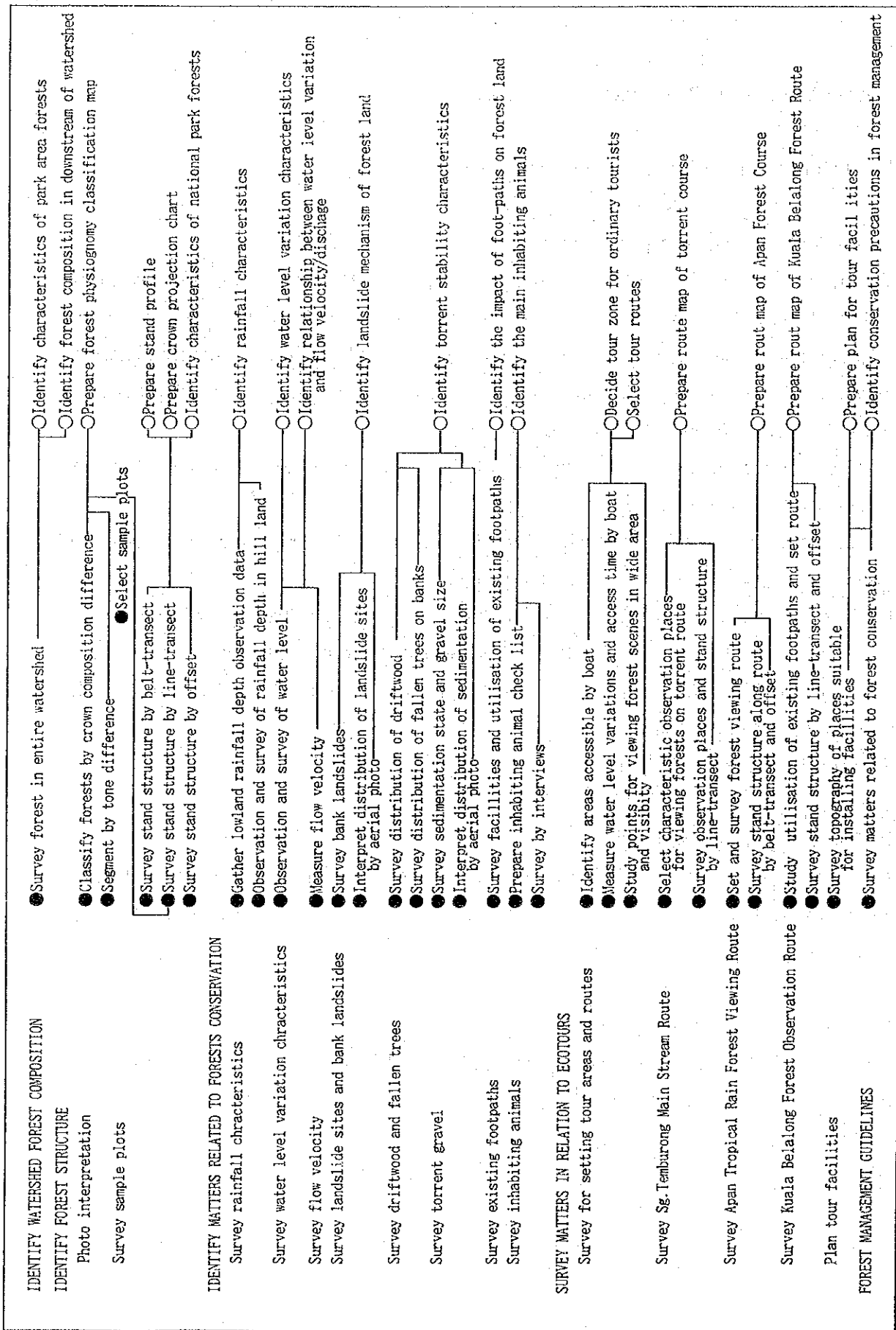


Figure-5 Outline of survey in National Park Area

## 2. Outline of the Temburong River Watershed and Forests

### 2.1. Natural Environment of the Watershed

#### 2.1.1. Mountains and rivers

Daerah Temburong is located in the eastern part of Brunei Darussalam, bordering Brunei Bay in the north and the Malaysian State of Sarawak in the east, west and south. Daerah Temburong is a detached territory 1,303km<sup>2</sup> in area. The district accounts for 23% of the total land area of Brunei Darussalam.

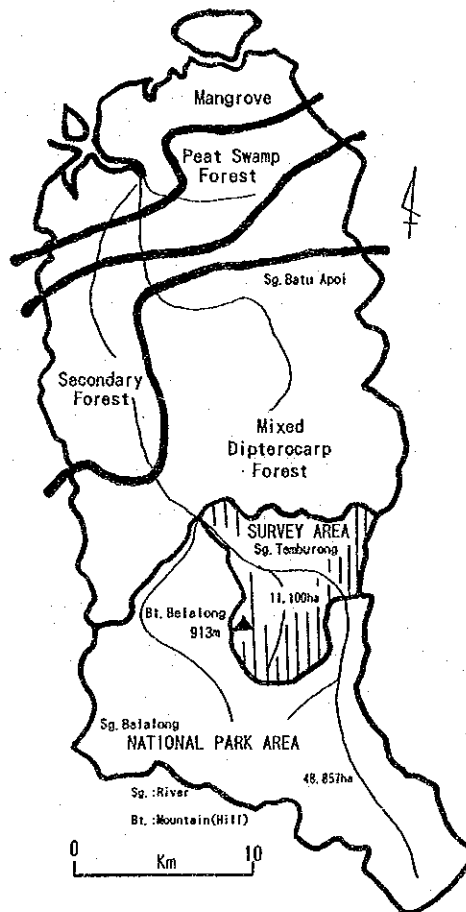


Figure-6 Outline of Temburong area

The main watershed is divided roughly into three parts by the Temburong, Batu Apoi and Labu Rivers. Both the Batu Apoi and Labu Rivers merge with the main stream near the its mouth of the Temburong River. Except for some zones, Daerah Temburong can be said to consist of land formed by the Temburong River.

The highest peak in the area is Bt. Pagon (1,850m). Mountains more than 1,000m high such as Bt. Retak (1,618m) and Bt. Tudal (1,181m) form the valley head areas.

### **2.1.2. Geology, Topography and Soil**

The geology of the watershed is sedimentary rocks of a relatively young age which was formed after the Paleocene of the Paleogene.

Most of the area was formed between the middle part of the Oligocene and early part of the Miocene. (16 to 30 million years ago)

The area consists mainly dark gray or black shale with sandstone formation at some locations.

These strata are folded, indicating there were uplifts in the past. Trial calculations show that uplifts have raised the ground at a rate of 0.25mm on average per year over the past eight million years.

These uplifts form narrow ridges (most ridges are only a few meters wide), steep valleys and rivers with steep valley walls. Rivers are extensively eroded, and bank landslides and rock terraces now in the process of formation can be found in many places.

According to a soil survey in the Land Capability Study of 1969, the National Park area in the watershed of the Temburong River has steep topography. Bedrocks and semi-weathered gravel are exposed. Skeletal soil containing a large amount of gravel is distributed mostly just below the soil surface. Associated soil of red-yellow podzolic content and skeletal soil is distributed in the areas on the north side of the Temburong River and on the west side of the Belalong River.

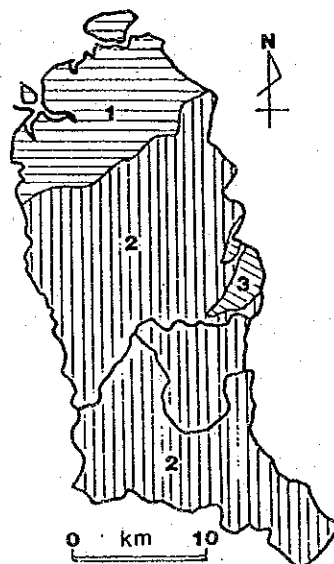
In a soil profile survey conducted on September 28, 1992 on the top and mid-slope parts of ridges along the Temburong and Belalong Rivers, gravel was found within 10cm of the surface of ridges about 300m in altitude. In the soil more than 13cm below the surface, more than 50% of sections contained

gravel. The soil texture consisted mostly of silt and clay and was clayey. The pH of the soil was low, 4.2 to 4.5, and the nutrition of the soil cannot be said to be good.

According to the new classification by the Soil Map of the World (Revised Legend) by FAO/UNESCO, the soil unit corresponds to Leptosols and the major soil grouping is Dystric Leptosols (LPd).

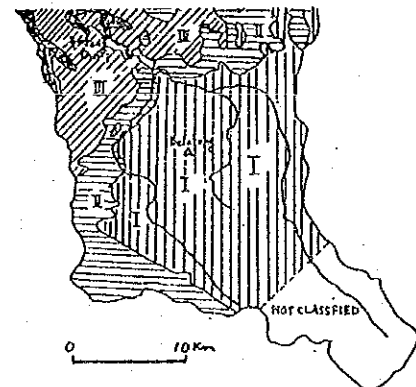
In soil profiles of mid-slope parts approximately 200m in altitude, the strata more than about 40cm below the surface contained a large amount of gravel. Ferrous mottling could be found in many places and the soil texture was clayey. The pH of the soil was low, 4.1 to 4.4, and the nutrition of the soil was poor. However, compared with the top parts of the ridges, the surface had a leaf mould stratum and roots were dense. The variety of species of forest type was large.

In soil classification, the soil unit is associated soil of Acrisols and Leptosols. The major soil grouping was a mixture of Ferric Acrisols (ACf) and Dystric Leptosols (LPd).



1:Holocene, 2:Pliocene and Miocene,  
3:Eocene and Paleocene

Figure-7 Geological sketch map of Temburong



(Land Capability Study, 1969)  
I: Skeletal, II: Red-Yellow Podzolic,  
Skeletal (Residual Soil), III: Red-  
Yellow Podzolic (Alluvial Soil),  
IV: Others

Figure-8 Soil map of Temburong

### 2.1.3. Meteorology

Meteorologically, Brunei Darussalam has a tropical rain forest climate having high temperatures, with high precipitation and humidity throughout the year. Variations in winds are noticeable generally in the coastal areas due to land and sea breezes, but are slight in the other areas. Brunei Darussalam is outside the typhoon area and has not been hit by severe tropical storms. Strong winds blow for short periods during thunderstorms.

Located close to a mountainous area, the rainfall in Daerah Temburong is high compared with the other areas to the west. Table-1 shows the annual average rainfall at an agriculture station in each district. The annual average rainfall exceeds 4,000mm. Even the minimum value exceeds the average rainfalls of the other a district indicating that the rainfall is high.

Table-1 Annual rainfall at each district (1971~1990/mm)

Station	Kilanas (Brunei/Muara)	Birau (Tutong)	Labi (Belait)	Selangan (Temburong)
Average	2,662	2,301	3,250	4,162
Maximum	3,410('75)	3,297('77)	4,760('89)	5,188('79)
Minimum	1,899('87)	1,289('82)	2,276('82)	3,076('90)

Temperature and rainfall data from the Selangan Agriculture Station (about 12km downstream from the entrance to the National Park), altitude about 15m, which was nearest to the National Park area, was used as reference meteorological data.

According to Figure-9 showing monthly average rainfall, in no month was the rainfall below 250mm. The monthly average rainfall is as high as 346mm. There is no distinct difference between the rainy and dry seasons. However, normally, rainfall is highest in two seasons, namely, from September to January and from April to May. Rainfall is less in February, March and from June to August.

Some months have recorded a minimum rainfall of around the 10mm mark. This is rare and occurs only once in about twelve years. There are no records indicating that such low rainfall continued for two months in succession. On the other hand, the records show that as much as 900mm of rain fell in some months. The variances between maximum and minimum

values against the annual average rainfall are very large. Another characteristic, monthly variances, particularly in rainfall trends from year to year, are very large. This can be explained by the fact that rainfall can be extremely local and that, generally, rainfalls are heavy. Thus, statistics contain large variances.

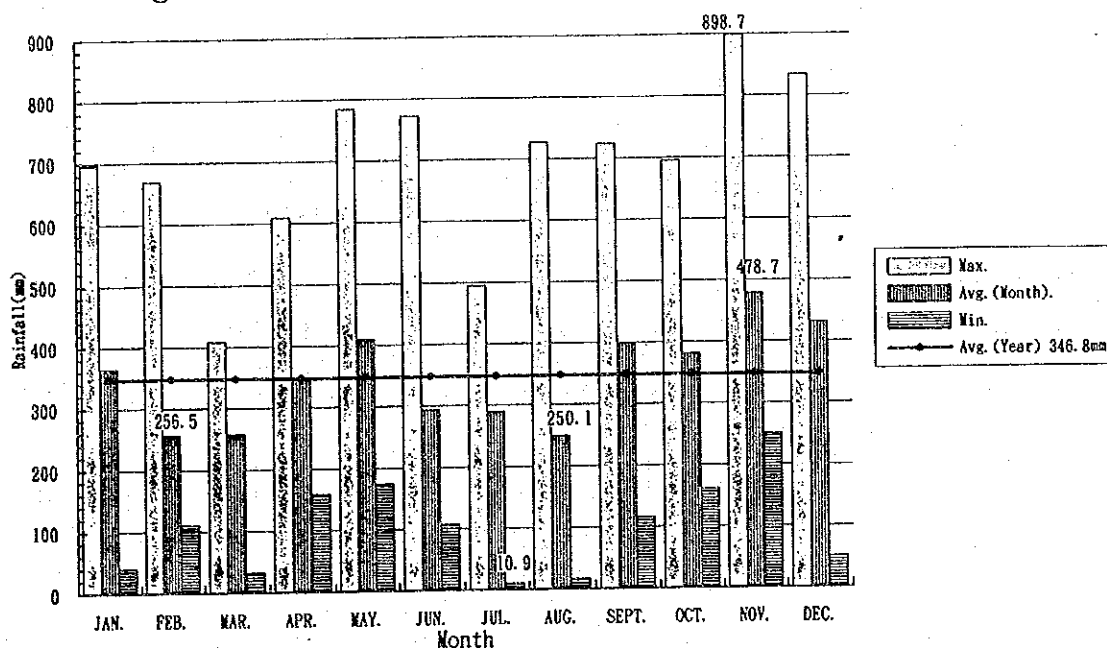


Figure-9 Monthly rainfall (1971~1990)

Average Temperature figures over the three years from 1989 to 1991, show average temperatures were 27 to 28°C, and maximum and minimum temperatures throughout the year ranged from 35 to 22°C. There is almost no temperature difference from month to month.

Thus, in Brunei Darussalam, the Temburong area has a typical environment of high temperature and high humidity, which is most favourable to tropical rain forests.

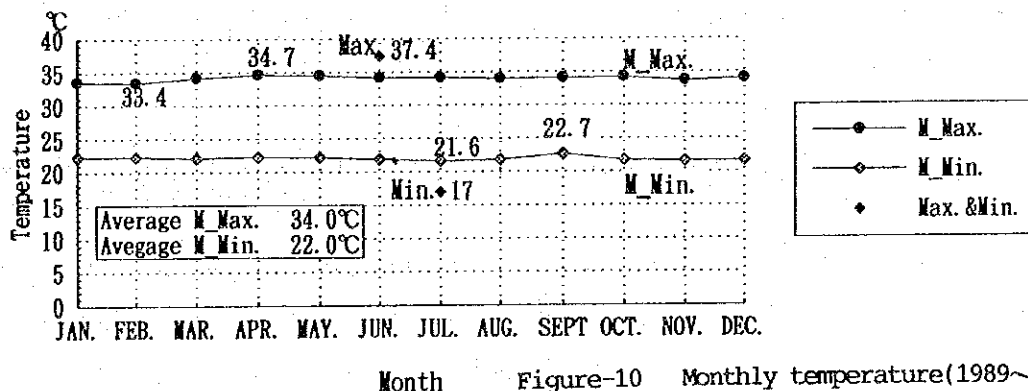


Figure-10 Monthly temperature(1989~1991)

## **2.2. Social Environment of the Watershed**

According to the Statistical Yearbook published in 1990, the watershed of the Temburong River had a population of about 9,300, broken down into 6,400 Malays, 1,400 indigenous, 900 Chinese and 600 other races.

Plains formed in the watershed of the Temburong River supply gravel which is suitable for civil engineering and architectural work. The Temburong district is the largest gravel producing area in Brunei Darussalam. Except for gravel supply, the area does not have other major industries. The local residents work for Government or public offices and stores, or manage retail stores.

There are no roads to access the watershed from outside, and all peoples travelling to the area go there by river. Speedboats carrying 12 passengers ply between the capital, Bandar Seri Begawan, and Bangar Town in the centre of the watershed, one hour trip from the capital.

The main communities in the watershed are connected by paved roads totaling 64km in distance. Kg. Selapun can be reached only by boat.

Many families of indigenous people, mostly Iban, reside along the length of the river living in common houses with a high floor, called longhouses. The people maintain a traditional life style by shifting cultivation, hunting, fishing and growing fruits.

## **2.3. The National Park viewed from the Watershed Forests**

Figure-6 outlines the composition of the forests in the Temburong area. Cruising the Temburong River upstream from its river-mouth to the National Park area, mangrove forests, peat swamp forests, housing shelter forests near houses in Bangar, kerangas forests (tropical heath forests), secondary forests and mixed Dipterocarp forests can be viewed. Mountain forests are distributed in mountain areas exceeding 750m in altitude such as at Bt. Belalong.

In mangrove forests, Bakau minyak and Bakau kurap, and nipa palm are widely distributed.

In other words, the forest composition from the mouth of the Temburong River to inside the National Park can be expressed symbolically as "mangrove forests grown by the sea and river", "palm forests spreading around the



riverside", "housing forests", "forests of shifting cultivation farmers", and "primeval tropical rainforests." The National Park area can be regarded as an "area which contains primeval forests."

### **3. Forests in the National Park**

#### **3.1. Purposes of the Forest Survey**

Primeval tropical rain forests exceeding 40m in tree height are considered to be valuable to the earth. In the forests of the Ulu Temburong National Park, virgin emergents stand with crowns 41 to 65m high. Rich rainfalls nourish the soil having been filtered by the crowns of these forests and become the clear flow of the Temburong river. Fragrances are emitted by green trees and spaces within the forest become diverse to provide shelter to large and small animals. Forests have become a most important factor in making up the natural environment.

Forest type classification was performed by interpreting aerial photographs to evaluate forests in the National Park. The forest stand structures were then analysed by entering the survey area on foot. A stereoscopic forest stand survey method was used in surveying the forest stand structures because of the importance of forest landscapes. This survey was conducted so that visitors to the National Park will be able to evaluate the nature of the National Park and to correctly recognise the forest landscapes of the Temburong Ravine.

#### **3.2. Forest Classification by Aerial Photo Interpretation**

##### **3.2.1. Aerial photographs used**

The survey area was photographed from the air in three photo types: Vertical color photos of 1:25,000 scale photographed in 1975, monochrome vertical photos of 1:25,000 scale photographed in 1982 and monochrome vertical photos of 1:40,000 scale photographed in 1992.

Those photographed in 1975 did not cover some zones in the southern part of the survey area due to a lack tie points links. The scale of the photos taken in 1992 was small and therefore not suitable for interpretation work. Hence, the photos taken in 1982 were used for forest type interpretation. The zones which could not be interpreted by the 1982 photos due to clouds, were interpreted using the 1975 photos.

