(3) Physiography Features

i. Great Natural Levee Area in the Middle Reaches of the Mahakam River

From Muara Pahu to Muara Kaman of the middle reaches of the Mahakam River, flows from the Southwest to the Northeast, and a group of lakes and marshes of Kenohan, Djempang, Kenohan Melintang, Kenchan Semajang, etc. that are deemed as blockaded lakes range in the direction from the southwest to the northeast. This area is the large scale natural levee area of the River Mahakam and can be considered similarly as Valzea which will be stated later.

Valzea is the topography of a low andhumid, flooded plain area along the Amazon, i.e., the topography being buried by the alluvial function in the recent age of geological features, and the topography of low and humid plain that is innundated to the height of the yearly average high water level in the increasing water period of the rainy season, repeating every year even now. Its width differs among the locations, but it is the low and humid zone that is 100 km in width at the wide places, and its length becomes as long as 2,000 km. At the Amazon such a low and humid land is utilized as a pasturage.

That topography, however, is not a complete flat land, but with several heights running in lines. In some cases, they are mutually crossed, showing considerably the intricate shape of flat surface. These heights are the natural levee. This is an assembly of this natural levee, hinter humid land, lakes and marshes.

The reason why the midstream zone of the Mahakam River can be seen similarly as Valzea is that it is about 3 m at the climate observation spot in the Muara Kaman colony on the natural embankment, 10 m at Kotabangun, 15m at Muara Muntai and trifle 20 m even at Melak of further upper stream as evident in Fig. 15. Thus, it can be learnt that the area is the low and humid one.

Photo 3 shows the natural levee of the tributary of Sungai Kedangrantau that meets the Mahakam River at Muara Kaman. A part of the colony and a part, covered with the forest corridor, can be recognized on the natural levee. The back of the natural levee is the humid land, i.e., the hinter humid land. Photo 4 shows the difference between the vegetation on the natural levee and that in the hinter humid land.

Photo 3 The natural levee of Muara Kaman

Photo 4 The natural levee forest and hinter humid land of Muara Kaman

At around the neighborhood of 5 - 10 km from the meeting point of the main stream and Sungai Kadagrantau, the height of the natural levee was higher by 2 - 3 m than the low water level in August, and the width was 20 - 30 m.

The natural levee of Sungai Kedongrantau is not of sand and is composed mainly of clay and silt, but the natural levee of Sungai Belajan that meets the main stream at Muara Kaman at a little downstream of Kotabagun and the sedimentary substance on the river bed of the present flowing route are composed of sand. While the upper stream zone of Sungai Kendangrantau is an alluvium (Qa) according to the map of geological features, the upper stream zone of Sungal Belajan that flows down from the north or north-northwest of Kenahan Semajang consists of Formasi Kampungharu (Tpkb) that is a layer of the Pliocene of the Tertiary, and this stratum reflects an alternation layer, containing sand layer.

With a view to compare with the sand layer of pasir Putih to be stated next, the river floor sand of Sungai Belajan was diged up at the two points of the meeting point with the main stream and the upper stream, several kilometers away from the meeting point, and the analysis of the granular degree was taken place.

The result of the granular analysis is as shown in Table 7. Number of sample is not enough but the sand on the stream bed of Sungai Belajan shows of finer granular diameter than the sand of the sand

layer of pasir Putih, and it indicates that even the sand of the same stream beds are affected by the geological features of the upper stream.

ii. Area of White Sand Layer (Pasir Putih)

In East Kalimantan, in the area consisting of the sand layer of the Formasi Kampungbari (Tpkb), considered to be the Tertiary layer from the geological features, a layer of white sand with extremely thin pedologically humus top layer is distributed and is called as Tanah Putih, The origin of topography of these white sand layer has not yet been utterly studied except being known as the podosol soil, and it has not been made clear in what forming process were affected but the following points were made clear by the observation from a low altitude by helicopter, taking photograph, interpreting the aerial photograph and investigation on the spot.

Table 7 Results of granular analyses of various kinds of sedimentary substance

No.	Name of place	Topography	Mean	S.D.	Skewness	Kurtosis
1	Kuala Samboja	Pasile Putih	1.597	0.174	0.238	3.840
2	Kuala Samboja	Tanah Putih	1.545	0.280	-0.746	5.900
3	Kuala Samboja	Sand at the present seashore	1.941	0.349	-2.297	10.349
4	Balikpapan	Sand at the present seashore	1.665	0.182	-1.370	10.888
5	Balikpapan	Seashore terrace	1.839	0.222	-1.054	9.205
6	S. Belajan	Riverbed sand	1.901	0.289	-0.336	4.043
7	S. Belajan (Meeting point with the main stream)	River sand	2.085	0.237	-0.497	2.965

That is to say, the topography of pasir putih seems to exist as a patchy, hollow land in the natural stand as shown in Photo 5. From the photo, density of standing trees is rougher on pasir putih, as compared with the circumferencial area, and it features that those height are low.

However, according to the investigation on the spot at Sebulu, Kuala Samboja, etc., they are morphologically the topography like flat plateau and is considered as having been formed by different erosion caused by the difference in resistability against erosion of the sand layer and thelayer other than the sand layer.

It is one of topographical features that development of valley is almost not found on the topographical surface of Tanah Putih white sand land. From the point of vegetation on the pasir putih, topographical surface differs from the topographical surface made of layer other than the sand layer and the height of trees is low. Consequently, the topography of form of a plateau seems hollow from the air.

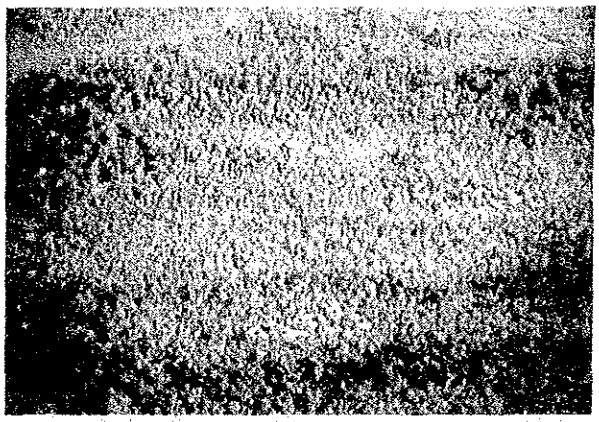


Photo 5 Pasir Putih area and stand

The topography formed with difference in geological features, difference in stiffness of rock and stone, and difference in water permeability is called as systematic topography. This topography is the eroded area reflected with the structure of geological features, and the topography caused by the movement of ground, like deformed flat surface, is called changed topography.