The forests in the survey area have maintained their primeval condition for a long time, and problems were not expected to arise with forest

classification by using both 1982 and 1975 photos.

### **3.2.2. Forest classification method**

Generally, canopies of mixed Dipterocarp forests were dense crowns, medium to large in size, growing unevenly in height. To subtype divisions using photo interpretation of forests of this nature, which are distributed over a wide area, was very difficult. Species compositions rarely changed clearly in accordance with location, and forest type classification depended solely on classification by canopy state.

Anderson and Marsden, in 1984 classified forests in this area into two forest types, i.e., Dense, uneven canopies of medium- and large-sized crowns: Type 5(4) and Dense, uneven canopies, mainly large crowns: Type 5(5) .

This survey followed the approach by Anderson et al. of basically classifying forest type by the states of the canopies.

Nevertheless, this survey was intended to classify the forests for the purpose of viewing forest landscapes of the National Park and the block boundaries were inevitably different from those by Anderson et. al.

After studying the condition of the canopies in the survey area, it was decided to interpret into two divisions: Forest Type 5(4) used by Anderson et. al, and Type 5 (5') which was the forest type with slightly smaller crowns and relatively flat canopies.

Mixed Dipterocarp forests in the Model Plantation area and in the National Park area had different forest types and the forest type of the National Park area was expressed as Type 5 (4 or 5')H which was the type for mixed Dipterocarp forests grown in hilly land.

Regarding mountain forests, the divisions used for them by Anderson et al. were used.

The divisions used by Anderson et al. for topographical classification were used for the various zones: I: less than 15°, II: 15° to 24°, III: 25° to 35° and IV: larger than III.

### **3.2.3. Characteristics in forest type photo interpretation**

Table-2 summarises the characteristics of each forest type interpreted from the aerial photographs.

Table-2 Characteristics of forest types by aerial photo interpretation

Forest physiognomy Division	Photo Interpretation characteristics	Area of Distribution
5(5')H Type	Canopy is relatively even in height. Crowns of upper-storey trees are relatively small and individual crowns are continuous.	Mostly distributed in top parts of ridges, In some areas, also distributed in valleys.
5(4)H Type	Canopies are uneven in height and are made up of medium and large sized crowns. Tall trees scattered, and some canopies consist of intermediate and lower-storey trees. Surface can be interpreted directly in some areas. Heights of tall trees are taller than 5(5')H type and are 55 to 65 m.	Mainly distributed in middle to bottom parts of hillside slopes and in bottoms of ridges.

Comparing Types 5 (5')H and 5 (4)H, forests in the Type 5 (4)H had more gaps, and this seemed to be related to unevenness of canopies.

The fact that forests of the Type 5 (5')H were distributed on ridges where soil was stable might offer some relationship. However, in the examining directions in which trees fell (uprooting and stem breakage), most trees fell with tree tops down. Therefore, it is assumed that gaps were caused more by imbalance of trees above the ground such as excessive branch spread rather than by the dynamic stability of the soil in which they grow.

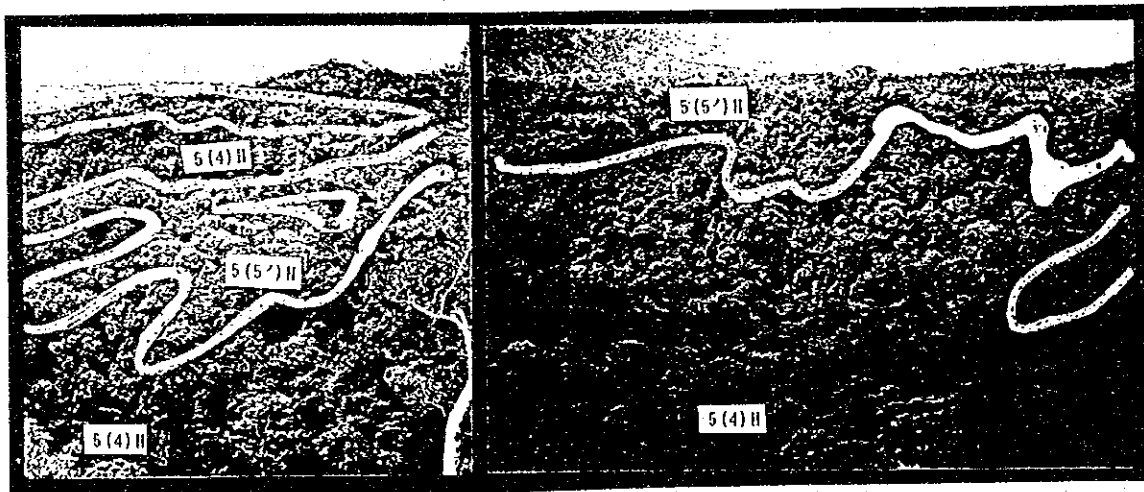


Figure-11 Classification of forest types

### 3.2.4. Expression accuracy of classification diagrams

The scale of 1:50,000 is the largest scale at present for topographical maps of the National Park area. Base maps of this scale have also had to be used in preparing classification maps.

Therefore, interpretation block lines by aerial photographs on a scale of 1:25,000 were transferred to match topographical expressions of topographical maps on a 1:50,000 scale.

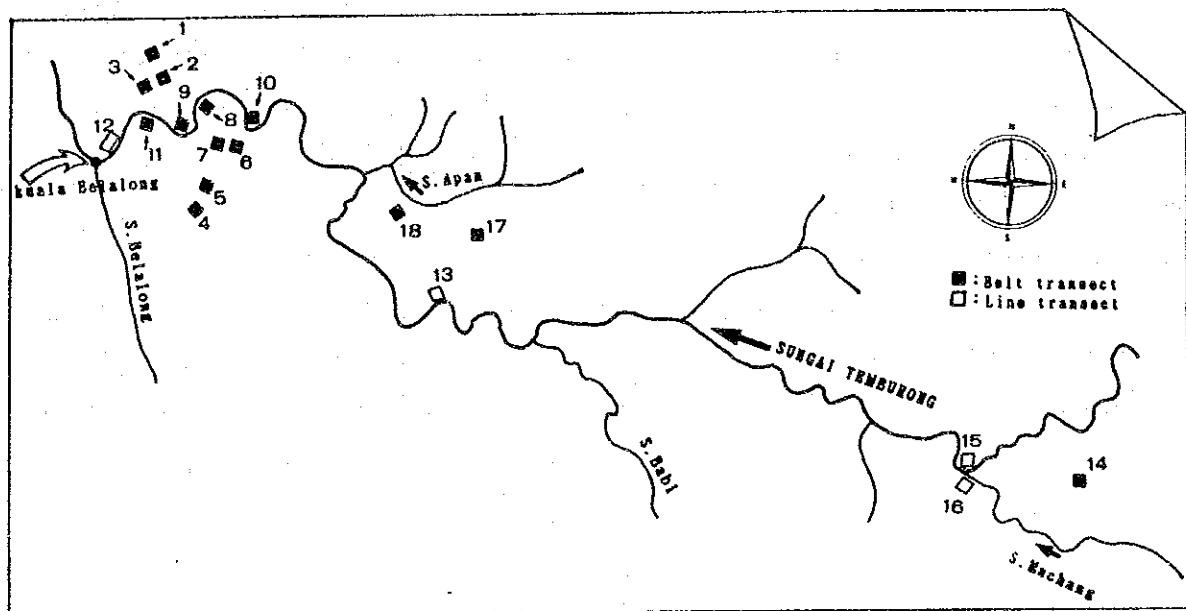


Figure-12 Survey plots of natural forest stands

### 3.3. Forest Stand Structure

#### 3.3.1. Selection of survey plots

The survey plots selected for the forest stands were identified from vegetation maps produced by interpreting the aerial photographs. These totalled 18 as shown in Figure-12. Ecotours of Ulu Temburong National Park are divided into day-trip and lodging-type tours. The survey was conducted by day-trip tours and many of the survey plots were set relatively close to Kuala Belalong. Plots 1, 2, 3 and 9 were set on ridges on the right bank of the Temburong River. Plots 4 to 8 were set on ridges on the left bank of the river. Plots 17 and 18 were in the Apan viewing route. Plot 14 was on the ridge at the Machang Fork. All of them are survey plots for forest stand structure inside

the Park. The Plot 12 on the right bank near Kuala Belalong, Plot 10 on the right bank further upstream, Plots 15 and 16 at the Machang Fork and other plots are for bank forest stands. Plots 11 and 13 were set to observe forest stands of bank slope areas.

### **3.3.2. Survey method**

Stereoscopic survey of forest structure was preferred to understand the forest characteristics of the National Park. For this purpose, the belt and line-transect methods, sometimes combined with the offset method, were found to be effective. The belt width was decided in accordance with the forest stand density and the number of species found. A belt width of 5m, which is generally used in Japan, was employed. The standard belt length was 50m. The line-transect method is effective in identifying forest landscapes on banks. The principal survey items recorded by these methods were species names (local and botanical names), tree height, diameter breast height, crown spread, buttress root height, withering condition and other parameters. Forest stand profiles and crown projection diagrams were sketched in the survey plots.

### **3.3.3. Results of the survey**

Figures-13 to 31 Belt (line)-transect of Natural Forest Stands and Table-3 to 20 Species Found and Dominance of Species show the survey results from each Plot, from Plot 1 to lot 18. The diagrams summarise profiles for individual species along with crown projection diagrams. The degrees of dominance of each species shown in the tables, is expressed as an accumulated value based on tree heights and crown areas. These values were obtained as a percentage of the total (averaged) value of tree height and crown area, for all species in the plot. The forest stand structure of each plot will be explained below using these diagrams and tables.

#### **a. Forest stand structures of plots on right-bank ridge**

##### **(a) No. 1 Belt-transect (Plot 1) (Figure-13, Table-3)**

This plot was located near Kuala Belalong and was the belt zone set at the highest point (altitude about 240 m) on a right bank ridge running nearly north to south. The foot of this ridge on the west side is connected to the forest viewing route for ecotours. A total of 22 species were found in this zone. Of

these species, six were Dipterocarp species. The tree density per ha was calculated to be 1,520 trees. The tree heights could be divided into five classes. The lowest was the ground class below 6m in height which is not shown in the diagrams. The number of trees in the ground class was 2,320 per ha. The highest tree height class was 41 to 45m. The dominant species in this belt zone were Damar hitam and Kumus.

(b) No. 2 Belt-transect (Plot 2) (Figure-14, Table-4)

This plot was a survey plot with an inclination of 10 set on a ridge connecting to the No. 1 belt zone. It was located about 450m from the main stream. A total of 22 species were found including seven Dipterocarp species. The number of trees per ha was 1,600 and tree heights could be classified into five classes. The number of trees in the ground class was 2,320 per ha. The top three dominant species in this belt zone were Malam, Damar hitam barun and Kedondong. Selangan batu tulang ikan and Damar hitam barun were prominent emergents.

(c) No. 3 Belt-transect (Plot 3) (Figure-15, Table-5)

This lower zone 100m west of the No. 2 Plot was set on the south-facing middle-slope of a valley. The 0 to 20m section of the 50m length was a gentle slope at 11° inclination. The inclination for the 20 to 50m section was about 30°. A total of 25 species were found including three Dipterocarp species. The tree density per ha was 1,240 and the tree height classes could be divided into four. The density of the ground class was 2,440 trees per ha. The dominant species of this zone were Mempisang and Pudu and the highest tree height class was 36 to 40m.

Three or four emergents were found scattered in an area 50m x 50m in the periphery of this plot. A survey of an area adjacent to the plot confirmed four emergents. The species and tree heights of these four emergents were as follows: Meranti puteh timbul: 55m, Selangan batu tulang ikan: 65m, Runggu: 55m, unknown species: 55m.

(d) No. 9 Belt-transect (Plot 9) (Figure-21, Table-11)

This plot was located at the bottom of a ridge on the right bank near Kuala Belalong. It was a tree belt facing nearly south bordering the main stream. The 0 to 20m section of the belt zone was a steep slope at 47 and the 20 to 50m section, a gentle slope with an inclination of 9°. A total of 12 species were

found including two Dipterocarp species. The tree density per ha was 720 trees. The ground class had 2,500 trees. The number of tree height classes was five. The highest tree height class was 46 to 50m, with Meranti sarang punai bukit and Menggaris as the dominant species that formed emergents.

b. Forest stand structures of plots on left-bank ridge

(a) No. 4 Belt-transect (Plot 4) (Figure-16, Table-6)

This belt zone was a plot with a gentle slope set at the highest point (altitude 300m) on a left bank ridge running north to south 200m upstream from the ridge on the right bank mentioned above. The large crowns of the tree species connected to this belt zone also spread into the survey belt to form emergents. The survey included these species also. These species were No. 19 Merawan and No. 20 Selangan batu daun nipis in Table-6. The number of species in this belt zone totaled 18 including four Dipterocarp species. The tree density per ha was 1,240 trees (ground class density was 4,200) and the highest tree height was the 46 to 56m class. There were five classes. The dominant species in this plot were Merawan, followed by Kedondong. Keruing ternek and Kempas formed the emergents, whose crown strata were continuous, with the Selangan batu daun nipis and Merawan adjoining the belt zone. Two withered trees were found, but they provided nests for wild birds in the National Park and had a value in enriching the natural environment.

(b) No. 5 Belt-transect (Plot 5) (Figure-17, Table-7)

This belt zone was a plot on a ridge about 250m down from the No. 4 plot. The 0 to 40m section had a gentle slope of 10° to 20° and the 40 to 50m section, a steep slope with an inclination of 30°. Eighteen species were found including four Dipterocarp species. The tree density per ha was 1,040 trees and the highest tree height class for this plot was the 46 to 50m class. The number of height classes totalled five. The ground class had 2,400 trees per ha. Kapur paji was present in significant numbers as the dominant species. Emergents were Kapur paji and Mempisang, a forming a continuous crown strata together with Ubah connected to the belt zone.

(c) No. 7 Belt-transect (Plot 7) (Figure-19, Table-9)

This belt zone had a length of 55 m set on a gentle slope on a ridge 250m below the No. 5 Plot. A total of 30 species were found and this plot had the



largest number of species found among the surveyed plots. The tree density of this plot per ha was 2,040 and the dominant species were Selangan batu tulang ikan and Merawan. The highest tree height class was the 61 to 65m class and the species Damar hitam barun in this class formed the emergent. Another Damar hitam barun tree adjacent to this belt zone was also an emergent on this ridge covering this survey plot. A tree height of 65 m found in this plot was the highest in all the plots. The ground class density was 2,250 trees.

(d) No. 6 Belt-transect (Plot 6) (Figure-18, Table-8)

This belt zone was set on an eastern slope 25m below the No. 7 Plot and had inclinations of 25° to 40°. The number of species totaled 19 including three Dipterocarp species. The tree density per ha was 1,000 trees and the tree height classes totalled five. The ground class had a density of 1,480 trees. Menggaris had the highest degree of dominance followed by Meranti majau which was responsible for the highest tree height class for this plot. Meranti majau and Meranti sarang punaib bukit formed emergents.

(e) No. 8 Belt-transect (Plot 8) (Figure-20, Table 10)

This belt zone was located in the bottom of the left bank ridge and was near the bank. Its inclination was about 20°. Fifteen species were found including three Dipterocarp species. This plot had five tree height classes and a density per ha of 1,560 trees (2,480 trees for the ground class). The dominant species was Meranti binatoh which was responsible for the highest tree height class (46 to 50m).

c. Forest stand structure of the Apan Viewing Route

The Apan Viewing Route in the watershed of the Sg. Apan 2.6km upstream from Kuala Belalong is set in a primeval forest with a continuous wide ridge abundant with a variety of species. It was refreshing to reach this forest along the wide ridge route stepping on fallen leaves. The Dipterocarp species had a bearing year during the survey, and key fruits flying down onto the ground could also be viewed. As mentioned previously, the trees along this route were surveyed by the offset method. Belt-transects were set in two places to interpret forest landscapes more stereoscopically.

(a) No. 13 Belt-transect (Plot 17) (Figure-25, Table-15) This belt zone was a plot set on a ridge near the peak of the viewing route and was nearly flat

running 35m from east to west. Fifteen species were found including seven Dipterocarp species. The tree density per ha was 1,770 trees. The dominant species were Meranti langgai bukit, Ubah and Merawan. This plot had four tree height classes, the highest class being the 41 to 45m class. Meranti langgai bukit and Selangan batu formed the emergents. The ground class density was 2,880 trees.

(b) No. 14 Belt-transect (Plot 18) (Figure-26, Table-16)

This belt zone was located in the lower part of the ridge on the Apan route. It was an almost level survey plot running roughly north to south set on the ridge path which traversed toward the hillside from the route entrance in order to avoid the steep slope. A total of 22 species were found including six Dipterocarp species. Ubah formed the largest number of trees and had the highest degree of dominance. The number of trees per ha was 1,880 and the plot had five tree height classes. The density of the ground class was high, 4,160 trees. The emergent class was the 41 to 55m class and the species Resak, Merpauh, Kapur paji and Pendarahan formed emergents of continuous crowns.

d. Forest stand structures of ridge at Machang Fork

(No. 12 Belt-transect)

(Plot 14) (Figure-24, Table-14)

Following the Temburong River upstream the fork with Sg. Machang is reached 8.3km from Kuala Belalong. The ridge developed by this fork contains continuous knife ridges. Climbing on this ridge track was quite difficult. This belt zone was set on a slope on this ridge track with inclinations of 16° to 29°, 50m below the first hilly plateau (altitude 380m). This belt zone had 13 species including three Dipterocarp species. Ubah and Merawan were the dominant species. The tree density per ha was 1,560 trees and the number of tree height classes was four. The highest tree height class was the 26 to 30m class and this plot did not have any emergents. Another characteristic of this belt zone was that the number of trees in the ground class was 7,360 and the forests were dense.

e. Descriptions of the forests along the banks

(a) No. 1 Line-transect (Plot 12)

(Figures-27 and 28, Table-17)

Forests at the waterside near Kuala Belalong were surveyed in this line zone. The line length was 100m and Figure-27 is expressed as a front view from the channel. Figure-28 is a side view. These two diagrams show crowns projected on the stream. Landscapes of boats cruising the channel upstream and quietly passing through green tunnels to be immersed in the beauty of nature under a shower of fragrance from forest trees could be imagined.

A total of 20 species were found in this plot. Principal species which covered the water surface by spreading crowns to form tunnels were two species, Keruing neram and Merawan jangkang. These two species were also the dominant species in this plot.

(b) No. 2 Line-transect (Plot 13)

(Figure-29, Table-18)

This was the line zone set from the upstream entrance to the Apan viewing route on the right bank of the main stream, and the offset method was also used. This plot was set to confirm species which comprised emergents on the slopes of the hillsides nearby. Figure-29 and Table-18 show that these species were Meranti binatoh, Kawang jantong and Ura mata bukit.

(c) No. 3 Line-transect (Plot 15)

(Figure-30, Table-19)

This was the line zone set parallel to the right bank of the main stream at the Machang Fork and the offset method was also used. Eight species were found in this line zone. As in the No. 1 line zone, Keruing neram showed a high dominance.

(d) No. 4 Line-transect (Plot 16)

(Figure-31, Table-20)

This was the line zone set parallel to the left bank of the tributary at the Machang Fork and 12 species were found along the 50m line. Species that showed a particularly high tree height class were not found. Ura mata bukit and Kunau drawn in the side view were found some distance from this line and were emergents in forest stands near this line zone.