The geological features that are called in the systematic topography are not geological features in the usual soil map with a purpose of expressing the relation of order of layers, but are the physical and chemical qualities of rocks, separated from qualities on the basis of the standard of weathering and erosion. Therefore, it is not sufficient to simply compared the ordinarily geological map features and topographical map. "Map of surface geological features" etc. are suitable for investigation of tissue topography, provided from the standpoint of the civil engineering geology.

iii. Hill Areas

The hill areas have developed from near seashore of East Kalimantan to the inland areas, approximately in parallel to the seashore line and in the direction from north-northeast to south-southwest, but these hills are at topography of the old age. Fig. 20 is a block diagram, showing the mountainous district and quasi-plain of the old age. The flat land in this diagram occupies a large portion, and changes since the old and mature ages are shrinkage at the mountainous area and enlargement at flattened districts.

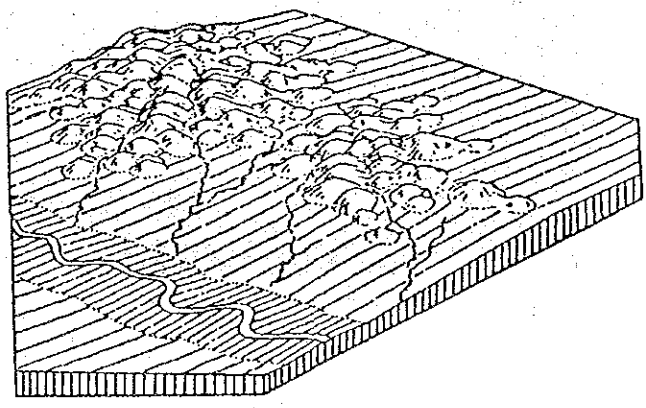


Fig. 20 [6] The block diagram of hilly topography of the old period.

As regards the development of mountainous district, as the pointed summit zone is least covered with weathered materials, the influence suffered from weathering is notable as compared with the lower parts of the hillside that were covered with the comparatively

thick weathered materials. Further, the transition of weathered materials is formed relatively soon, resulting in faster weathering advancement to that degree, and the hill area, correspond to the crossing line of slants, is inflicted with weathering simultaneously from the both sides, i.e., affecting remarkably the sharply pointed zone and highly projected zone. As a result, the hilltop and upper parts of hill became round with removal of edges, and the ridgeline that showed edged bent lines became to show lines of furrows and multibends. Such smooth forms of mountain is called as the subdued form.

The form of slant surface also had changed from the old term when reaching the mature period. The slant wall of valley became gradually smoother, and transformation of materials became slow. As a result, the slant came to be gradually flat and smooth by thickly covered with soil, and the lower parts of valley wall came to have wider flat valley at valley bottom, forming a concave hollow slant, and the weathered materials are heaped thickly in the concave parts. In East Kalimantan under the tropical rain forest climate, however, the development of soil is unfavorable, owing to soil erosion with rain, but, at the flat surface of small hilltop of the old period topography, convex formed smooth slant and lower parts of the mountainside slant, the development of soil is comparatively favorable.

Photo 6 Old-period topography around Balikpapan

Further, Fig. 21 shows with the nine-point method[7], a portion of the slope form at hill area, measured along the logging road, timber company K.T.I. (Kutai Timber Indonesia) area near riverside at Sebulu area.

Photo 6 is the hill topography of the old period near the seashore of Balikpapan. Due to lack of trees by repetition of burning for cultivation features of the old period topography can be seen well.

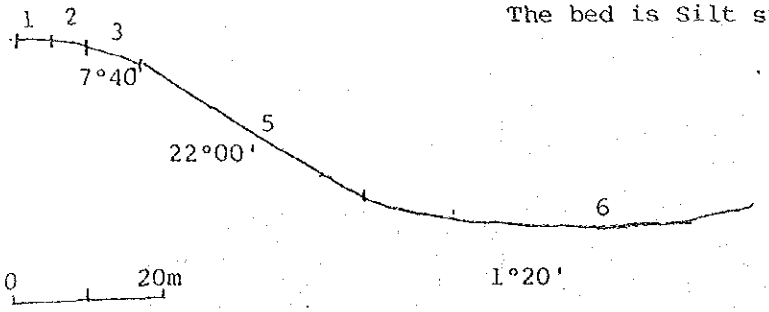
iv. Seashore Terrace

At the seashore zone from Balikpapan to Kuala Samboja, at least two steps of seashore terrace develop by separating the hill, shown by Photo 6. The upper terrace is from a few meters to 10 m in height from the sea level. The low situated terrace is 1 - 2 m in height above the sea level. In consideration that Kalimantan did not almost suffer any crust change in the 4th Period, it is clear that these seashore terraces are those formed in accordance with the alteration change of sea surface by glacier. Regarding the topographical change concerned with the change of sea surface by glacier in this area, there is a report of D. Tjia (1980)[8], Malaysian National University, as a part of the Sunda Shelf.

According to Tjia, high sea levels of +5m, +2 - 3m, +1.5m and 0.5m in the post glacial period were confirmed at many spots of the Indonesian Archipelago. Further, this data, which was made by assessing the C^{14} eras of oyster, coral and beach rock, was collected at the seashore of West Malaysia (part of peninsula). Fig. 22 is a curved line of sea surface change made by samples (40 pieces) which Tjia collected from islands in the Malaysian Peninsula and South China Sea. By this curved line of change of sea surface, Tjia pointed out that, in the High Sea water surface period (3 - 3.5m of about 6,000 years ago, 2.5m of about 4,000 years ago, 1.5m of about 2,800 years ago and 0.5m of about 200 years ago) and 1,700 years ago, the sea level was lower than the present.

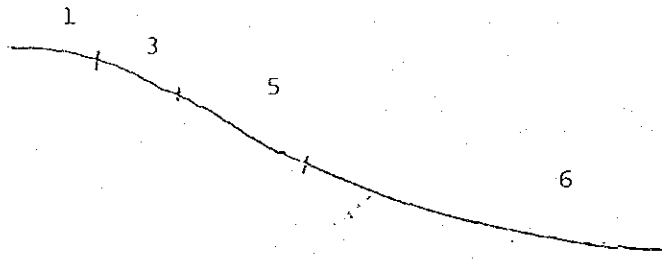
No. 1 (Spot of 42 km)

Valley of the extent of order 2. Ratio of height of 1 and 6 is ±30m at the largest.
The bed is Silt stone.



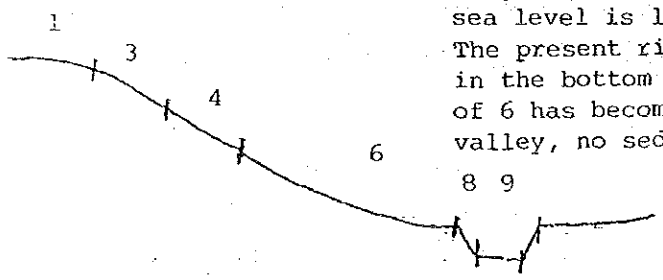
No. 2 (Spot of 13 - 14km)

The fault surface is ±1 km in width. No humid land.
Height above the sea level is 70m.
Distance is impossible to measure.



No. 3 (Spot of 9 km)

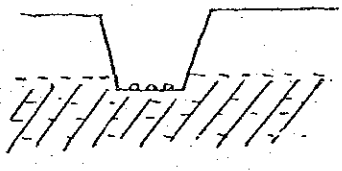
Hilly mountain having the stream order of 3 - 4.
Height of valley (the lower part of 6) from the sea level is 115m.
The present river is engraved down about three meters in the bottom of valley of 6. The bottom of valley of 6 has become a terrace, but, on the bottom of valley, no sedimentary substance is recognized.



Remarks: The valleys of order 1 - 2 are as shown in Fig. A.
The valleys of order 3 - 4 show the cross sectional surface as in Fig. B.

Fig. A

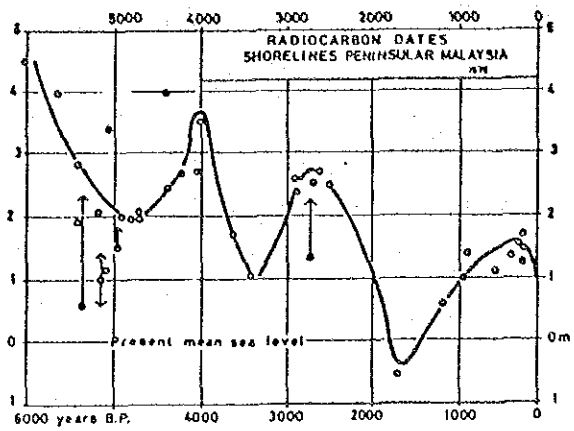
Fig. B



Weathered

Not yet weathered

Fig. 21 Slope form of Sebulu area



Eustatic (?) sea level curve based on circa 40 radiometrically dated shoreline indicators (in situ oysters, coral and beachrock) from Peninsular Malaysia and a few from the South China Sea. Original data was published by Tjia, Fujii & Kigoshi (1977). The arrows indicate the possible vertical range of some samples.

Fig. 22 Eustatic Sea Level Curve by Tjia (1980)

v. The Relationship between the Seashore Terrace and topography of Kuala Samboja

The upper and lower seashore terraces that develop in the seashore area from Balikpapan to Kuara Samboja are considered, from their heights above the sea level, to correspond to either of the High Sea Water Level Period of the Post Glacial Period which is designated by Tjia. In addition, there is, in this terrace, an area that developed in the buried form of a valley, cut with the upper terrace surface, and it is presumed that there was, underseas, a corresponding forming period of valley after forming the terrace surface of upper part.

The terrace of upper part is considered to have been formed before the Post Glacial Period, viewed from the scale of this valley and the forming condition of soil. Photo 7 shows the lower terrace (alluvial plain of Kuala Samboja). The comparatively large valley becomes a wide basin valley as the place that is buried and heaped by the transgression to be the alluvial plain.

Photo 7 The alluvial plain of Kuala SAMBOJA

However, the levee terrace that is the relatively small river near the seashore and is contrasted with the lower seashore terrace by engraving the upper terrace has a relative height of about one meter in the dry season, as shown in Photo 8.

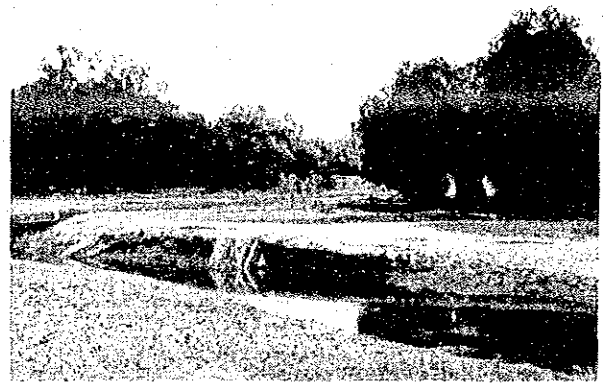


Photo 8 The lower terrace of along the small river of Kuala Samboja

From the 3rd of August to the 3rd of September, it is beginning of rainy season, when it continues to rain for two or three days, the situation changes suddenly as Photo 9. The terrace in the previous photo (Photo 8) can be known as being the flooding plain. The water level, however, does not reach the maximum water level surface to be judged by the trunks of trees on the terrace surface of Photo 8. In addition, though not practically measured, the speed of a water flow is greater if the river is flowing only in the flowing way of its terrace surface engraved like Photo 10. During increasing

water (the time of the condition, given in Photo 9), there are almost no running speed with the almost stagnant state, it is understood that in the rainy season the paddy rice cultivation growing is carried out on this terrace surface.

Photo 9 The condition that the terrace of lowland is flooded by rain fall of two - three days

vi. Topography and Erosion

° The Side Erosion of Natural Levee

The side erosion of the natural levee is found in middle stream zone of the Mahakam River during low water level. Such side erosio of the wall surface of the natural levee is generated from that checked-in water of underground, and marsh land, at the time of high water level, oozes out, to start swelling, of land from the base of levee, and the land mass slides enter to the river like terraced fault.

Photo 8 shows that the natural levee, used as banana field, slides down to the surface of water in the mass state, the side erosion is not generated at any voluntary spots, but by the differences in width of the meandering zone and layer of the natural levee, and the sand layer has generally less resistant than silt layer.

Photo 10 The sliding down by a side erosion at the natural levee of River Kedangrantau at the time of low water level

Photo 11 The developed of Rill on slope

° Erosion of the Slant

The slant, composed of silt layer and clay layer of low water permeability, has much surface flowing water and rill, as shown in photo 11, develops. Against the above, the slant composed of sand layer of permeability of water has remarkably developing gully as shown in Photo 12, and the retrogression of slant is more notable than the former.