(e) No. 10 Belt-transect (Plot 10)

(Figure-22, Table-12)

This was the belt zone 60m in length set parallel to the main stream of the Temburong River and was a standard plot which represented forests of banks

in this neighborhood. Species in this belt zone totaled 17 including four Diptetrocarp species. The dominant species was Matan. The tree density per ha in this belt zone was 700 trees and was sparse. However, the projected crowns were continuous. The tree height classes totaled five and the highest was the 41-45m class. Meranti sarang punai bukit spread its large crowns and formed emergents. The number of trees in the ground class was 1,260 per ha.

(f) No. 11 Belt-transect (Plot 11) (Figure-23, Table-13)

This belt zone was set toward a hillside on the left bank near Kuala Belalong. The section from the waterside to 20m was a steep slope with an inclination of 42° and the section 20 to 50m was a slope with an inclination of 22°. This zone had 22 species. The number of trees per ha was 1,280 and the density of the ground class below 6m was 2,960. This belt zone had five tree height classes. The highest tree height class was the 51 to 55m class and three species formed emergents higher than 41m, namely, Menggaris, Geronggang and Empaling. The dominant species were Medang with the highest number of trees and Empaling which had large crown areas.



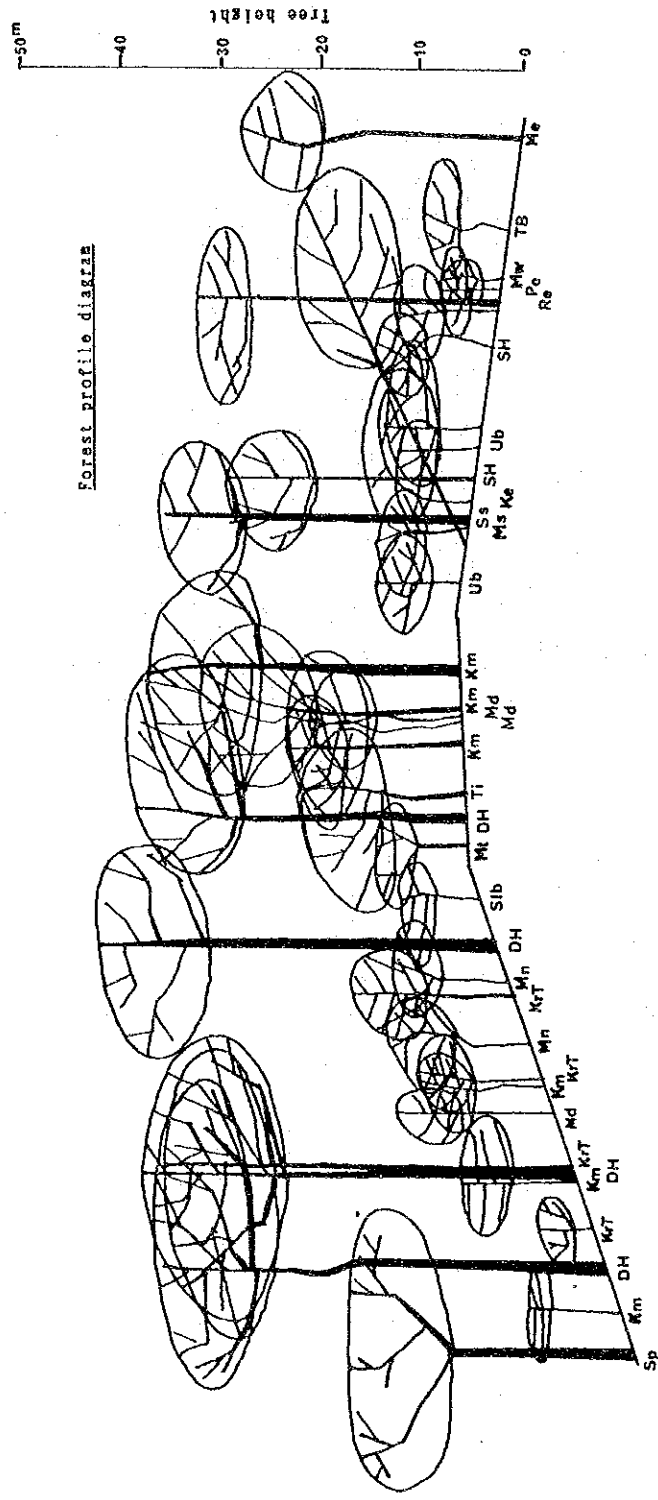


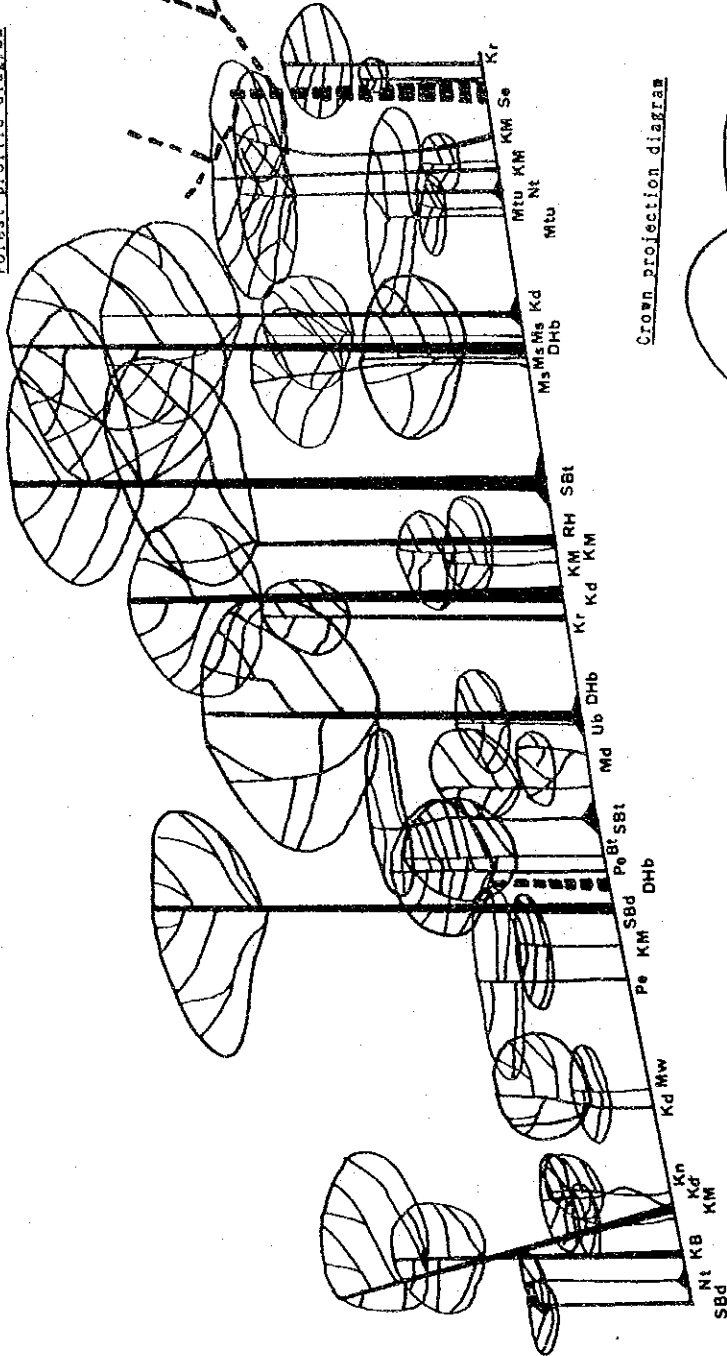
Figure-13 No.1 Belt-transect (Plot No.1)

Table-3 Tree species and dominance No.1 Belt-transect (Plot No.1) Notes : - - - - unknown species (Death)- - - - Dead tree

Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Dominance							
No	Vernacular name		Botanical name	6-10	11-15	16-20	21-25				26-30	31-35	36-40	41-45	46-50	51-55	56-60
1	Meranti(Me)	<i>Shorea</i> sp.	1			1									28	11.84	2.7
2	Telinga basing(TB)	<i>Cleistanthus winkleri</i>	1	1											8	8.16	1.1
3	Merawan(Mw)	<i>Hopea</i> spp.	1	1											6	1.28	0.4
4	Rengas(Re)	<i>Androtium astyllum</i>	1			1									30	30.88	4.2
5	Pendarahan(Pe)	<i>Myristica</i> spp.	1												6	9.44	1.1
6	Sertul hutan(SH)	<i>Sandoricum</i> sp.	2	1		1									35	20.96	3.9
7	-		1	1											10	4.32	1
8	-		1	1											9	16	1.7
9	Ubah(OB)	<i>Eugenia</i> spp.	2	2											15	18.4	2.3
10	KerANJI(Ke)	<i>Dialium cochinchinense</i>	1	1											10	20.8	2.1
11	Selunsor(Ss)	<i>Tristania anomala</i>	1			1									30	11.84	2.9
12	Menpisang(Ms)	<i>Disepalum anomalum</i>	1		1										18	5.76	1.6
13	-		1		1										20	33.28	3.7
14	Kumus(Km)	<i>Shorea laevis</i>	6	2	2	1		1							115	120	16.2
15	Medang(Md)	<i>Actinodaphne</i> sp.	3	1	2										48	37.92	5.9
16	Tibadak(Ti)	<i>Artocarpus integer</i>	1		1										17	31.68	3.4
17	Damar hitam(DH)	<i>Shorea richetioides</i>	4					1	1	2					162	198.4	24.9
18	Meritam(Mt)	<i>Nephelium mutabile</i>	1	1											10	10.08	1.4
19	Selangan batu(Slb)	<i>Shorea</i> spp.	1	1											8	16.32	1.7
20	Mempening(Mn)	<i>Lithocarpus</i> spp.	2		2										24	21.6	3.1
21	Keruing ternek(Krt)	<i>Dipterocarpus Palembangicus</i>	4	1	2					1					76	76.64	10.5
22	SePETIR(Sp)	<i>Sindora corriaceae</i>	1			1									28	32.96	4.2
Total			38	12	7	7	2	4	2	1	3				713	738.56	100

50m  
40  
30  
20  
10  
0  
Tree height

Forest profiles diagram



Crown projection diagram

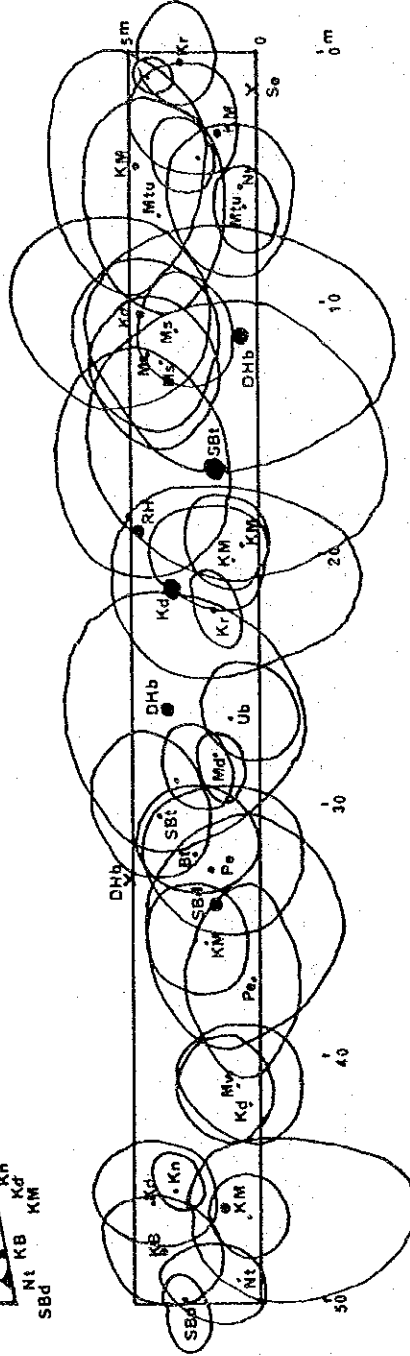


Figure-14 No.2 Belt-transect (Plot No.2)



Table-4 Tree species and dominance No.2 Belt-transect (Plot No.2)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class						Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance					
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30	31-35				36-40	41-45	46-50	51-55	56-60
1	Keruing(Kr)	Dipterocarpus sp.	2			1									48	9.8	3.8
2	Selunsor(Se)	Tristania anomala	1						1						35	-	2.3
3	Halam(Ml)	Diospyros spp.	6	1	2		1	1	1						123	89	14.1
4	Nyatch(Nt)	Chrysophyllum lenceletum	2			1									42	26.5	4.5
5	Medang tiga urat(Mtu)	Cinnamomum spp.	2	1	1										19	32.1	3.4
6	Kedondong(KG)	Burseraceae spp.	4	2						2					109	78.8	12.5
7	Mempisang(Ms)	Disepalum anomalum	3	1			1	1							64	51.9	7.7
8	Damar hitam baru(DBb)	Shorea xanthophylla	3	1						1					98	91.7	12.6
9	Selangan batu tulang ikan(SBt)	Shorea superba	2				1							1	74	65.9	9.3
10	Resak hijau(RH)	Vitica micrantha	1								1				40	28.8	4.6
11	Ubah(Ub)	Eugenia spp.	1	1											12	7.4	1.3
12	Medang(Md)	Actinodaphne spp.	1	1											7	3.9	0.7
13	Birtawak(Bt)	Artocarpus anisophyllus	1			1									20	16.5	2.4
14	Pendarahan(Fe)	Myristica spp.	2	1				1							37	39.5	5.1
15	Selangan batu daun nipis(SBd)	Shorea glaucescens	2			1						1			61	35.6	6.4
16	Merawan(Mw)	Hopea spp.	1	1											7	11.9	1.3
17	Runaw(Rn)	Baccaurea racemosa	1	1											12	3.5	1.0
18	Kapur bukit(KB)	Dryobalanops beccarii	1										1		28	12.9	2.7
19	-		1	1											10	5.1	1.0
20	-		1	1											15	7.2	1.5
21	-		1	1											12	2.3	0.9
22	-		1	1											6	6.3	0.8
Total			40	6	12	4	4	5	2	2	3	1	1	0	879	626.6	100.0

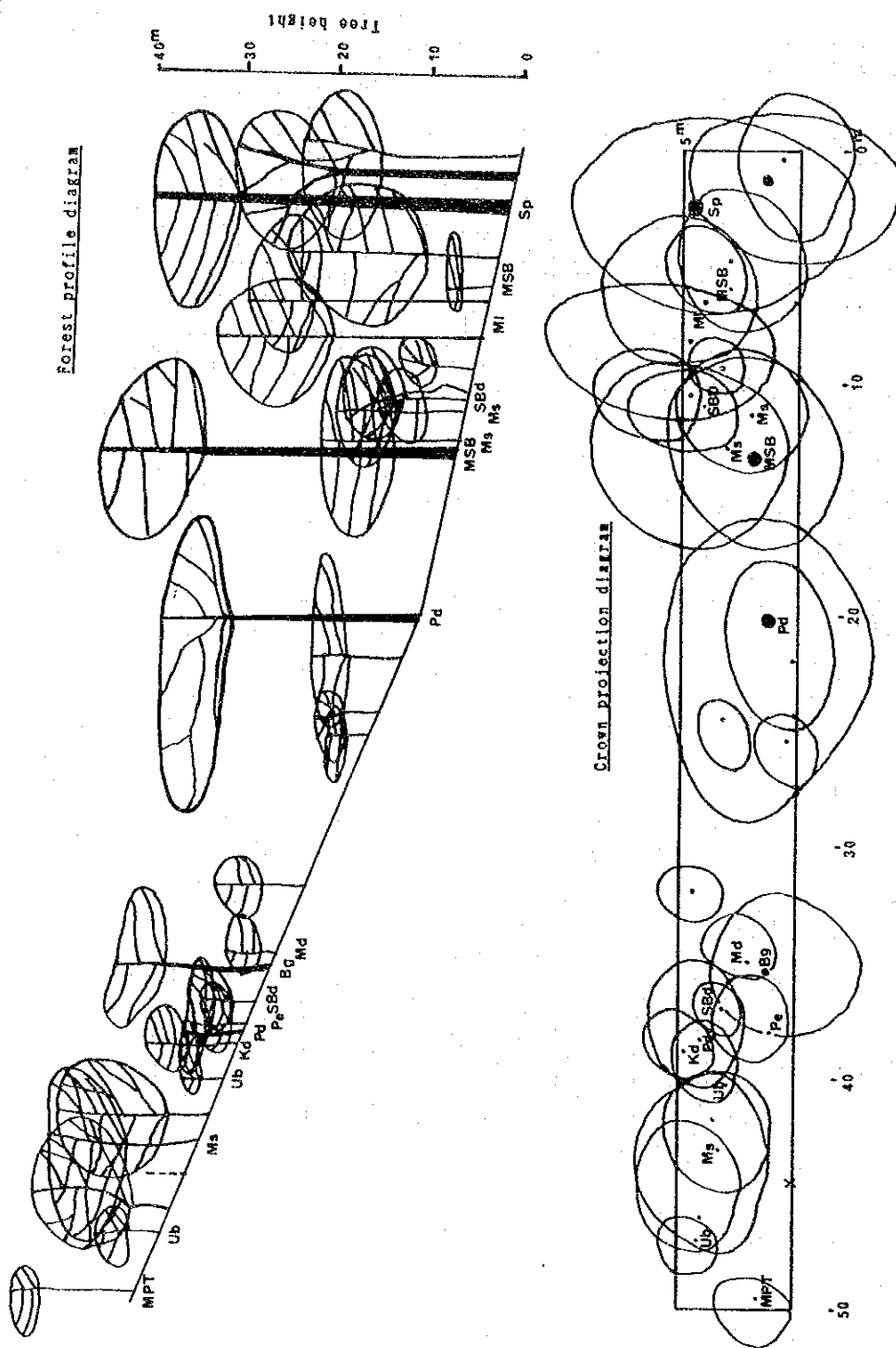


Figure-15 No.3 Belt-transect (Plot No.3)

Table-5 Tree species and dominance No.3 Belt-transect (Plot No.3)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domi-nance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Meranti puteh timbul(MPT)	Shorea agani	1	1											13	3.7	1.8
2	Ubah(Ub)	Eugenia spp.	2	2											15	10.8	2.8
3	Wempisang(Ms)	Disepalum anomalum	3	2	1										43	76	12.9
4	Kedondong(Kd)	Eurseraceae spp.	1	1											10	3.8	1.5
5	Pudu(Pd)	Artocarpus kemandu	2	1		1									41	71	12.1
6	Pendarahan(Pe)	Myristica spp.	1	1											7	10.3	1.9
7	Selangan batu daun nipis(SBd)	Shorea glaucescens	2	2											17	10.6	3.0
8	Bintangor(Bg)	Calopteryx spp.	1		1										17	17.1	3.7
9	Medang(Md)	Actinodaphne spp.	1	1											8	4	1.3
10	Meranti sarang punai bukit(MSb)	Shorea ovata	2	1					1						46	44.4	9.8
11	Sepetir(Sp)	Sindora corriacea	1						1						40	34.1	8.0
12	Malam(Ml)	Diospyros spp.	1							1					28	18.7	5.1
13	-		1	1											15	12.5	3.0
14	-		1		1										17	18	3.8
15	-		1	1											6	7.1	1.4
16	-		1	1											8	4.4	1.3
17	-		1	1											8	4.7	1.4
18	-		1	1											10	18.5	3.1
19	-		1		1										13	1.8	1.6
20	-		1	1											8	4.6	1.4
21	-		1			1									26	17.1	4.7
22	-		1		1										23	24.3	5.1
23	-		1			1									30	20	5.4
24	-		1		1										24	8.1	3.5
25	-		1	1											4	0	0.4
Total			31	14	6	3	2	4	0	2	0	0	0	0	477	445.6	100.0