When viewed the eroded form of soil in East Kalimantan, the most conspicuous place of that form is occurs on burnt shifting cultivation field and new road side. These places are the phenomena on the land, respectively made naked. The max. slanting angle of slope, availed as shifting cultivation field, amounts to 45°. The form of soil erosion became varied with the border of 30°C, i.e., with the slope of over 30° of slope angle, the gully erosion of 1 m wide and about 1 m deep is generated and with the slant below the above, the erosion of surface layer state excels the gully erosion. This is considered that threre appeared a hydrophobic nature in the soil by repetition of burning fields and by scattered fallen trees left away on burnt fields; therefore, these left trees became to serve as a kind of dumming up embankment, and the gully erosion is not generated. Further,

also with the road surface, not covered with vegetation and in case that layer being a sand layer, many locations where gully phenomena, reaching 1.4 m wide, 1.1 m deep and 4 m long are witnessed at any place, causing destruction of road. On the other hand, the slant, covered with the growing plant, such phenomena are not found.

Photo 12 The developed slant of Gully

Photo 13 The erosion of roadside

(4) Soil

There are many kinds of soil classification methods, but there are studies on assessment of soil fertility and adding partly research of the physical and chemical soil properties and observation was made on the soil profill along the road connecting from Balikpapan to Samarinda and from Samarinda to Muara Kaman with reference to the classification of soil type of the world soil map by FAO-UNESCO. In classifying the soil types, they are largely divided into the alluvial plain, hill and mountain area. The alluvial plain was further divided into the low land of littoral zone and low land that spreads in the lower stream and middle stream areas of the Mahakam River, and investigation was made accordingly.

i. The Alluvial Land of the Seashore Littoral Zone

The low land soil in the littoral zone connects the extension of sandy soil of the seashore line, affected by the ebb and flow of tide and covered by mangroves; sandy soil of coarse grains of sand hill that extends in the inland; muddy soil, heaped on the

sandy soil in the circumference of a delta at the mouth of the Mahakam River and further inner peat soil.

It is considered that the sandy soil and muddy soil, affected by the ebb and flow of tide, have a number of problems. A portion of the muddy soil is heaped up to the water surface, not being affected by the ebb and flow of tide and the soil, having the A layer of several centimeters and the zone, being utilized as field land, is found. The drainage work was made on a part of the peat soil and utilized as coffee yeard and coconut palm yard, but due to the soil environment of thick layer of several meters of peat soil, the limitation seems to be in the land utilization.

ii. Low Humid Land along the Mahakam River and in the Middle Stream Area

When we see the low wet land along the Mahakam River and in the middle stream area and low altitude humid land in the circumference of Mahakam, we find, in the natural levee area in the circumference of rivers, lakes and marshes, a fertile land where it has a dark, brown A layer of the nature of soil being from soil to sandy soil and gradually changed with the border of about 10 cm underground and transferred to the B layer and there is, at present, also the soil where the land utilization has made progress. That outer circumference is the soil - clayer soil and in the area that are flooded in the rainy season becomes the peat soil (Histosol according to the FAO classification). Further, in the low altitude humid land near the mountain area, a glysols zone where the low layer soil became the restored soil to the former condition. The land utilization is advancing with the natural levee as field land, but as to the not yet utilized land of other low altitude humid land, it is considered that there are many favorable locations to be available as the paddy fields if the exploration of water control facilities is made. This low altitude humid land is also recognized in the alluvial land of basin, scattering within the hill district along the seashore, and among them, there are places of exploring paddy fields. The physical nature of the surface layer of this soil presented as Table 8, and therefore, a large-scale exploration may be expected, provided the irrigation and drainage facilities, etc. are made in order.

Table 8 The scientific nature of the surface layer of alluvial low humid land

Capacity weight	Max. q'ty of water capacity (%)	Water q'ty at the packing time (%)	Porous crevice q'ty (%)	Porous crevice analysis (%)		Min. q'ty of air capacity (%)	Permeability nature cc/min
				Small hole crevice	Crude porous crevice		
52	77	71	77	68	9	0	18

iii. The soil of Hilly Kerangas Forest (Heath forest)

The Arenosol, according to the FAO/UNESCO's classification, is distributed on the seashore line from Balikpapan to Samarinda and hill that continues to the low land of the Mahakam River. The vegetation in this area becomes mainly a Kerangas Forest, the A layer is 5 - 20 cm thick and from 10 cm below A layer is changes to the B layer of grey color.

The representative soil profile near Sebulu is shown in Fig. 23.

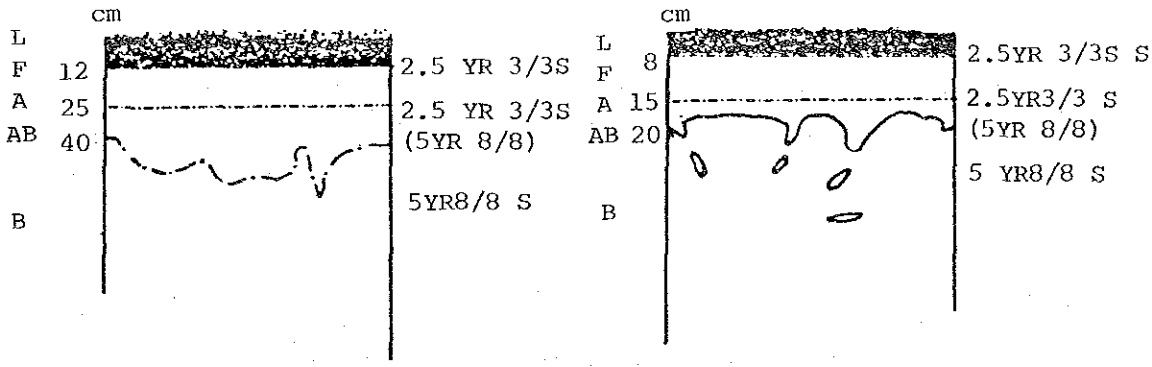


Fig. 23 The soil profile near Sebulu

This Kerangas Forest was burnt partly and is utilized as agriculture field. As regards the soil of pineapple field near Samboja the land availability as field land was studied. There are pineapple field to be sufficiently able to expect harvest and the field in which the pineapple growing is not favorable with completely no fruit formation adjoin each other and further, there are spots of having not been burnt and left as bare field grown Alang Alang, and of the unburnt remaining Kerangas Forest. Comparing the soils of these four spots (soil profile Fig. 24), as seen from the