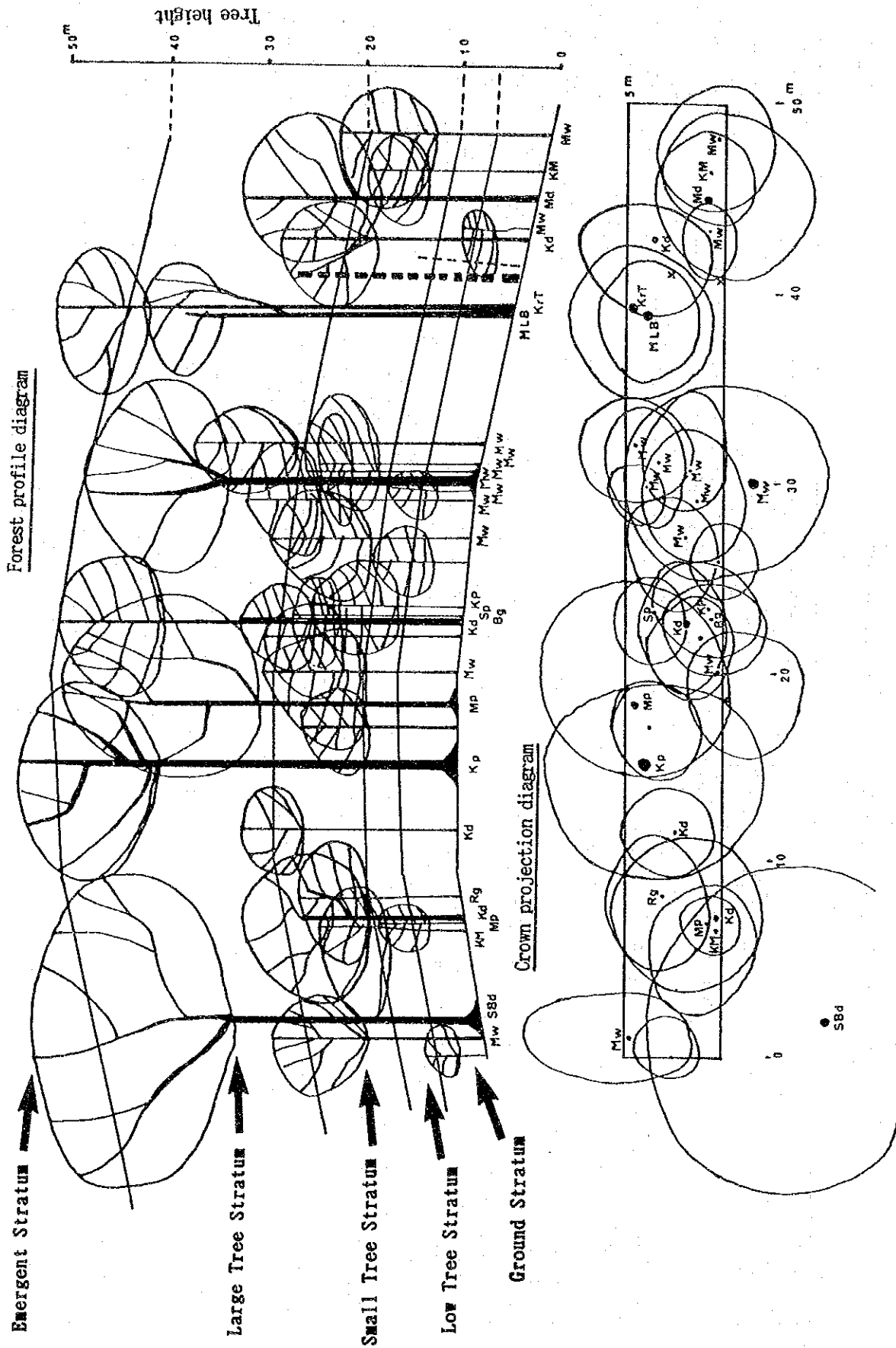


Figure-16 No.4 Belt-transect (Plot No.4)

Table-6 Tree species and dominance No.4 Belt-transect (Plot No.4)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (mf)	Domiance					
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55
1	Merawan(Mw)	Hopea spp.	10	2	4	2	2	2						190	148.1	27.1
2	Malam(Ml)	Diospyros spp.	2		1	1								32	18.7	4.1
3	Medang(Md)	Actinodaphne spp.	1				1							30	26	4.5
4	Kedondong(Kd)	Burseraceae spp.	4			3			1					109	95.3	16.4
5	Meranti langgai bukit(MLB)	Shorea pinanga	1						1					37	19.9	4.6
6	Keruing ternek(KRT)	Dipterocarpus palembanicus	1								1			47	29	6.1
7	Kapur paji(KP)	Dryobalanops lanceolata	1		1									15	14.2	2.3
8	Sepetir(Sp)	Sindora corriacea	1					1						17	12.9	2.4
9	Bintangor(Bg)	Calophyllum spp.	1					1						22	12	2.7
10	Merpauh(Mp)	Swintonia glauca	2	1					1					49	50.5	8.0
11	Kengas(Kp)	Koompassia malaccensis	1									1		45	50.5	7.7
12	Runggu(Rg)	Azadirachta excelsa	1					1						16	25.5	3.3
13	-		1	1										9	5	1.1
14	-		1					1						19	16.9	2.9
15	-		1					1						16	17.4	2.7
16	-		1	1										6	5.8	0.9
17	(Death)		1	1										10	0	0.8
18	(Death)		1					1						30	0	2.4
19	(Merawan(Mw))	(Hopea spp.)	(1)											(45)	(22.2)	
20	(Selangan batu daun nipis(Sbd))	(Shorea glaucescens)	(1)											(45)	(21.6)	
			32	6	2	9	6	4	0	3	1	1	1	699	547.7	100.0
		T o t a l	(2)													

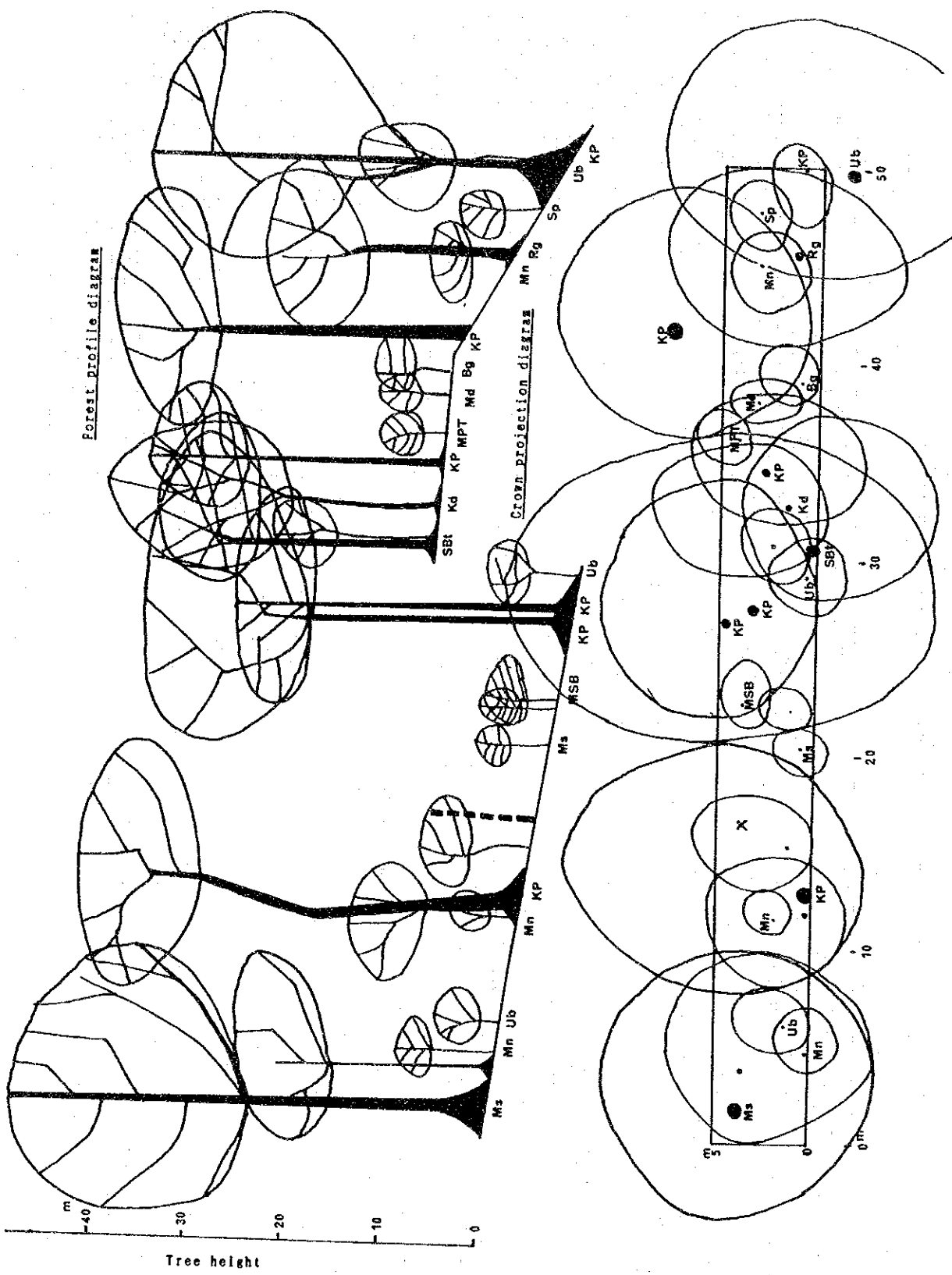


Figure-17 No.5 Belt-transect (Plot No.5)

Table-7 Tree species and dominance No.5 Belt-transect (Plot No.5)

Notes : - - - Unknown species  
(Death) - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Mempisang(Ms)	<i>Disepalum anomalum</i>	2	1							1				56	51.2	10.4
2	Melumak(Mn)	<i>Pentace floribunda</i>	3	3											25	22.6	4.6
3	Ubar(Ub)	<i>Eugenia spp.</i>	2	2											17	18.4	3.4
4	Kapur paji(KP)	<i>Dryobalanops lanceolata</i>	5			1	1	1							172	223.3	38.4
5	Meranti sarang punai bukit(Msb)	<i>Shorea ovata</i>	1	1											7	7.2	1.4
6	Selangan batu dulan ikan(SET)	<i>Shorea superba</i>	1				1								28	20.2	4.7
7	Kedondong(Kd)	<i>Burseraceae spp.</i>	1					1							34	28.8	6.1
8	Meranti puteh timbul(MPT)	<i>Shorea agardi</i>	1	1											6	4.2	1.0
9	Medang(Md)	<i>Actinodaphne spp.</i>	1	1											6	6.6	1.2
10	Birtangor(Bg)	<i>Calophyllum spp.</i>	1	1											6	7.2	1.3
11	Runggu(Rg)	<i>Azadirachta excelsa</i>	1					1							24	44.6	6.7
12	Sepetir(Sp)	<i>Sindora corriacea</i>	1	1											8	8.9	1.6
13	-		1					1							25	46	6.9
14	-		1			1									17	29.7	4.5
15	-		1	1											10	21	3.0
16	-		1	1											7	4.4	1.1
17	-		1			1									16	10.5	2.6
18	(Death)		1	1											11	0	1.1
19	(Ubar(Ub))	<i>(Eugenia spp.)</i>	(1)												(42)	(25.7)	
20	(Kapur paji(Kp))	<i>(Dryobalanops lanceolata)</i>	(1)												(40)	(38)	
Total			26	13	1	2	3	2	2	0	2	1	0	0	475	554.8	100
			(2)								(1)	(1)					

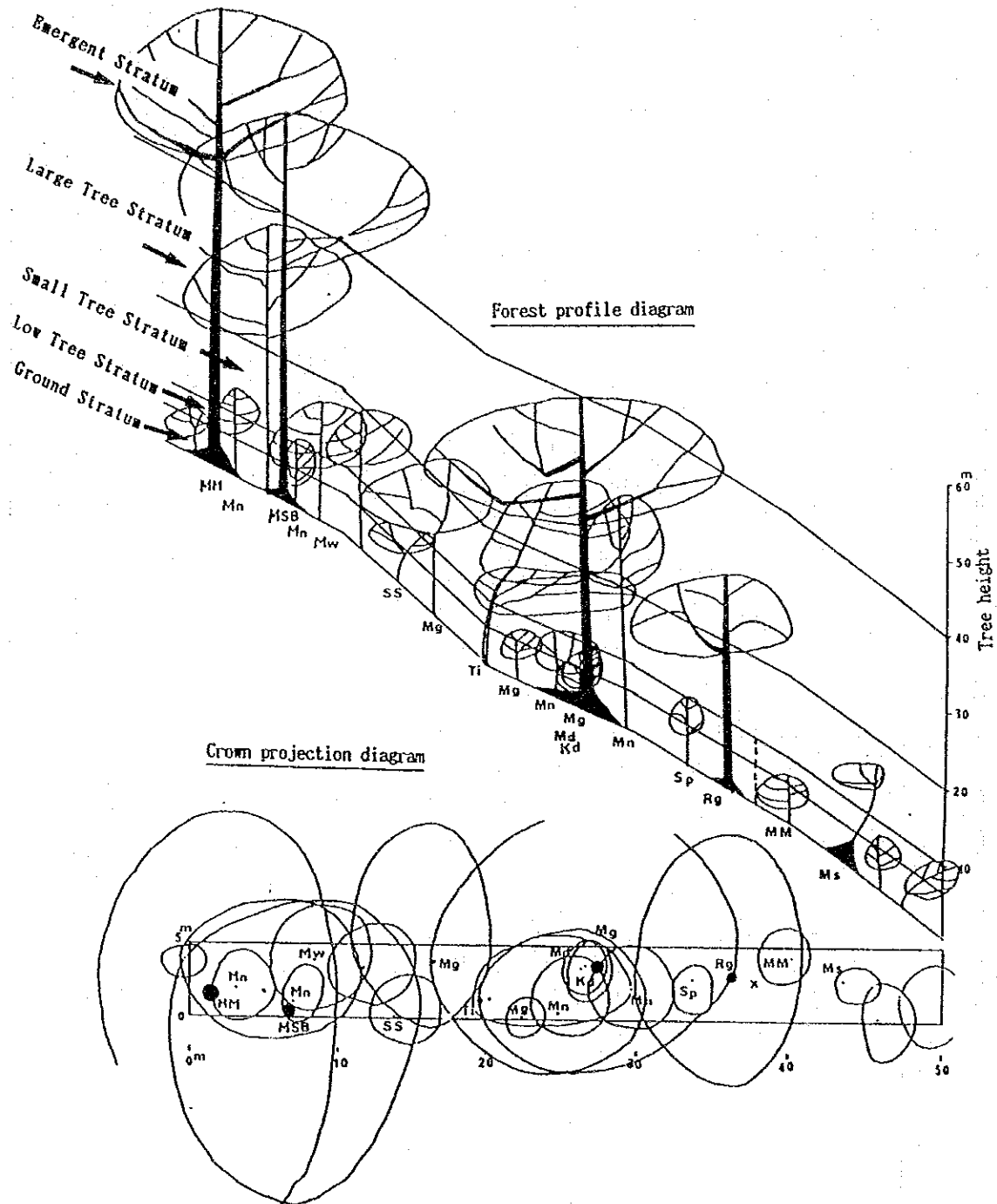


Figure-18 No.6 Belt-transect (Plot No.6)



Table-8 Tree species and dominance No.6 Belt-transect (Plot No.6)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Mempisang (Ms)	<i>Disepalum anomalum</i>	1	1											13	6.8	1.8
2	Runggu (Rg)	<i>Azadirachta excelsa</i>	1			1									28	54.9	7.6
3	Melunak (Mn)	Pentace floribunda	4	2	1										55	65.1	11.1
4	Sepetir (Sp)	<i>Sindora corriacea</i>	1	1											8	8.5	1.5
5	Meranti majau (Mj)	<i>Shorea leptoclados</i>	2	1										1	67	62.8	12.0
6	Menggaris (Mg)	<i>Koompassia excelsa</i>	3	1			1								68	137.2	18.9
7	Medang (Md)	<i>Actinodaphne</i> spp.	1	1											9	8.6	1.6
8	Kedondong (Kd)	<i>Burseraceae</i> spp.	1	1											8	7.4	1.4
9	Tibadak (Ti)	<i>Artocarpus integer</i>	1				1								25	45.6	6.5
10	Sireh sireh (Ss)	<i>Pternandra coeruleoscens</i>	1	1											8	12.3	1.9
11	Merawan (Mw)	<i>Hopea</i> spp.	1		1										15	24.8	3.7
12	Meranti sarang punai bukit (Msb)	<i>Shorea ovata</i>	1								1				50	74.1	11.4
13	-		1	1											7	0.4	0.7
14	-		1	1											8	6.2	1.3
15	-		1	1											13	48.9	5.7
16	-		1		1										20	20.1	3.7
17	-		1			1									28	54.5	7.6
18	-		1	1											7	2.1	0.8
19	(Death)		1	1											8.5	0	0.8
20																	
Total			25	12	4	1	3	2	0	1	0	0	0	1	445.5	640.3	180.0



Table-9 Tree species and dominance No.7 Belt-transect (Plot No.7)

Notes : - - - Unknown species (Death) - - - Dead tree

No	Species		Number of trees	Number of trees in each height classes						Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance				
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30	31-35				36-40	41-45	46-50	51-55
1	Salangan batu tulang ikan(SBT)	<i>Shorea superba</i>	3			1	1	1						111	138.9	12.7
2	Damar hitam baru(DHb)	<i>Shorea xanthophylla</i>	2				1							103	87.7	9.7
3	Melunak(Mn)	<i>Pentace floribunda</i>	2	2										15.5	20.1	1.8
4	Kandis(Kd)	<i>Garcinia baccharii</i>	1		1									20	15.4	1.8
5	Meranti putih timbul(MPT)	<i>Shorea agami</i>	3	2	1									27.5	32.2	3.0
6	Merawan(Mw)	<i>Hopea spp.</i>	10	6	4									102	147.5	12.6
7	Geronggang(Gg)	<i>Cratogeomys ligustrinum</i>	1				1							30	55.1	4.3
8	Kembang somangkok(KS)	<i>Scaphium macropodium</i>	2		2									38	67.5	5.3
9	Keranji(Ke)	<i>Dialium cochinchinense</i>	1				1							28	14.1	2.1
10	Bintangor(Bg)	<i>Calophyllum spp.</i>	3	2	1									31	15.3	2.3
11	Ubah(Ub)	<i>Eugenia spp.</i>	4	1	2				1					83	79.1	8.2
12	Mempisang(Ms)	<i>Disepalum anomalum</i>	3	2			1							49	60.3	5.5
13	Salangan batu daun ripis(SBd)	<i>Shorea glaucescens</i>	1				1							23	39.6	3.2
14	Telinga basing(TB)	<i>Cleistanthus winkleri</i>	3	1	1		1							41	68.5	5.5
15	Pulai(Pl)	<i>Alstonia angustifolia</i>	1		1									14	14.1	1.4
16	Malan(Ml)	<i>Diospyrus spp.</i>	1		1									11	10.9	1.1
17	Nyatoh(Nt)	<i>Cryophyllum lenceletum</i>	1						1					38	20.6	3.0
18	Kedondong(Kd)	<i>Burseraceae spp.</i>	2					1						37	42.7	4.0
19	Medang(Md)	<i>Actinodaphne spp.</i>	1	1										7.5	12.3	1.0
20	-	-	1	1										7	6.4	0.7
21	-	-	1	1										8	3.1	0.6
22	-	-	1	1										8.5	6.5	0.8
23	-	-	1	1										6	10	0.8
24	-	-	1	1										9	12.9	1.1
25	-	-	1	1										12	8.2	1.0
26	-	-	1	1										9	5.9	0.8
27	-	-	1	1										12	30.3	2.1
28	-	-	1	1			1							22	27.2	2.5
29	(Death)	-	1	1										14	0	0.7
30	(Death)	-	1	1										6	0	0.3
31	Damar hitam baru(DHb)	<i>Shorea xanthophylla</i>	(1)											(60)	(55.9)	
	Total		55	25	13	5	3	5	0	4	1	0	0	1	1052.4	100.0

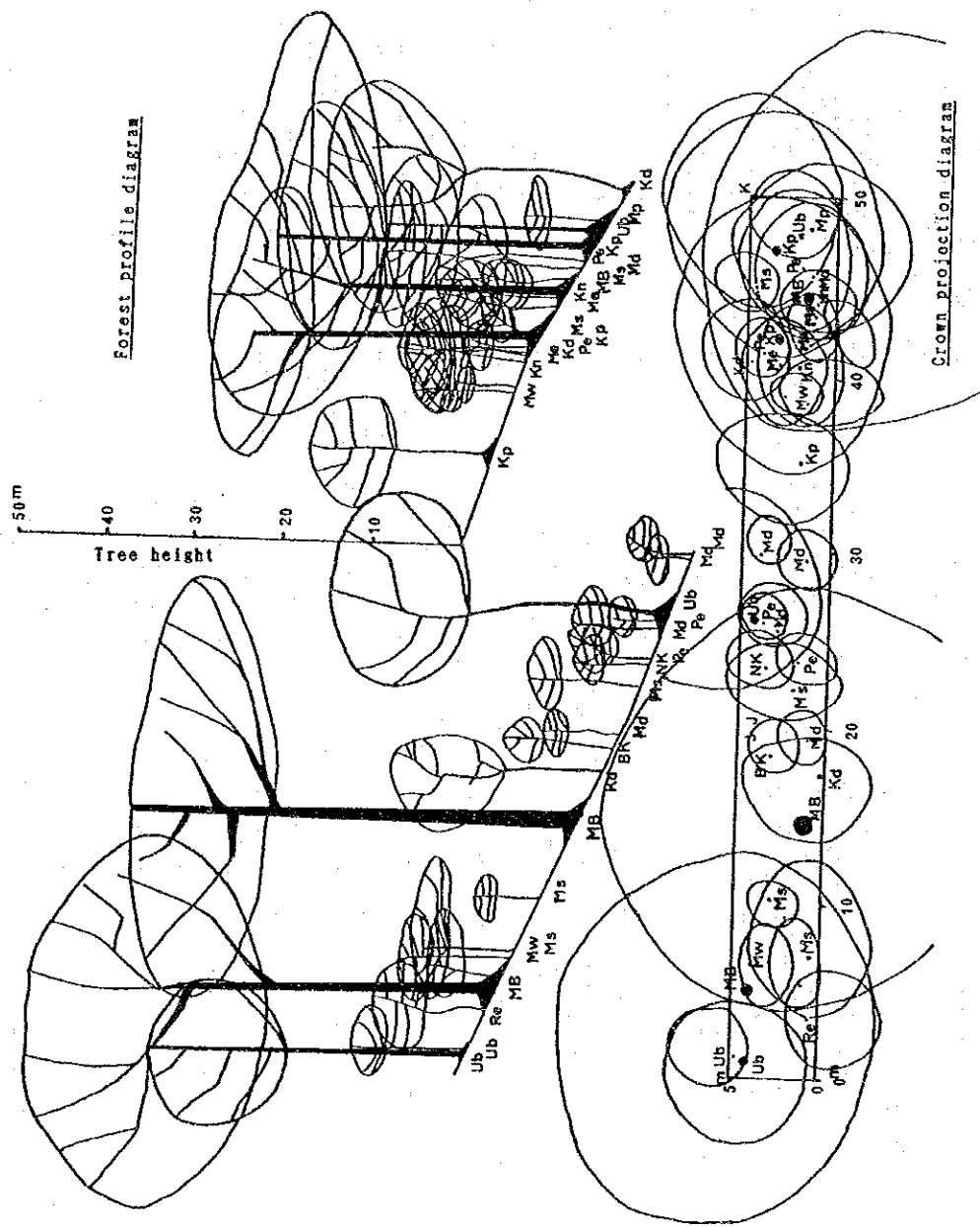


Figure-20 No.8 Belt-transect (Plot No.8)

Table-10 Tree species and dominance No.8 Belt-transect (Plot No.8)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Ubah(Ub)	<i>Eugenia</i> spp.	4	1	1	1	1	1							110	93.2	12.9
2	Rengas(Re)	<i>Androtium astyllum</i>	1	1											12	7.8	1.3
3	Meranti binatoh(MeB)	<i>Shorea argentifolia</i>	3				1	2							136	280.1	26.3
4	Merawan(Mw)	<i>Hopea</i> spp.	2	2											24	21.2	2.9
5	Mempisang(Ms)	<i>Disepalum anomalum</i>	6	5	1										56.5	74	8.3
6	Bangkoh(Bk)	<i>Xylopia caudata</i>	1	1											12	6.6	1.2
7	Kedondong(Kd)	Burseraceae spp.	3	1	1			1							74	60.4	8.5
8	Medang(Md)	<i>Actinodaphne</i> spp.	5	3	2										45	61.5	6.7
9	Nipis kulit(NK)	<i>Memecylon</i> spp.	1	1											8	8.8	1.1
10	Pendarahan(Pe)	<i>Myristica</i> spp.	4	3			1								43	53.1	6.1
11	Kempas(Kp)	<i>Koopassia malaccensis</i>	3			1			1						94	147.5	15.3
12	Kunau(Kn)	<i>Baccaurea racemosa</i>	2	2											29	35.7	4.1
13	Meranti(Me)	<i>Shorea</i> sp.	2	2											26	30.5	3.6
14	-		1	1											7	11.7	1.2
15	-		1	1											7	5.7	0.8
16																	
17																	
18																	
19																	
20																	
Total			39	14	13	1	3	0	2	4	0	2	0	0	683.5	897.8	100.0

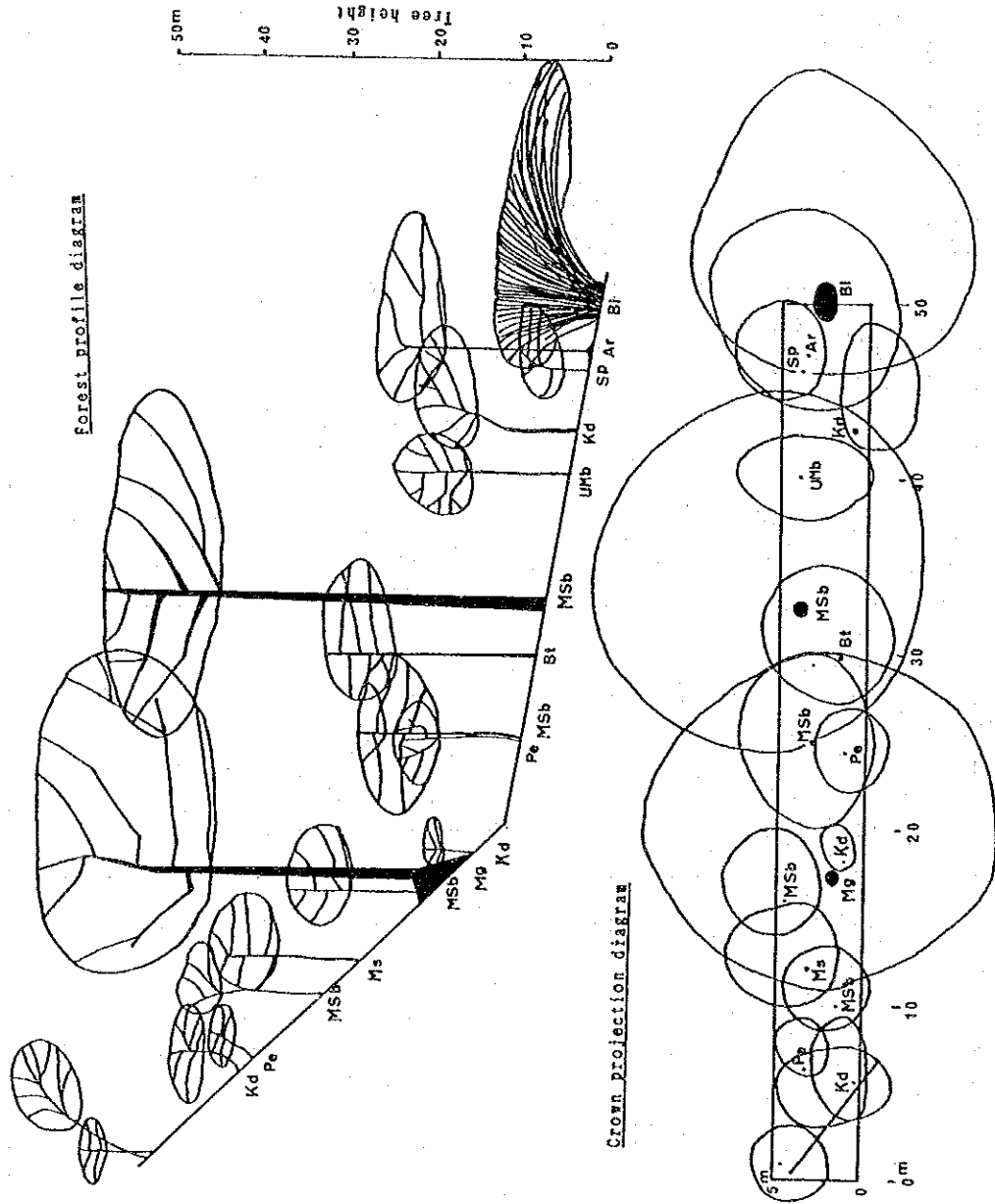


Figure-21 No.9 Belt-transect (Plot No.9)

Table-11 Tree species and dominance No.9 Belt-transect (Plot No.9)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

Species		Number of trees	Number of trees in each height class						Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Dominance							
No	Vernacular name		Botanical name	6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60	61-65
1	Kedondong(Kd)	Burseraceae spp.	3	2	1	1										32.5	27.5	7.4
2	Pendarahan(Pe)	Myristica spp.	2	1	1											21	19.4	5.0
3	Meranti sarang punai bukit(MSb)	Shorea ovata	4		3					1						101	172.1	33.5
4	Mempisang(Ms)	Disepalum anomalum	1		1											17	19.5	4.5
5	Menggaris(Mg)	Koompassia excelsa	1							1						50	94	17.7
6	Bintawak(Bt)	Artocarpus anysophyllus	1					1								23	36	7.2
7	Urut mata bukit(Umb)	Parashorea parvifolia	1		1											20	22.3	5.2
8	Simpox(Sp)	Dillenia suffruticosa	1	1												9	11.6	2.5
9	Ara(Ar)	Ficus spp.	1					1								25	30.3	6.8
10	Buluh(Bl)		1		1											11	20.7	3.9
11	-		1		1											15	20	4.3
12	-		1	1												7	9.2	2.0
Total			18	5	3	6	2	0	0	0	2	0	0	0	0	331.5	482.6	100.0

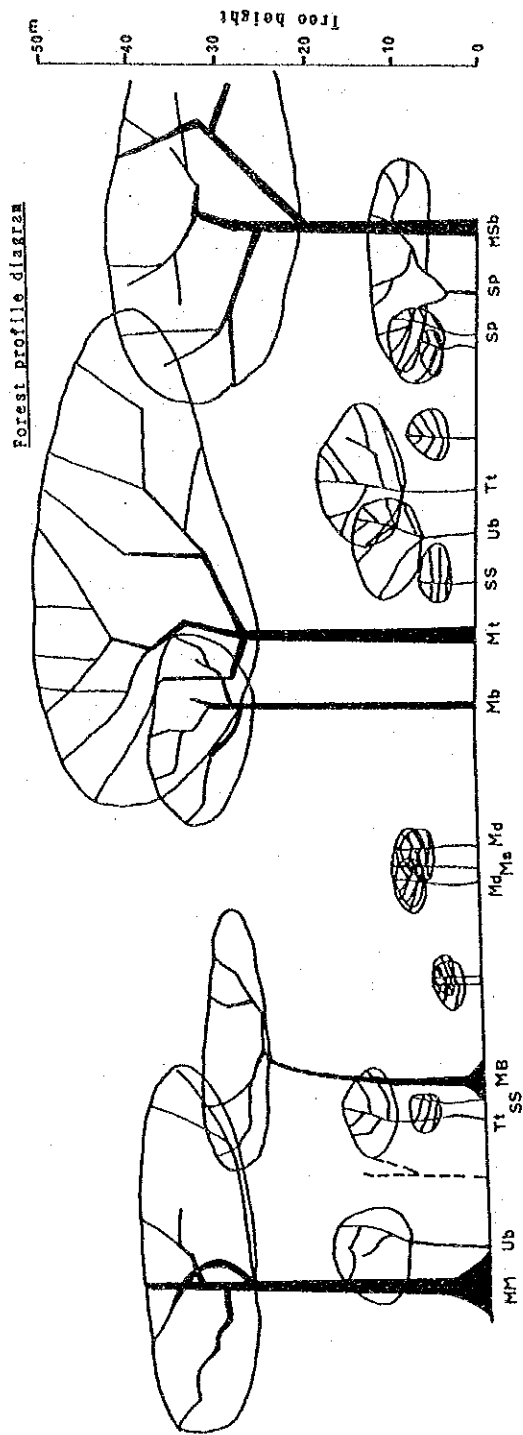


Figure-22 No.10 Belt-transect (Plot No.10)



Table-12 Tree species and dominance No.10 Belt-transect (Plot No.10)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

Species		Number of trees	Number of trees in each height Class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Diameter							
No	Vernacular name		Botanical name	6-10	11-15	16-20	21-25				26-30	31-35	36-40	41-45	46-50	51-55	56-60
1	Meranti majau(MM)								1						38	63.4	10.9
2	Ubah(Ub)			1	1										32	21.3	5.7
3	Tismantok(Tt)				1										17	10.4	2.9
4	Sireh sireh(SS)				2										16	15.9	3.4
5	Meranti binatoh(MB)							1							32	74.9	11.5
6	Medang(Md)				2										19.5	25.1	4.8
7	Mempisang(Ms)				1										10	14.9	2.7
8	Membangan(Mb)								1						38	49	9.3
9	Matan(Mt)									1					40	142.5	19.6
10	Terantang(Tt)									1					18	22	4.3
11	Simpex(Sp)				2	1	1								22	54.8	8.2
12	Meranti sarang punai bukit(MSb)				1							1			42	49.3	9.8
13	-				1	1									7.5	6.7	1.5
14	-				1	1									7.5	3.7	1.2
15	-				1	1									8	6	1.5
16	-				1	1									6.5	4.1	1.1
17	(Death)				1										15	0	1.6
Total			21	10	3	3	0	0	1	3	1	0	0	0	369	564	100.0

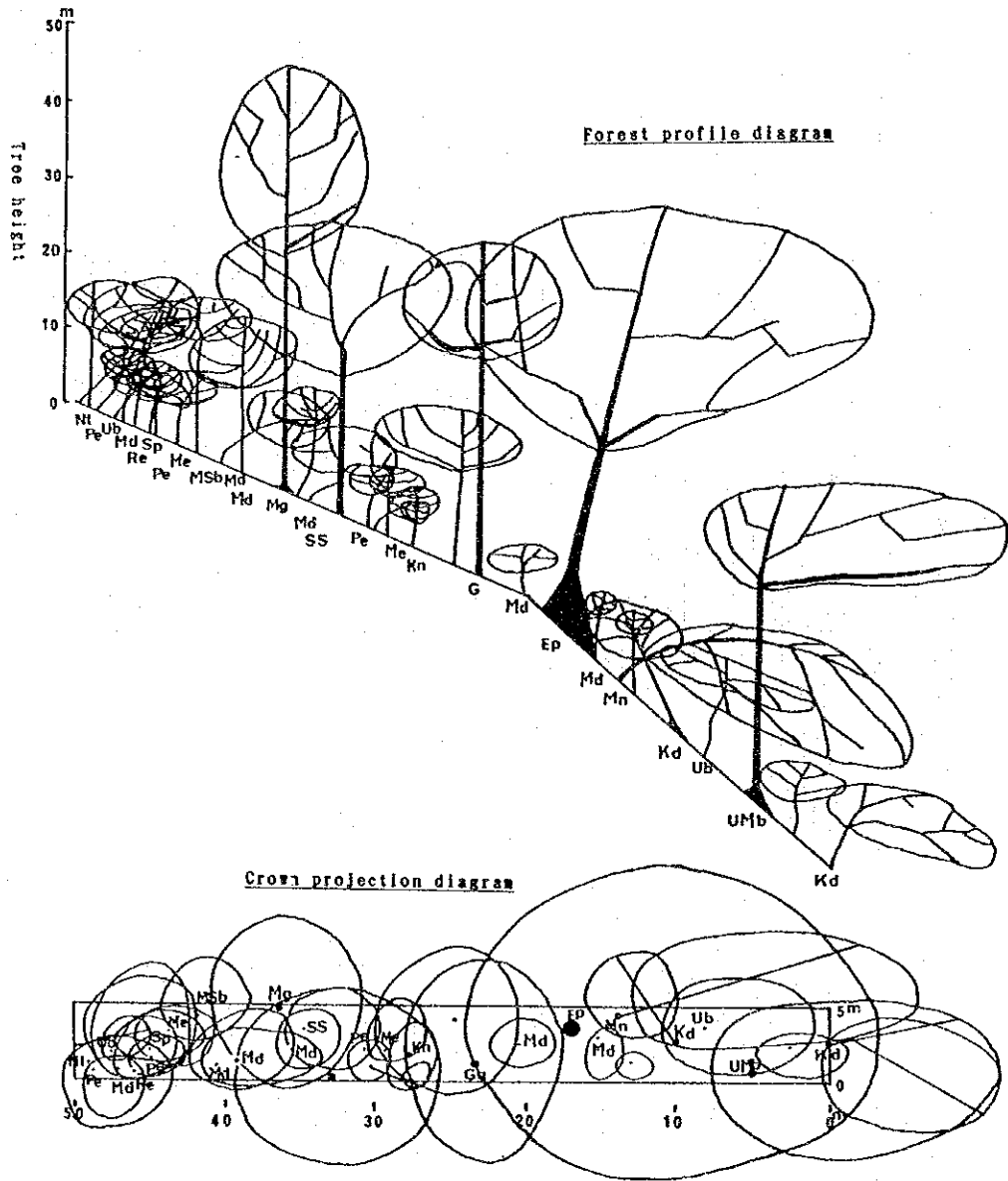


Figure-23 No.11 Belt-transect (Plot No.11)