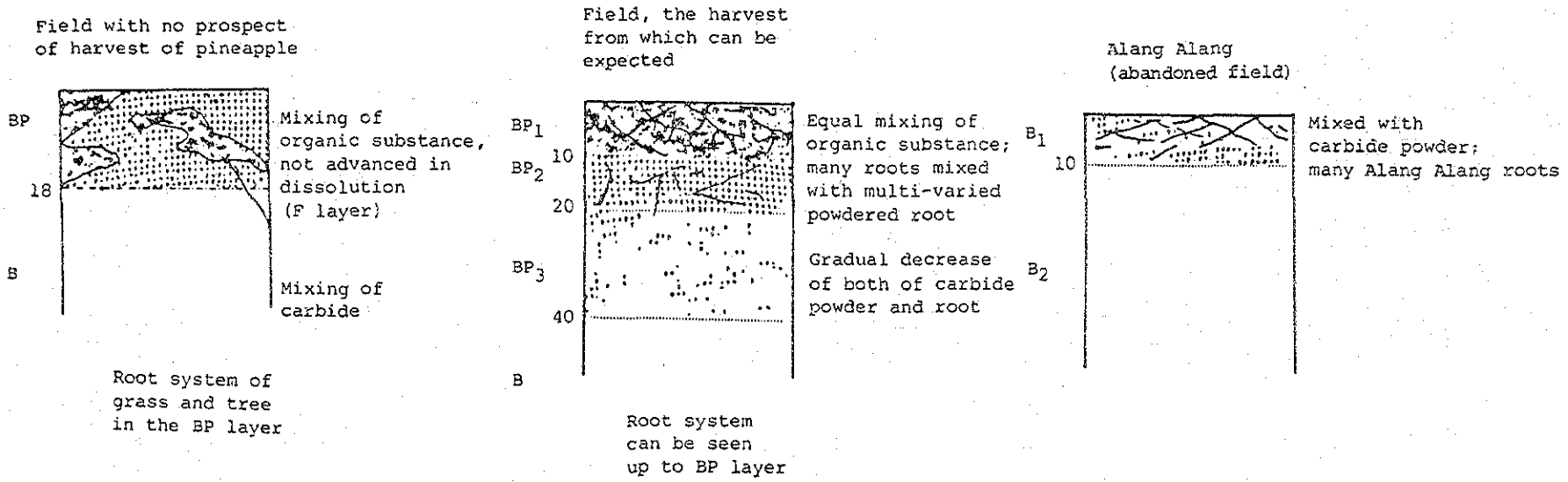


Fig. 24 The treatment after burning of Kerangas Forest and soil profile

physical nature (Fig. 25, Table 9) of soils of separate layer position there are differences among the fields capable of harvesting pineapple and the unfavorable fields and Alang Alang, particularly in the surface layer. The field, being capable of harvest has high quantity of porous crevice, main root volume, water content and minimum air volume bulk dencity weight and favorable permeability and low macro pore content of crude porous crevice.

In addition, it can be understood that there are much of the carbide and organic matter in the upper layer soil profile and are scattered equally. Thus, the difference in improvement of soil by mining the organic matter, caused by change of farm, seems to be the difference in harvest.

Soils in Kerangas Forest has always high water content owing to existing in the forest and having thick layer of organic substance in the surface layer favorable water permeability of the B layer.

The unfavorable physical and chemical character or property such as PH of A layer, however, is as 2.0 - 3.0, the quantity of porous crevice is little and others caused the productive capacity to be low. Though these soils are divided by using the classification of FAO/UNESCO include the Arenosols, they seem to be near the Podzols.

iv. Soils of Mountain and Hill area

According to the FAO/UNESCO classification the type of soil that is most widely distributed in East Kalimantan is the Acrisols. From the investigation of soil profile in the distribution of this Acrisols there are many differences in character, color, existence or non-existence of pebble, water content, etc. Consequently, the type of soil seems to be finely divided. Among them such a soil, possibly called as Podzolic soil that appears in the mountain area, concavely slope and in the middle and low parts of the gentle slope is included. In accordance with the transfer from the surface layer to the low layer, the viscosity increases and the permeability of water of A layer appears to be favorable in Acrisols and even if the bleaching layer is seen in the B layer, the integrated layer is not distinct. As to the fertility most survey spots have many large diameter trees of the disterocarpaceae family from selective cutting, so it is considered to belong to high site class.