Table-13 Tree species and dominance No.11 Belt-transect (Plot No.11)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Dominance								
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60	61-65	
1	Nyatch(NT)	<i>Chrysophyllum lenceletum</i>	1		1									16	28.8	3.4			
2	Pendarahan(Fe)	<i>Myristica</i> spp.	3	3										24	18.9	3.2			
3	Ubah(Ub)	<i>Eugenia</i> spp.	2	1	1									21.5	46.9	5.2			
4	Medang(Me)	<i>Actinodaphne</i> spp.	6	3	1	2								74.5	112.1	14.1			
5	Rengas(Re)	<i>Androtium astylum</i>	1		1									15	13.1	2.1			
6	Simpur(Sp)	<i>Dillenia suffruticosa</i>	1	1										7	16.2	1.8			
7	Meranti(Me)	<i>Shorea</i> spp.	2	2										16.5	29.2	3.4			
8	Meranti sarang punal bukit(MSB)	<i>Shorea ovata</i>	1			1								18	19.4	2.1			
9	Menggaris(Mg)	<i>Koempasia excelsa</i>	1									1		55	40.9	7.2			
10	Sireh sireh(SS)	<i>Pternandra coerulea</i>	1	1										10	23.6	2.5			
11	Kunau(Kn)	<i>Baccaurea racemosa</i>	1	1										8	10.7	1.4			
12	Geronggang(Gg)	<i>Cratogeomys ligustrinum</i>	1							1				45	50.7	7.2			
13	Empaling(Ep)	<i>Norrisia major</i>	1											55	120.3	13.2			
14	Mengening(Mn)	<i>Lithocarpus</i> spp.	1				1							24	38.2	4.7			
15	Kedondong(Kd)	Burseraceae spp.	2	1	1									29	10.6	3.0			
16	urat mata bukit(UMB)	<i>Parashorea parvifolia</i>	1								1			40	36.2	5.8			
17	-		1		1									12	29.2	3.1			
18	-		1								1			38	62.8	7.6			
19	-		1	1										6.5	1.8	0.6			
20	-		1			1								20	43	4.8			
21	-		1		1									20	3.8	1.8			
22	-		1	1										10	12.7	1.7			
Total			32	14	5	7	1	0	0	2	1	0	2	0	0	0	565	760.1	100.0

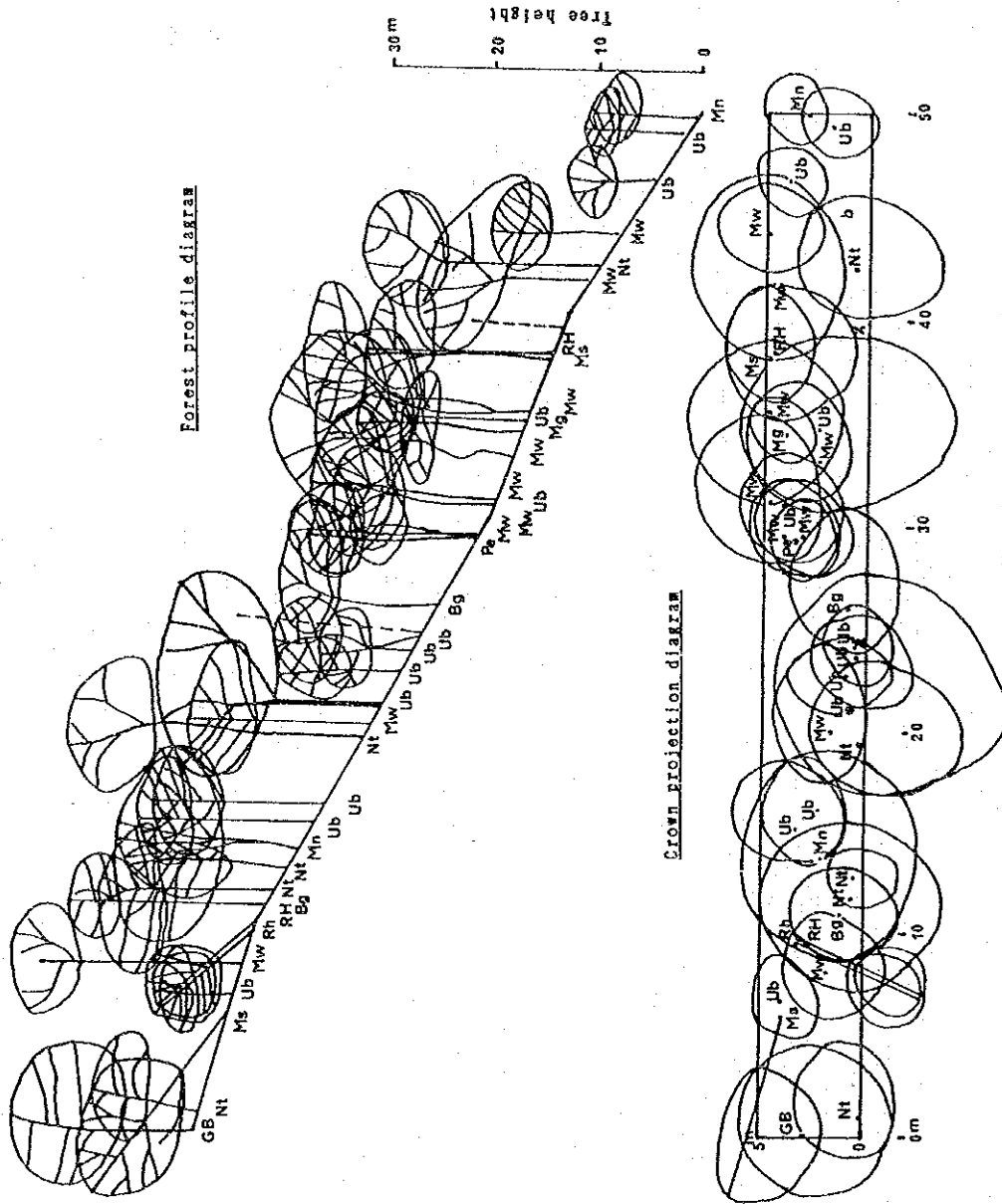
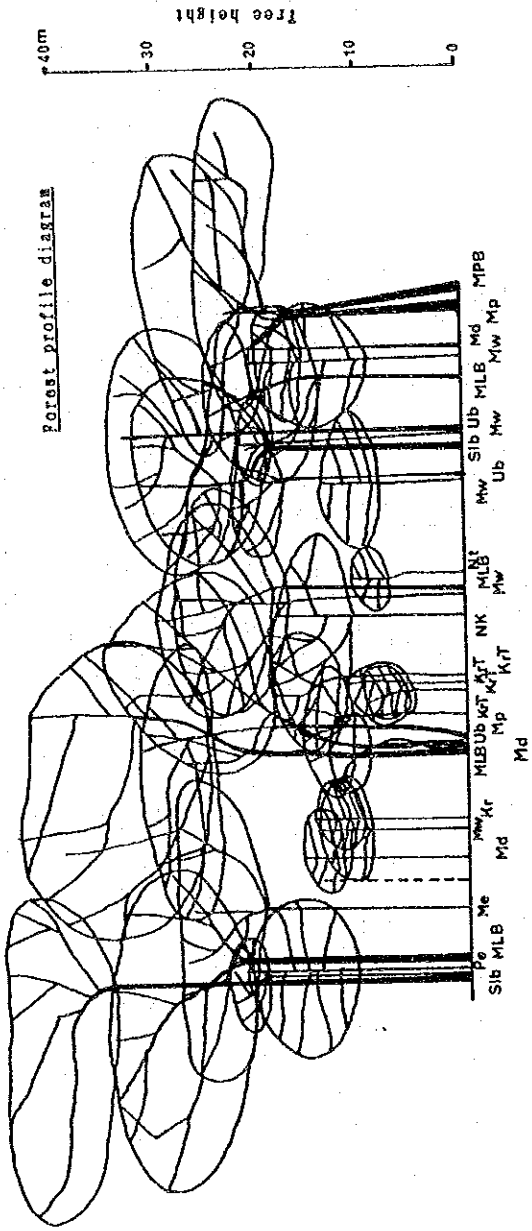


Figure-24 No.12 Belt-transect (Plot No.14)

Table-14 Tree species and dominance No.12 Belt-transect (Plot No.14)

Notes : - - - Unknown species  
(Death) - - - Dead tree

Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domi- nance							
No	Vernacular name		Botanical name	6-10	11-15	16-20	21-25				26-30	31-35	36-40	41-45	46-50	51-55	56-60
1	Gurah bukit (GB)	Canthium confertum	1		1										17	20.4	3.1
2	Nyatch (NT)	Cryosophyllum lenceletum	5	2	1	1	1								95	82.6	14.8
3	Mempisang (Ms)	Dissepalum anomalum	2	1		1									34	33	5.6
4	Ubah (Ub)	Eugenia spp.	11	4	2	3	2								156	182.9	28.2
5	Merawan (Mw)	Hopea spp.	9	4	4	3	2								149.5	145.6	24.6
6	Resak hitam (Rh)	Cotylelobium melanoxylon	1	1											8	1.8	0.8
7	Resak hijau (RH)	Vatica micrantha	2	1	1										27	11.4	3.2
8	Bintangor (Bg)	Calophyllum spp.	2		2										36	40.6	6.4
9	Mempining (Mn)	Lithocarpus spp.	2	1	1										26	51	6.4
10	Perarahan (Pd)	Myristica spp.	1		1										19	14.2	2.8
11	Menggaris (Mg)	Koopassia excelsa	1		1										17	6.3	1.9
12	(Death)		1		1										19	0	1.6
13	(Death)		1	1											8	0	0.7
Total			39	9	8	15	6	1	0	0	0	0	0	0	611.5	589.8	100.0



Crown projection diagram

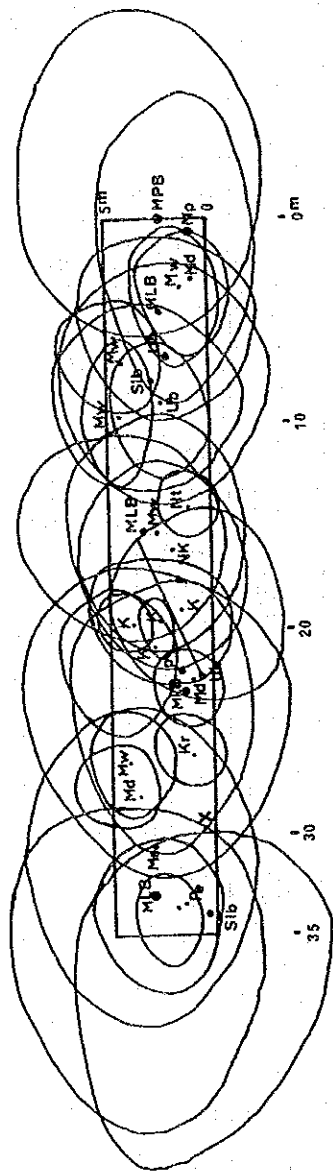


Figure-25 No.13 Belt-transect (Plot No.17)

Table-15 Tree species and dominance No.13 Belt-transect (Plot No.17)

Notes : - - - Unknown species  
(Death) - - - Dead tree

No.	S p e c i e s		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Meranti paya bersisek(MPB)	<i>Shorea scaberrima</i>	1				1								25	29	3.3
2	Merpauh(Mp)	<i>Swintonia glauca</i>	2				1	1							62	116.5	11.0
3	Medang(Me)	<i>Actinodaphne</i> spp.	3		1	2									49	35.7	5.2
4	Merawan(Mw)	<i>Hopea</i> spp.	5		2	2	1								99.5	114.7	13.2
5	Meranti langgai bukit(MLB)	<i>Shorea Pinanga</i>	4				1	1	1						132	189.4	19.7
6	Ubah(Ub)	<i>Eugenia</i> spp.	3				1	2							90	136.9	13.9
7	Selangan batu(Sib)	<i>Shorea</i> Spp.	2					1	1						77	65	8.7
8	Nyatoh(Nt)	<i>Chrysophyllum lenceletum</i>	1		1										11	7.4	1.1
9	Nipis kulit(NK)	<i>Memecylon</i> spp.	1			1									19	57.4	4.7
10	Kerung ternek(Krt)	<i>Dipterocarpus palenbanicus</i>	4	1	1	2									57	60.2	7.2
11	Keruing(Kr)	<i>Dipterocarpus</i> sp.	1		1										15	8	1.4
12	Meranti(Me)	<i>Shorea</i> sp.	1					1							28	52.2	4.9
13	Pendarahan(Pe)	<i>Myristica</i> spp.	1				1								22	22.1	2.7
14	-		1				1								23	9	2.0
15	(Death)(kapur bukit)	<i>(Dryobalanops beccarii)</i>	1		1										15	0	0.9
	Total		31	1	7	5	7	4	5	0	2	0	0	0	724.5	903.5	100.0

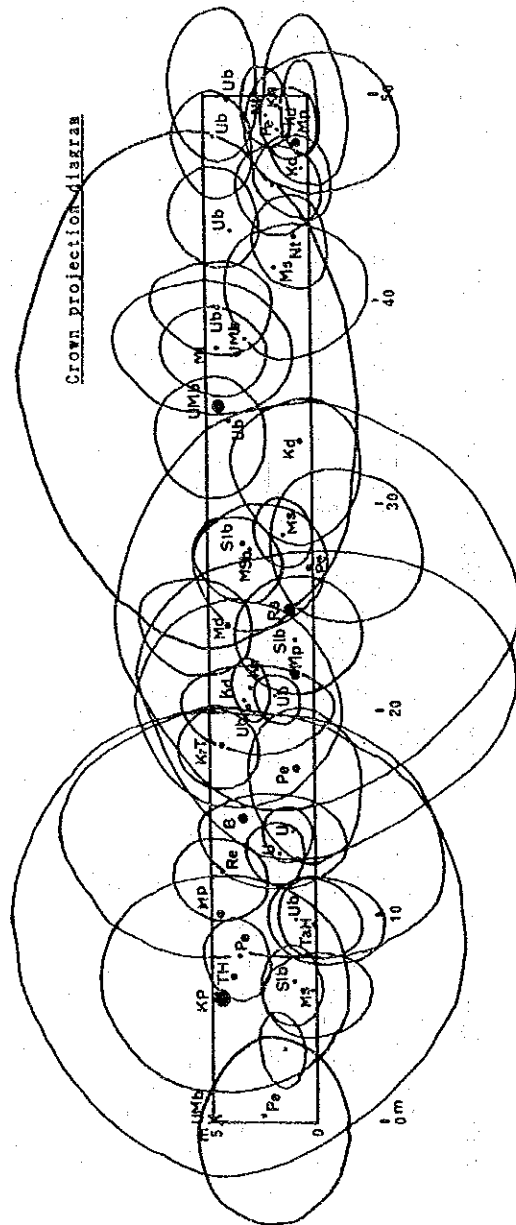
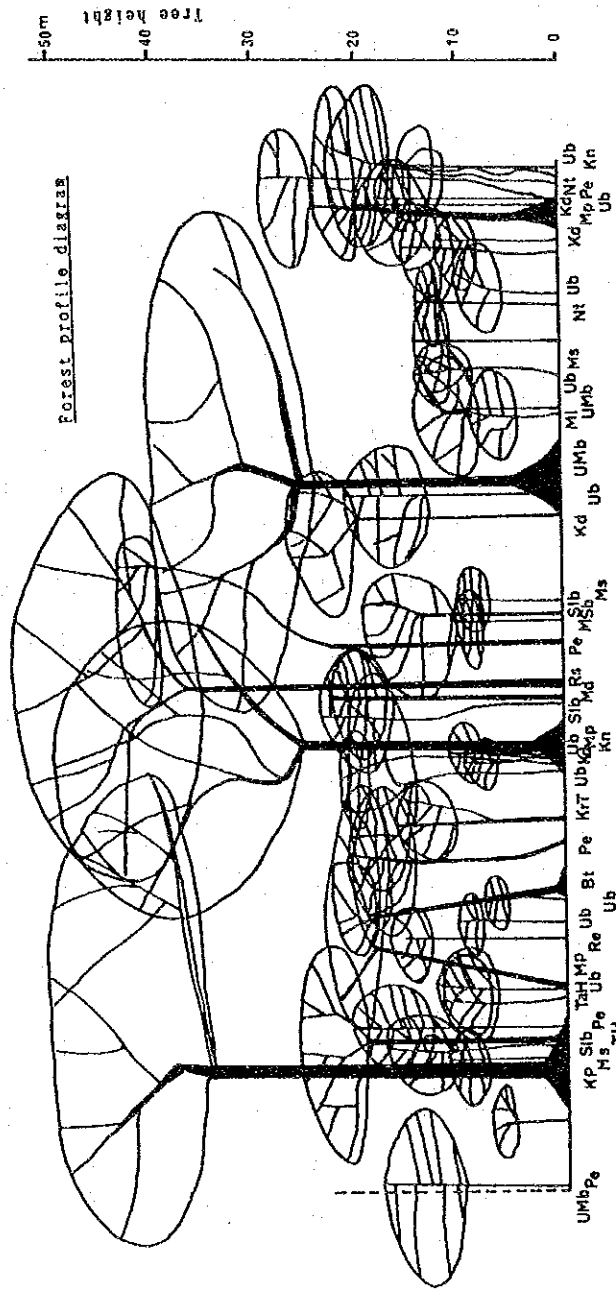


Figure-26 No.14 Belt-transect (Plot No.18)



Table-16 Tree species and dominance No.14 Belt-transect (Plot No.18)

Notes : - - - - Unknown species (Death) - - - - Dead tree

Species		Number of trees in each height class							Number of trees	Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domiance						
No	Vernacular name	Botanical name	6-10	11-15	16-20	21-25	26-30	31-35					36-40	41-45	46-50	51-55	56-60	61-65
1	Pendarahan(Pe)	<i>Myristica</i> spp.			2	2			1					121	63.5	9.4		
2	Kapur paji(KP)	<i>Dryobalanops lanceolata</i>								1				50	99	7.6		
3	Mempisang(Ms)	<i>Disepalum anomalum</i>		2	1									33	38.1	3.6		
4	Selangan batu(Sib)	<i>Shorea</i> spp.			2	1								60	54	5.8		
5	Terap hutan(TH)	<i>Artocarpus odoratissimus</i>					1							26	48.9	3.8		
6	Tampoi(TaH)	<i>Baccaurea</i> spp.			1									12	5.9	0.9		
7	Ubah(Ub)	<i>Bugenia</i> spp.		4	2	1	3							149	133.7	14.5		
8	Merpaah(MP)	<i>Swintonia glauca</i>					2				1			97	146.3	12.4		
9	Rengas(Re)	<i>Andoritium astylum</i>			1									17	9.2	1.3		
10	Bintawak(Bt)	<i>Artocarpus anisophyllus</i>						1						23	20.8	2.2		
11	Keruing ternek(KRT)	<i>Dipterocarpus palembanicus</i>						1						17	7.9	1.3		
12	Xedordong(Xd)	Burseraceae spp.			1	1	2							90	66.8	8.0		
13	Kunau(Kn)	<i>Baccaurea racenosa</i>			1	1								27	8.5	1.8		
14	Medang(Md)	<i>Actinodaphne</i> spp.					1							30	7.7	1.9		
15	Resak(Rs)	<i>Vatica</i> sp.										1		54	96.7	7.7		
16	Meranti sarang punai bukit(MSb)	<i>Shorea ovata</i>			1						1			10	12.5	1.2		
17	Urut mata bukit(Umb)	<i>Parashorea parvifolia</i>												54	135.4	9.7		
18	Malam(Ml)	<i>Diospyros</i> spp.			1									9	10	1.0		
19	Nyatch(Nt)	<i>Chrysophyllum lenceletum</i>												29	18	2.4		
20	-				1									7	5.8	0.7		
21	-					1								15	14.1	1.5		
22	(Death)(Urut mata)						1							23	0	1.2		
Total			47	9	10	8	11	4	0	1	1	2	1	0	0	953	1002.8	100.0

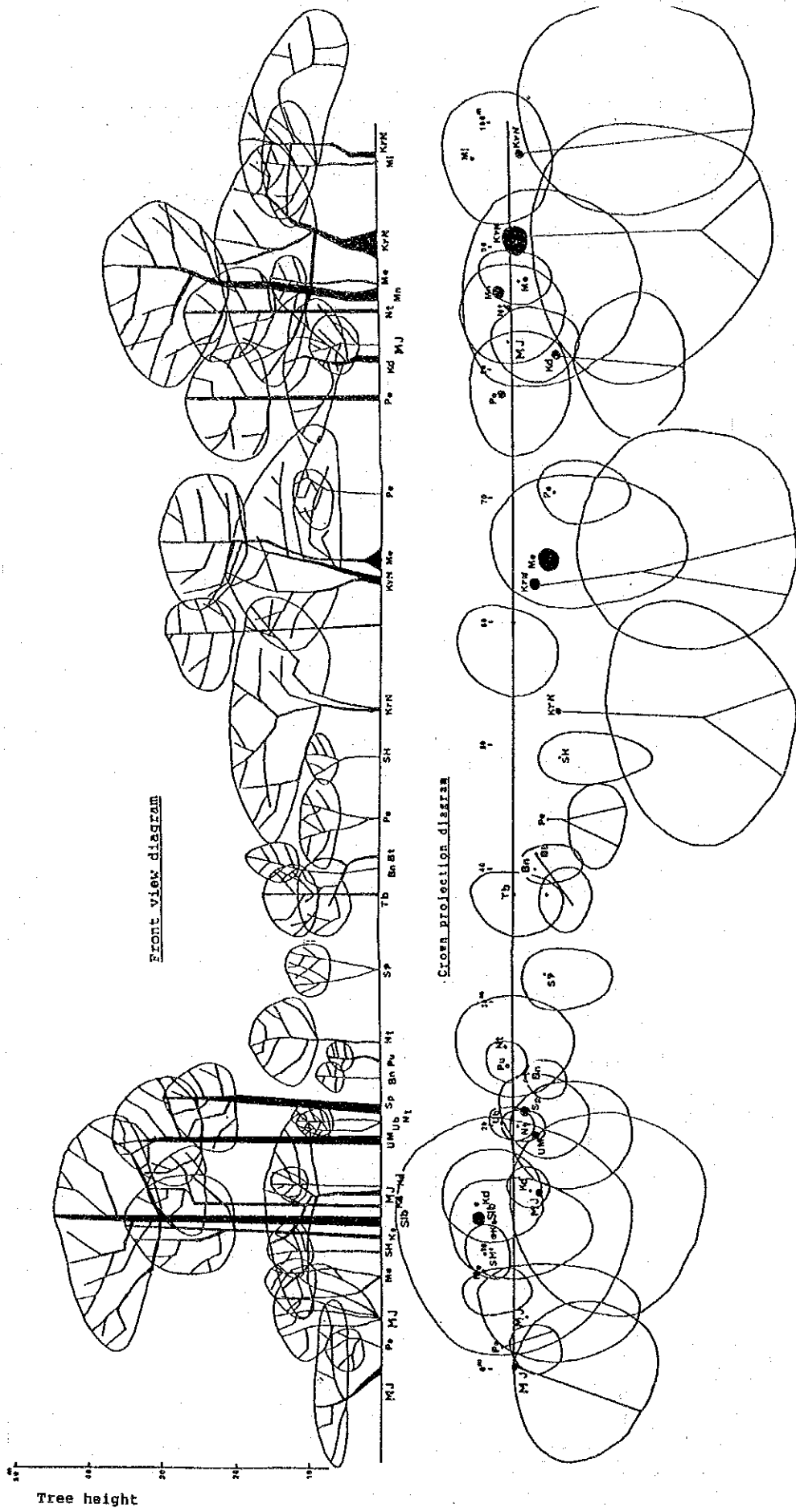


Figure-27 No.1 Line-transect (Plot No.12)



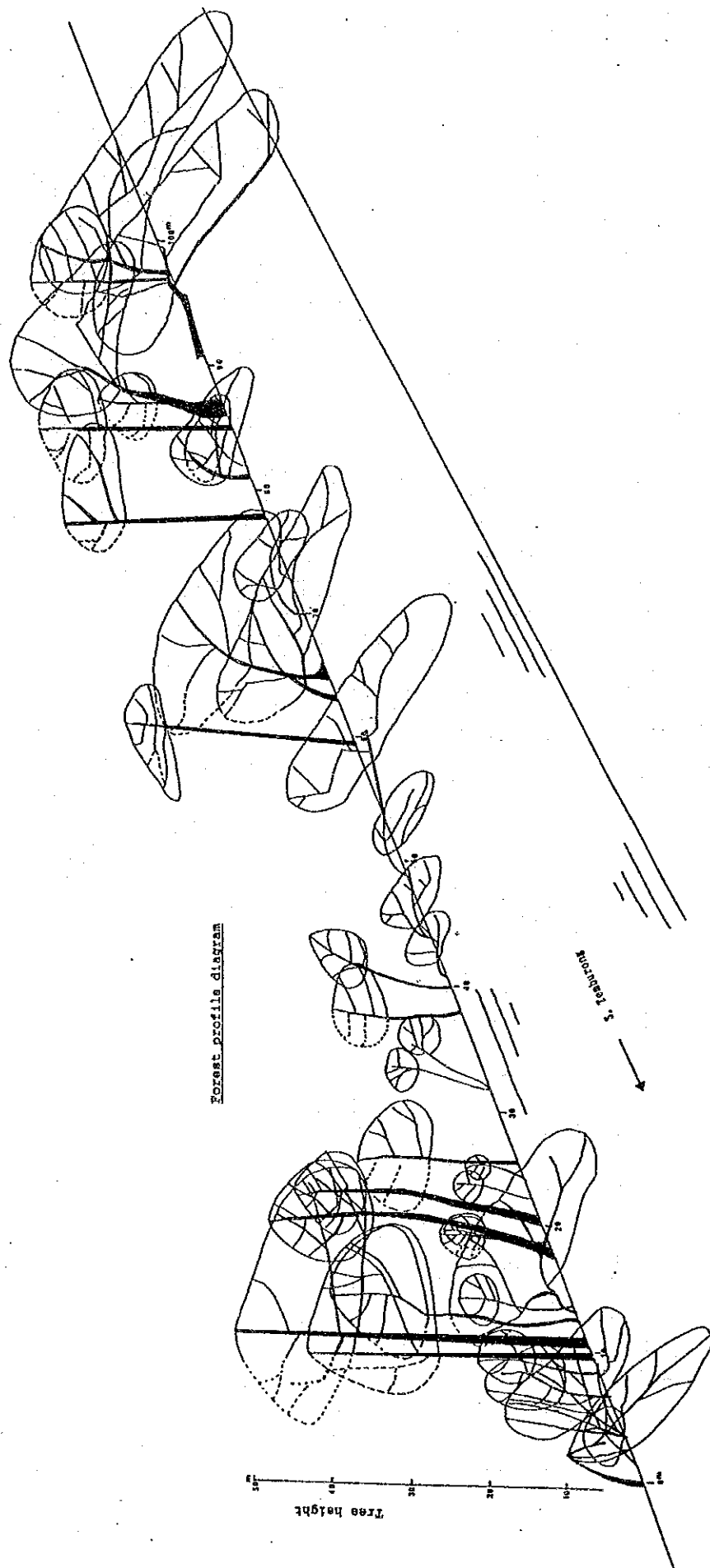


Figure-28 No.1 Line-transect (Plot No.12)

Table-17 Tree species and dominance No.1 Line-transect (Plot No.12)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Domi-nance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Merawan jangkang(MJ)	<i>nopea nervosa</i>	4	2	2										48	438.1	12.5
2	Pendarahan(Pe)	<i>Myristica</i> spp.	4	1	2		1								57	135.2	4.9
3	Meranti(Me)	<i>Shorea</i> sp.	3	1	1	1									59	171.2	5.9
4	Sentul hutan(SH)	<i>Sandoricum</i> sp.	2	1	1										25	39.5	1.7
5	Kasai(Ks)	<i>Pometia pinnata</i>	1					1							34	72	2.7
6	Selangan batu(Slb)	<i>Shorea</i> spp.	1						1						45	289.6	8.6
7	Kedondong(Kd)	<i>Burseraceae</i> spp.	3		2			1							60	138.9	5.1
8	Urut mata(UMB)	<i>Parashorea parvifolia</i>	1						1						38	74.1	2.9
9	Ubah(Ub)	<i>Eugenia</i> spp.	1		1										12	7.2	0.5
10	Nyatch(Nt)	<i>Chrysophyllum lanceolatum</i>	3	1	1	1									57	124.5	4.7
11	Sepetir(Sp)	<i>Sindora coriacea</i>	1				1								30	38.4	1.8
12	Bankal(Bn)	<i>Neonauclea crytopoda</i>	2	1	1										26	154.4	4.6
13	Singor(Si)	<i>Dillenia suffruticosa</i>	1		1										12	32	1.1
14	Tembaran(Tb)	<i>Artocarpus tamaran</i>	1		1										15	28.8	1.1
15	Bintawak(Bt)	<i>Artocarpus anisophyllus</i>	1	1											10	17.6	0.7
16	Keruing neram(KRN)	<i>Dipterocarpus oblongifolius</i>	4		2	2									83	1102.7	30.5
17	Mengening(Mn)	<i>Lithocarpus</i> spp.	1							1					37	204.8	6.2
18	Malam(Ml)	<i>Diospyros</i> spp.	1		1										17	73.6	2.3
19	-		1					1							28	48	2.0
20	(Death)		1	1											7.5	0	0.2
Total			37	7	13	5	2	2	5	2	2	1	0	0	700.5	3190.6	100.0

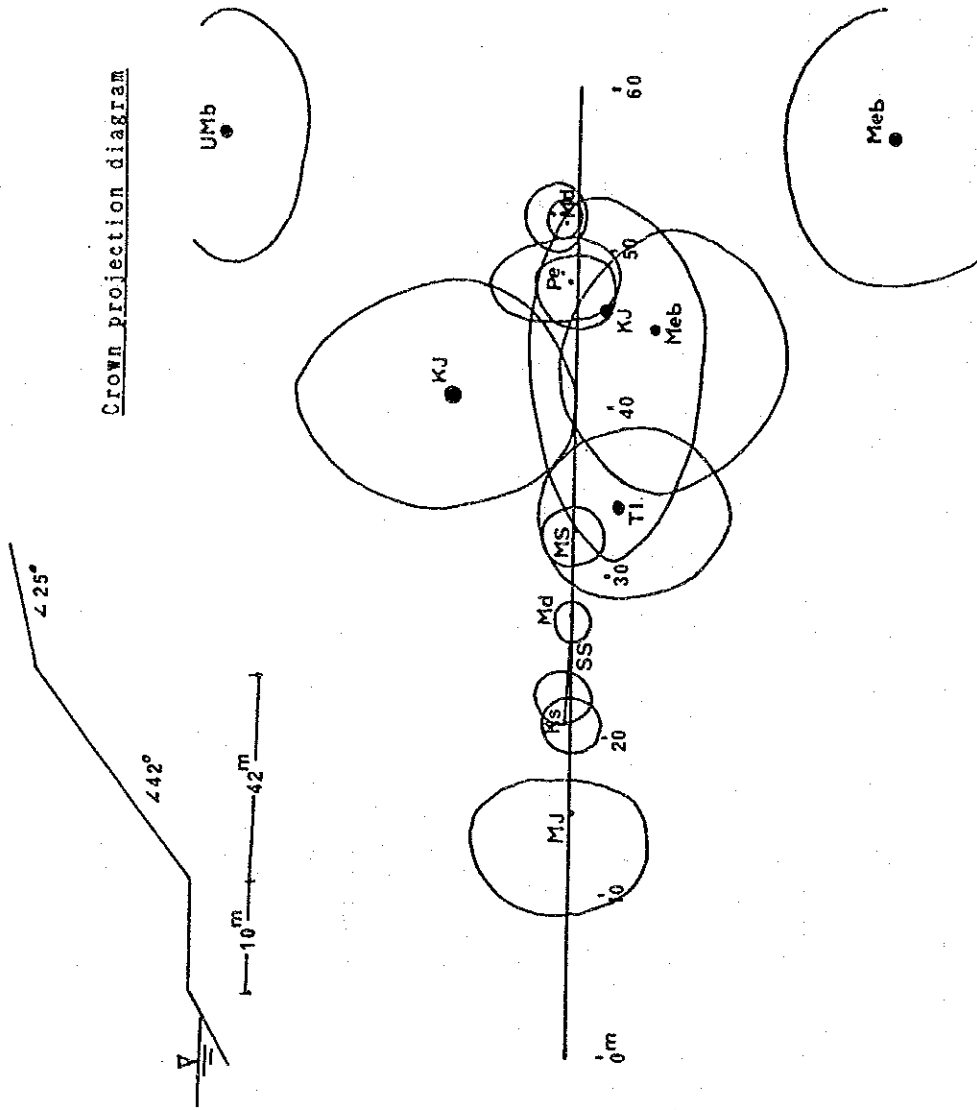


Figure-29 No.2 Line-transect (Plot No.13)

Table-18 Tree species and dominance No.2 Line-transect (Plot No.13)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Dominance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Merawan jangkang(KU)	<i>Hopea nervosa</i>	1	1											14	74.9	5.9
2	Kasai(Ks)	<i>Fometia pinnata</i>	1	1											12	9.5	1.4
3	Sireh sireh(SS)	<i>Pternandra coerulea</i>	1	1											7	8.8	1.1
4	Medang(MG)	<i>Actinodaphne</i> spp.	2	1	1										18	8.5	1.8
5	Mempisang(Ms)	<i>Disepalum anomalum</i>	1	1											15	10.9	1.7
6	Tulang(Tl)	<i>Irvingia malayana</i>	1				1								27	97.6	8.3
7	Kawang jantong(KJ)	<i>Shorea macrophylla</i>	2						2						78	369.2	29.9
8	Pendarahan(Pe)	<i>Myristica</i> spp.	1	1											12	17.5	2.0
9	Meranti binatoh(MeB)	<i>Shorea argentifolia</i>	2							1	1				82	406.6	32.5
10	Urut mata bukit(Umb)	<i>Parashorea parvifolia</i>	1							1					40	113.3	10.2
11	-		1			1									20	32	3.5
12	-		1	1											12	12.3	1.6
	Total		15	2	6	1	0	1	0	4	1	0	0	0	337	1161.1	100.0

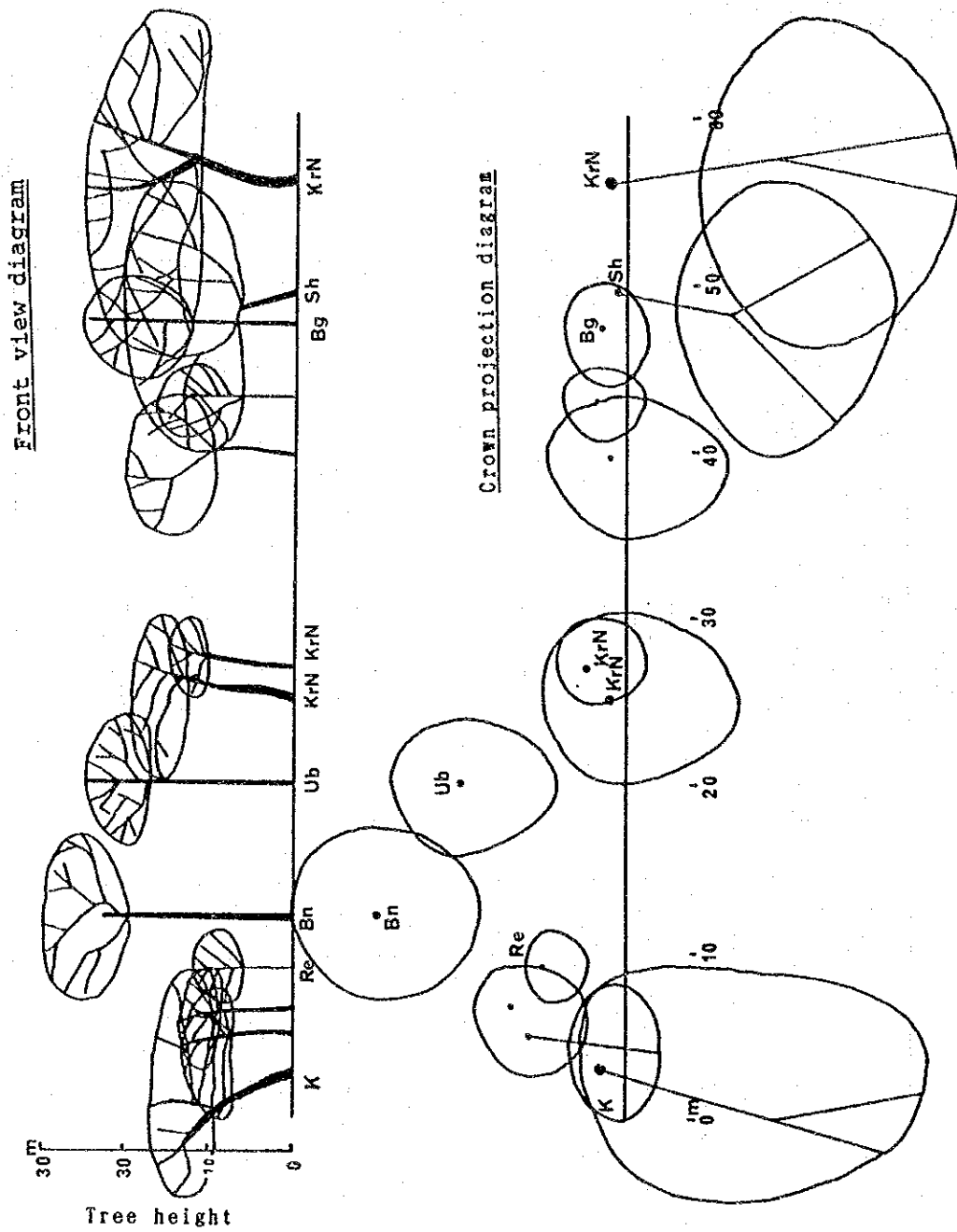


Figure-30 No.3 Line-transect (Plot No.15)