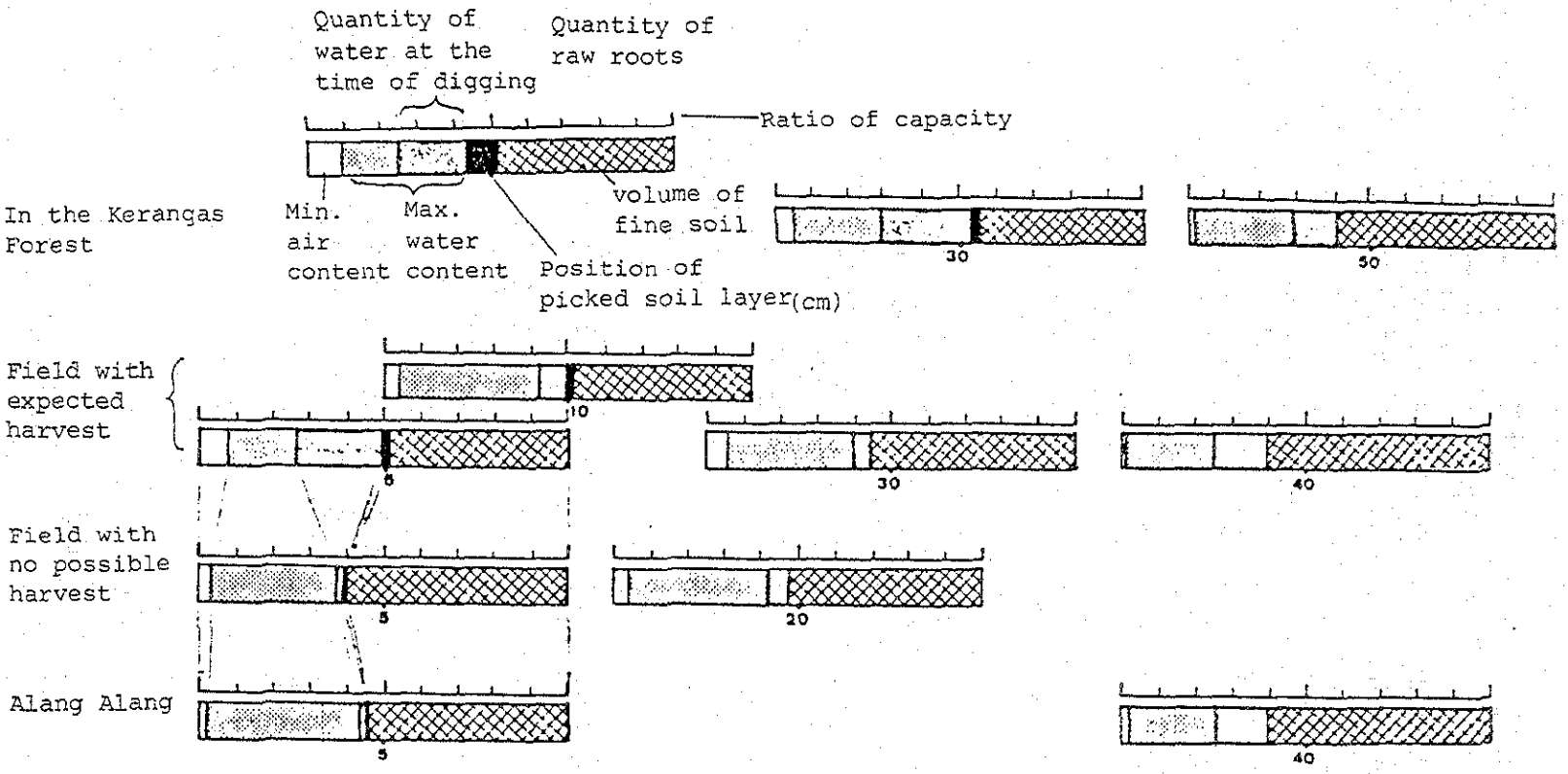


Fig. 25 The scientific description according to separate depths by land use arenosol

Table 9 Each layer of soil of the physical and chemical nature, viewed in Fig. 4

Position of soil sampling (cm)	I. Capacity weight A	P	R	H	II. Permeability A	P	R	H	III. Volume of raw roots A	P	R	H
5	140.0	151.6	127.3		88	70	169		3.3	0.2	6.1	
10			130.0				190				7.3	
20		137.4				80				0.2		
30			143.3	112.1			74	134			0	4.0
40	160.7		155.2		32		82		0		0	
50				146.2				106			0	

	A	P	R	H	A	P	R	H	A	P	R	H
5	8.45 (35.20)	9.88 (29.47)	33.08 (15.82)		6.40 (4.64)	6.30 (5.19)	4.39 (4.30)		0.25	0.25	0.40	
10			27.43 (22.05)				4.91					
20		17.85 (29.10)				6.51 (6.10)						
30			18.58 (25.45)	23.25 (32.90)			5.90 (4.72)	4.19			0.25	
40	15.21 (23.31)		14.95 (24.50)		6.68 (6.08)		6.00		0.25	0.15		
50				17.22 (23.20)				6.40				

A: Alang Alang (left as it is)
D: Field with no prospect of harvest (pineapple)
R: Field to be able to expect harvest
H: Kerangas Forest (Heath forest)

As a typical soil profile, a result of survey made at the experimental forest of Mulawarman University, located at Lempake is shown in Fig. 26. The Acrisols has a thin layer under loarm by deep layer B yellowish brown and reddish brown color clayed to loamy specked structure on the wall-surface. As the distribution of the Acrisols is wide and there are differences in the appearing way of soil profile such as the soil property and soil color, that sectional diagram, and physical and chemical property are shown below:

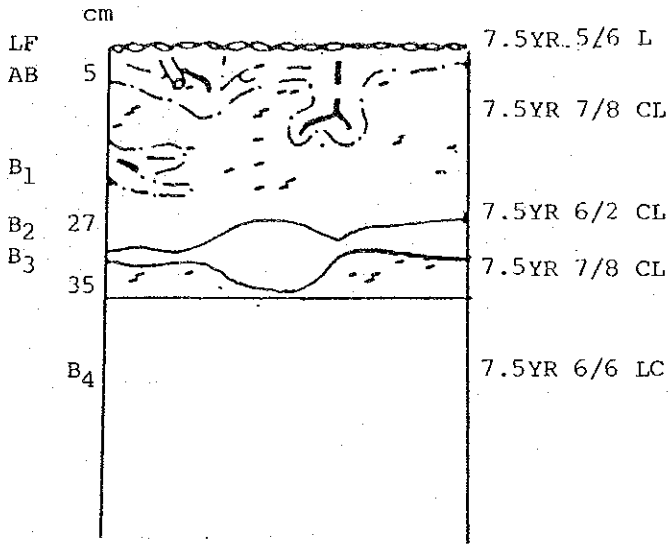


Fig. 26 The soil profile at Lempake

Profile of yellowish brown lateritic soil

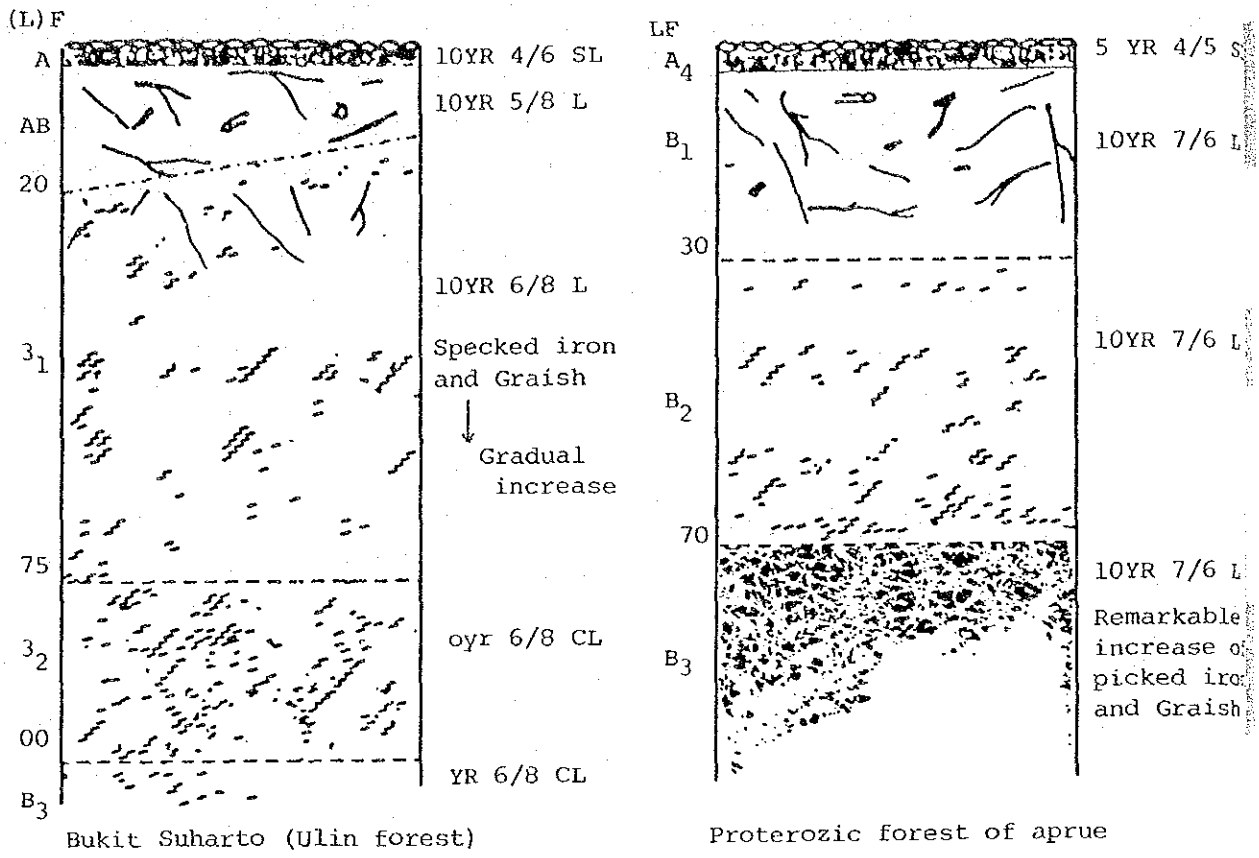


Fig. 27 Profile of yellowish brown lateritic soil

The lateritic soil of yellowish brown color at Lempake is concentrated, as shown in Fig. 27, is up to about 40 m below A and AB layers to B_1 layer as to the root system. The small specked iron appears under it as it goes down, it increases. As shown in Table 10, stiffness of the A layer is low and it becomes rapidly high under the AB layer and the chemical nature is as a whole poor. At the secondary forest, centered by Macaranga of Bukit Soeharto investigation on the physical properties by digging up the soil from the A layer and B layer of the profile of lateritic soil was made and the result is shown in Fig. 28.

Table 10 Chemical analysis of yellowish brown lateritic soil

PH H_2O KCl	NO_2-N mg/100g	NO_3-N mg/100g	NH_4-N mg/100g	Av. P_2O_5 mg/100g	Av. K_2O mg/100g	Ex.Ca %	Ex.Mg mg/100g	Ex.Mn PPm	Fe+3	Fe+2	Hardness kg/cm
A 5.5 4.5	0.1	1	1.0	0	0	0.07	35	2.5	25>	25>	3
AB 5.5 4.5	0.1	1	1.0	0	0	0.07	35	2.5	25>	25>	24
B_1 6.0 4.5	0.1>	1	1.0	0	0	0.07	10	2.5	25>	25>	19
B_2 6.0 4.5	0.1>	1>	1.0	0	0	0.07	10	1.0	25>	25>	20
B_3 6.0 4.5	0.1>	1>	1.0	0	0	0.07	10	1.0	25>	25>	20
A 4.5 4.0	0.1>	1>	1.0	0	0	0.07	20		25	25	4
B_1 4.5 4.0	0.1>	1>	1.0	0	0	0.07	10		25	25	26
B_2 4.5 4.0	0.1>	1>	1.0	0	0	0.07	10		25>	25>	24
B_3 4.5 4.0	0.1>	1>	1.0	0	0	0.07	10		25>	25>	26

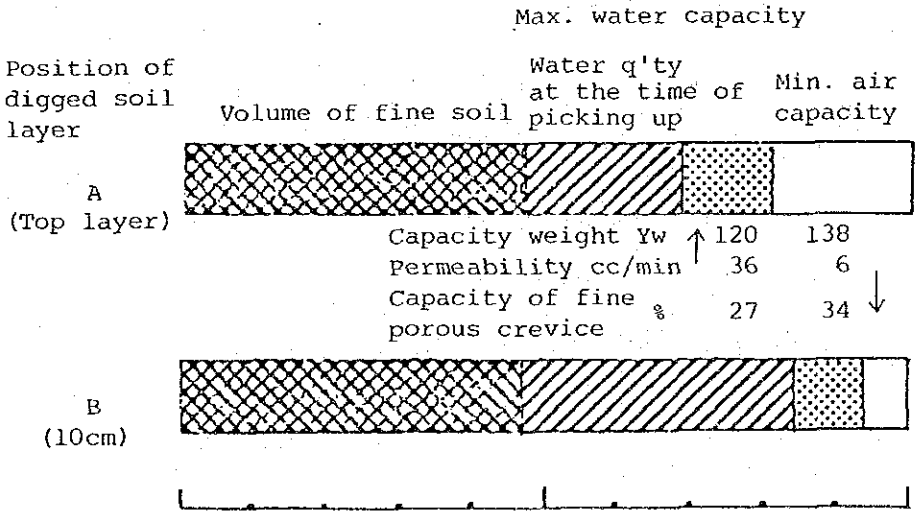


Fig. 28 Water permeability by layer

Such physical nature has high capacity weight, little porous crevice quantity and permeability of water is also unfavorable. As compared with A layer and B layer, however, the capacity weight of the A layer is less, and minimum air capacity and permeability are higher.

As regards this permeability the result was as per Fig. 29 when the difference between its relation with the slant angle at three spots of Gunungkelua and Bukit Soeharto was investigated.

Though the survey spots are few, permeability becomes worse as the layer becomes lower at each sampling spot and as the slant angle becomes higher, permeability becomes lower. Even at the shallow position it becomes to be below almost 10 ml/min. This shows that the falling water runs in the surface layer and it is considered that this is a matter of attention from the land use side.