Table-19 Tree species and dominance No.3 Line-transect (Plot No.15)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Dominance							
No	Vernacular name		Botanical name	6-10	11-15	16-20	21-25				26-30	31-35	36-40	41-45	46-50	51-55	56-60
1	Keruing neran(NRN)	4		1	2	1		1							76	593.6	49.7
2	Berangan(Bg)	2		1		1									38	61.6	7.4
3	Ubah(Ub)	2		1		1									39	94.6	9.9
4	Rengas(Re)	1		1											12	13.3	1.9
5	Bakei(Bn)	1						1							30	89.8	8.9
6	Sentul hutan(SH)	1			1										20	156.4	13.1
7	-	1			1										20	70.6	6.7
8	-	1			1										16	16.6	2.4
Total		13	0	4	5	3	1	0	0	0	0	0	0	0	251	1096.5	100.0

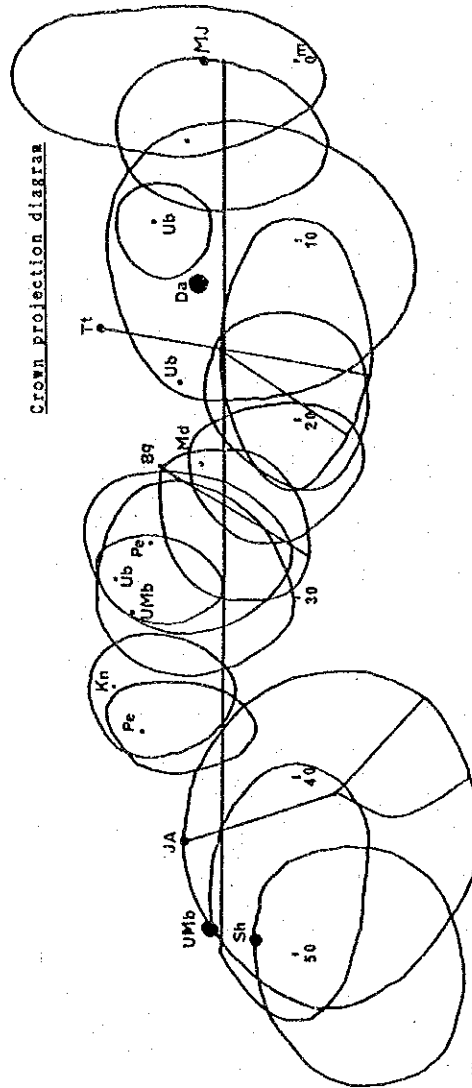
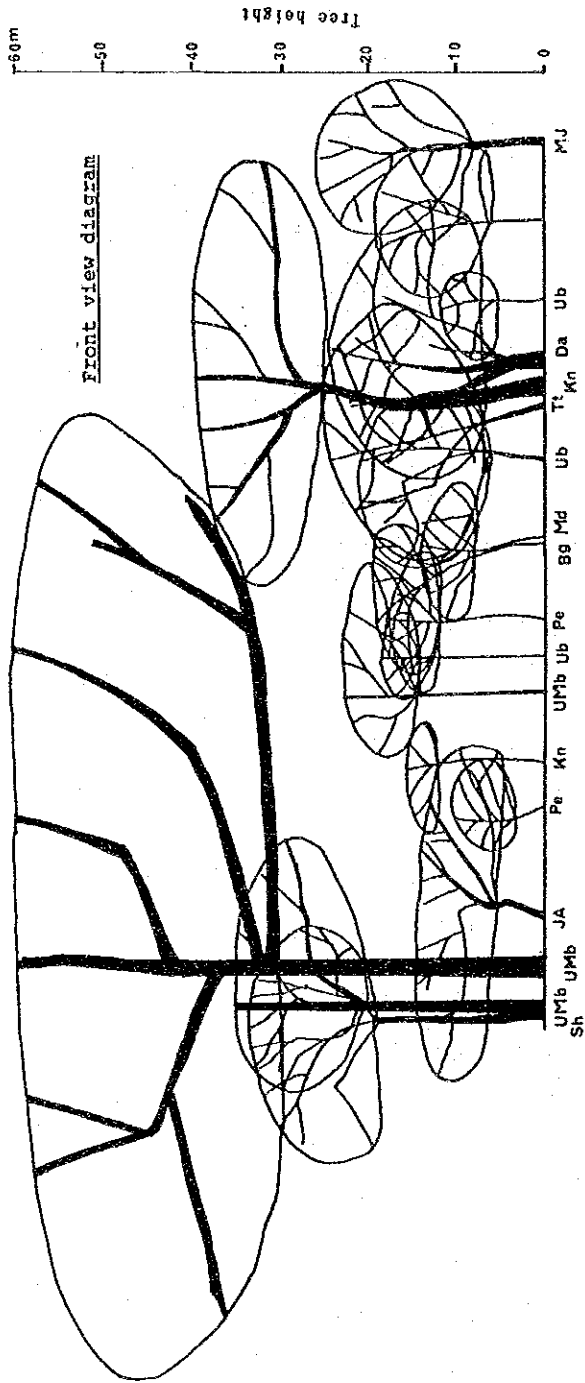


Figure-31 No.4 Line-transect (Plot No.16)

Table-20 Tree species and dominance No.4 Line-transect (Plot No.16)

Notes : - - - - Unknown species  
(Death) - - - - Dead tree

No	Species		Number of trees	Number of trees in each height class					Sum of heights (m)	Sum of crown areas (m <sup>2</sup> )	Doml-nance						
	Vernacular name	Botanical name		6-10	11-15	16-20	21-25	26-30				31-35	36-40	41-45	46-50	51-55	56-60
1	Merawan jangkan(MJ)	Hopea nervasa	1				1								25	114.3	7.8
2	Ubah(Ub)	Eugenia spp.	3		1		1								53	121.3	9.7
3	Dabai(Da)	Canarium patentinervium	1				1								24	209.8	13.0
4	Tismantok(Tt)	Shorea multiflora	1				1								25	98.1	6.9
5	Berangan(Bg)	Castropsis spp.	1				1								19	57.1	4.2
6	Medang(Md)	Actinodaphne spp.	1		1										14	59.2	4.1
7	Pendarahan(Pe)	Myristica spp.	2		1		1								28	115.4	8.0
8	Urut mata budit(UMB)	Parashorea parvifolia	2				1		1						58	197.3	14.2
9	Kumau(Kn)	Baccaurea racemosa	1		1										15	44.6	3.3
10	Janbu ayer(JA)	Eugenia baranense	1		1										14	246.3	14.6
11	Sentul hutan(SH)	Sandoricum sp.	1						1						30	129.5	8.9
12	-		1				1								19	76.7	5.3
Total			16	1	4	4	5	1	1	1	0	0	0	0	324	1469.6	100.0

### **3.4. Summary of Survey Reports**

#### **3.4.1. Forest stand survey**

The forest stands were surveyed using the belt-transect, line-transect, and offset methods as appropriate. The 18 plots surveyed included ridges, hillsides, banks and other places, as shown in Figure-12 showing the survey positions which were considered to be mainly suitable for day-trip tours. The survey results are shown in Figures-13 to 31 and Tables-3 to 20. Table-21 summarises the characteristics of the forest stands surveyed. This table was rearranged to enable a comparative study with the forest type classification diagrams based on the aerial photography data.

#### **3.4.2. Match with the results of photo interpretation**

Forest types were divided into two types based on canopy conditions. The one type had canopies which were relatively even and continuous. The other type had canopies which were uneven and had many gaps (disturbance type). The summary table shows that many canopies on top parts of ridges were even (circle mark) or nearly even (triangle mark) and were continuous (circle mark) or nearly continuous (triangle mark). Compared with these, canopies on middle and bottom parts of the hillsides were uneven and had gaps. Canopies at the bottoms of ridges were uneven and had gaps. Canopies on bank lines were nearly even in height and were continuous. Thus, the results of forest type classification using aerial photographs was verified by the results of the forest stand survey conducted in the field.

#### **3.4.3. Characteristics of forests in Temburong watershed from the forest stand survey**

The species found in the forests of the Temburong River watersheds surveyed can be summarised as shown in Table- 22. A total of 76 species were found including 26 Dipterocarp species. There were a fairly large number of unknown species and the total number of species would exceed 80.

Typical canopies of tropical rain forests are known to be classified into five strata. Studies in this survey were conducted classifying tree height classes into five strata. They were the emergent stratum (height more than 41m), large

tree stratum (21 to 40m), small tree stratum (11 to 20m), low tree stratum (6 to 10m) and ground stratum (below 6m). The species comprising the emergent stratum were called emergents. In the survey, the plots in which the forest stands that comprised all five strata, totalled 13 of the 18 plots. There was a total of 24 dominant species over all the 18 plots. The number of species forming emergents totalled 19. Of those, seven species, i.e., Selangan batu tulang ikan, Meranti majau, Damar hitam, Empaling, Menggaris, Urat mata bukit and Resak formed high strata of 51 to 65m. Two species, Damar hitam and Meranti sarang punai bukit, which were found in three plots, appeared most frequently among the 19 emergent species, followed by six species, Keruing ternek, Meranti binatoh, Menggaris, Urat mata bukit, Damar hitam barun, Selangan batu found in two plots. Thirteen of the 19 emergent species were Dipterocarp species. Withered trees could be observed in nine plots. These trees provided nesting sites for wild birds, a further enrichment of nature in Ulu Temburong.

Table-21 Characteristics of each forest stands

Notes : Canopy -  
 ○ ... Even, Continuous  
 △ ... Nearly even, Nearly continuous

Plot No.	Belt No.	Line No.	Distribution area			Canopy		Number of storey	Dominant tree	Emergent		Dead tree
			Ridge Top	Hillside Middle	Bank Low	Even	Uneven			Continuous	Disturbance	
1	1		○			○	5	DH, Km	DH, Krt			
2	2		○			△	5	ML, DHb, Kd	DHb	SBt		
3	3			○			4	Ms, Pd				
4	4		○			○	5	Mw, Kd	Xp, Krt		2	
5	5		○			○	5	KP	KP, Ms		1	
6	6		○			○	5	Mg, Mm	MSb	Mm	1	
7	7		○			○	5	SBt, Mw	MeB	DHb	2	
8	8		○			△	5	MeB				
9	9		○			○	5	MSb, Mg	Mg, MSb			
10	10			○		△	5	Mt	MSb		1	
11	11	1		○		△	5	Me, Ep	Gg	Ep, Mg		
12	12	2		○		△	5	Krn, MJ	Slb		1	
13	13			○		○	5	MeB, KJ	MeB, KJ, Umb			
14	14		○			○	4	Ub			2	
15	15	3		○		△	3	Krn				
16	16	4		○		△	4	JA, Umb	Kn	Umb		
17	17		○			○	4	MLB, Ub, Mw	MLB, Slb		1	
18	18		○			○	5	Ub		Rs	1	

DH: Damar hitam (S. rich. etmoides)  
 Krt: Keruing ternek (D. palembanicus)  
 SBT: Selangan batu tulang ikan (S. superba)  
 Xp: Kempas (K. malaccensis)  
 KP: Kapur paji (D. lanceolata)  
 Ms: Mempisang (D. anomalum)  
 MSB: Meranti sarang punai bukit (S. ovata)  
 Mm: Meranti majau (S. leptoclados)  
 MeB: Meranti binatoh (S. argentiifolia)  
 Mg: Menggaris (K. excelsa)  
 Gg: Geronggang (C. ligustrinum)  
 Ep: Empaling (N. major)  
 KJ: Kawang jantong (S. macrophylla)  
 Umb: Urat mata bukit (P. parvifolia)  
 Kn: Kunau (B. racemosa)  
 MLB: Meranti langgai bukit (S. pinanga)  
 Slb: Selangan batu (shorea spp.)  
 Rs: Resak (Vatica sp.)  
 Km: Kumus (S. laevis)  
 Ml: Malam (D. spp.)  
 Kd: Kedondong (B. spp.)  
 Pd: Pudu (A. kemando)  
 Mw: Merawan (Hopea spp.)  
 Mt: Matan (M. longipetiolata)  
 Ms: Medang (A. spp.)  
 MJ: Merawan jangkang (H. nervosa)  
 Ub: Ubah (E. spp.)  
 JA: Janbu ayer (E. baramense)  
 Krn: Keruing neram (D. oblongifolius)  
 DHb: Damar hitam baru (S. xantho.)

Table-22 Summary of tree species

T No	Mark	Vernacular Name	DN	Botanical Name
1	DH	Damar hitam	D	<i>Shorea richetioides</i> Heim
2	DHb	Damar hitam barun	D	<i>Shorea xanthophylla</i> Sym.
3	KB	Kapur bukit	D	<i>Dryobalanops beccarii</i> Dyer
4	KP	Kapur paji	D	<i>Dryobalanops lanceolata</i> Burck
5	KJ	Kawang jantung	D	<i>Shorea macrophylla</i>
6	Kr	Keruing	D	<i>Dipterocarpus</i> sp.
7	KrN	Keruing neram	D	<i>Dipterocarpus oblongifolius</i> Bl.
8	KrT	Keruing ternek	D	<i>Dipterocarpus palembanicus</i> V.Sl.
9	Km	Kumus	D	<i>Shorea laevis</i> Ridl.
10	Me	Meranti	D	<i>Shorea</i> sp.
11	MeB	Meranti binatoh	D	<i>Shorea argentifolia</i> Sym.
12	MLB	Meranti langgal bukit	D	<i>Shorea pinanga</i> Scheff.
13	MM	Meranti majau	D	<i>Shorea leptocladus</i> Sym.
14	MPB	Meranti paya bersisek	D	<i>Shorea scaberrima</i> Burck
15	MPT	Meranti Puteh timbul	D	<i>Shorea agami</i> Ashton
16	MSb	Meranti sarang punai bukit	D	<i>Shorea ovata</i> Dyer ex Brandis
17	Mw	Merawan	D	<i>Hopea</i> spp.
18	MJ	Merawan jangkang	D	<i>Hopea nervosa</i> King
19	Rs	Resak	D	<i>Vatica</i> sp.
20	RH	Resak hijau	D	<i>Vatica micrantha</i> V.Sl.
21	Rh	Resak hitam	D	<i>Cotylelobium melanoxylon</i>
22	Slb	Selangan batu	D	<i>Shorea</i> Spp.
23	SBd	Selangan batu daun nipis	D	<i>Shorea glaucescens</i> Meijer
24	SBI	Selangan batu tulang ikan	D	<i>Shorea superba</i> Sym.
25	Tt	Tismantok	D	<i>Shorea multiflora</i> (Burck) Sym.
26	Umb	Urut mata bukit	D	<i>Parashorea parvifolia</i> Wyatt Smith ex Ashton
27	Ar	Ara(Br.)	N	<i>Ficus</i> spp.
28	Bk	Bangkoh(Br.)	N	<i>Xylopia caudata</i> Hook.f.
29	Bn	Bankal(Melabi)	N	<i>Neonuclea cyrtopoda</i> Mig.
30	Bgn	Berangan	N	<i>Castanopsis</i> spp.
31	Bg	Bintangor	N	<i>Calophyllum</i> spp.
32	Bt	Bintawak(Kelidang babi)	N	<i>Artocarpus anisophyllus</i> Miq.
33	Bl	Buluh	N	
34	Da	Dabai	N	<i>Canarium patentinervium</i>
35	Ep	Empaling	N	<i>Norrisia major</i> Soler
36	Gg	Geronggang	N	<i>Cratoxylon ligustrinum</i> (Spack)Bl.
37	GB	Gurah bukit	N	<i>Canthium confertum</i> Kunth
38	JA	Janbu ayer	N	<i>Eugenia baramense</i> Merr.
39	Kds	Kandis(Br.)	N	<i>Garcinia beccarii</i> Pierre
40	Ks	Kasai	N	<i>Pometia pinnata</i> Forst.
41	Kd	Kedondong	N	<i>Burseraceae</i> spp.
42	Ks	Kembang semangkok(Br.)	N	<i>Scaphium macropodum</i> (Miq)Beumee
43	Kps	Kempas	N	<i>Koompassia malaccensis</i> Maing.ex Benth.
44	Ke	KerANJI(Br.)	N	<i>Dialium cochinchinense</i> Pierre
45	Kn	Kunau	N	<i>Baccaurea racemosa</i> (Reinw)Muell.Arg.
46	Ml	Malam	N	<i>Diospyros</i> spp.
47	Mt	Matan(Br.)	N	<i>Mangifera longipetiolata</i> Griff.
48	Md	Medang	N	<i>Actinodaphne</i> spp.
49	Mtu	Medang tiga urat	N	<i>Cinnamomum</i> spp.
50	Mnk	Melunak(Br.)	N	<i>Pentace floribunda</i> King
51	Mb	Membangan(Br.)	N	<i>Mangifera foetida</i> Lour.
52	Mn	Mempening(Br.)	N	<i>Lithocarpus</i> spp.
53	Ms	Mempisang(Br.)	N	<i>Disepalum anomalum</i> Hook.f.
54	Mg	Menggaris	N	<i>Koompassia excelsa</i> (Becc)Taub
55	Mrt	Meritam	N	<i>Nephelium mutabile</i> Bl.
56	Mp	Merpauh	N	<i>Swintonia glauca</i> Engler
57	NK	Nipis kulit(Br.)	N	<i>Memecylon</i> spp.
58	Nt	Nyatoh(Br.)	N	<i>Chrysophyllum lencelatum</i>
59	Pe	Pendarahan	N	<i>Myristica</i> spp.
60	Pd	Pudu	N	<i>Artocarpus kemando</i> Miq.
61	Pl	Pulal(Br.)	N	<i>Alstonia angustifolia</i> Wall.ex DC.
62	Rg	Ranggu	N	<i>Azaderachta excelsa</i> (Jack)Jacobs
63	Re	Rengas	N	<i>Androtium astylum</i> Stapf
64	Se	Selunsor	N	<i>Tristania anomala</i> Merr.
65	SH	Sentul hutan	N	<i>Sandoricum</i> sp.
66	Spt	Sepetir(Br.)	N	<i>Sindora corriacea</i> Maing.ex Prain
67	Sp	Simpur(Br.)	N	<i>Dillenia suffruticosa</i> (Griff)Martelli
68	SS	Sireh sireh	N	<i>Pternandra coerulescens</i>
69	TaH	Tampoi	N	<i>Baccaurea</i> spp.
70	TB	Telinga basing	N	<i>Cleisthenus winkleri</i> Jabl.
71	Tb	Tembaran(Br.)	N	<i>Artocarpus tamaran</i> Becc.
72	Ttg	Terantang(Br.)	N	<i>Camptosperma auriculata</i> Bl.
73	TH	Terap hutan	N	<i>Artocarpus odoratissimus</i>
74	Ti	Tibadak(Br.)	N	<i>Artocarpus integer</i> (thumb)Merr.
75	Tl	Tulang	N	<i>Irigia malayana</i> Oliv.
76	Ub	Ubah	N	<i>Eugenia</i> spp.

Notes : D, N ---- Dipterocarp, Non-Dipterocarp