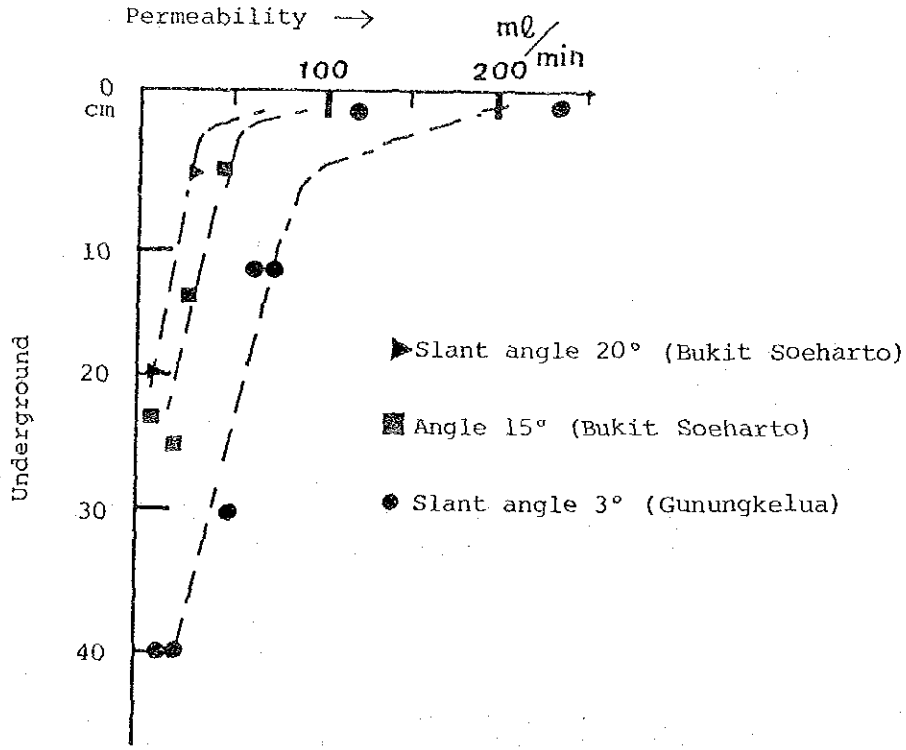


Fig. 29 Slant angle, permeability of each different layer position

° The Lateritic reddish brown soil

The soil profile in the casava field in the suburbs of Samarinda, and the physical and chemical nature of different layer position are shown in Fig. 30 and Table 11.

As regards differences between the reddish brown lateritic soil and the yellowish brown lateritic soil, they lie allegedly in some differences according to a degree of hydration, difference of the basic materials, accumulation of organic matter, disintegration, etc. By the survey of this time differences in fertility, etc. could not be made clear.

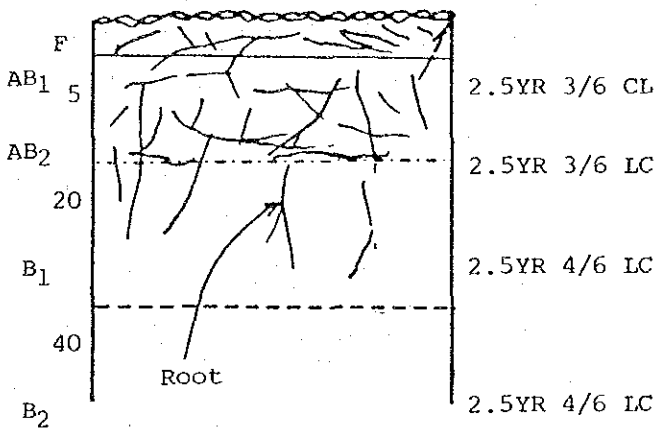


Fig. 30 The soil profile of the casava field

Table 11 The chemical nature of the casava field

	PH H_2O	PH KCl	NO_2-N mg/100g	NO_3-3 mg/100g	NH_4-N mg/100g	AV P_2O_5 mg/100g	AV K_2O mg/100g	Ex.Mn PPm	Al_2O_3 mg/100g	FE^{+3}	FE^{+2}	Hardness kg/cm^3
A_0												
AB_1	6.0	4.5	0.1	1>	1.0	0	0	10	15	25>	25>	8
AB_2	5.5	4.5	0.1	1>	1.0	0	0	2	20	25>	25>	4
B_1	5.5	4.5	0.1>	1>	1.0	0	0	2	30	25>	25>	17
B_2	5.5	4.5	0.1	1>	1.0	0	0	2	30	25>	25>	17

° The other soil

The distribution of Andosole is found from the middle stream area of the River Mahakam up to its upper stream and there are parts that are utilized as the agricultural land.

° The chemical nature of soil in the Sebulu district

1) At Sebulu, the virgin forest, selective cutover forest, afforestation land of caribbean pine, shrub forest (heath forest, the low layer earth is Pasir Putih (white colored sand soil)), high cauline grassy plain and at Bukit Biru the chemical elements of soil were respectively measured.

2) The PH of soil was 4.0 - 5.0 with acidity being slightly strong. The soil of shrub forest had a trend of a little power than that of the selective cutting forest.

3) The amount of nutrid acid N and that of ammonium N of each forest soil was little and having no much difference. Though the cause is not clear but the NO_2-N value of primewal forest at Bukit Biru had a bigger value.

4) As to the content quality of effective form of phosphorous, the value of surface layer earth is higher than that of the low layer earth. In the shrub forest zone of the humid land the value of a layer affected by the thickly hearped humus layer was bigger, i.e., over 20mg/10g.

5) Against Al_2O_3 and Fe^{3+} being plentifully contained in the top layer of the selective cutting forest (high forest), the soil of shrub forest had scanty of them.

6) Differences due to the layer position and type of forest, etc. were not recognized with the displaceable Ca and displaceable Mg.

7) The A layer soil of the Virgin Forest had higher content of Fe (Fe^{3+} + Fe^{2+}) and effective form P_2O_5 than the selective cutover forest.

8) From a result of chemical element the influence on the organic humus with the soil of selective cutting forest was as shallow as several centimeters of soil layer and the lower layer was clayed soil and differences in the chemical element of soil among the heigh forest also were not almost found. The A layer was generally thinner and worse than the soil of forests of the Temperate zone and subtropical zone. The shrub forest (heath forest) finds much freguently the pitcher plant that is allegedly to be the index of the environment of poor nutrition and no high trees were completely found. As the survey points were limited, the relation between the chemical nature of soil and the type of forest was not also made clear. Further, hereafter, the number of sampling points must be increased and if possible, the method of soil analysis also shall not be only the simple method, but implements and devices of high accuracy have to be necessarily brought in.

(5) Vegetation

i. Decipherment of Vegetaion and Condition of Land Use by an Aerial Photograph

By use interpretation of an aerial photograph of Kutai Timber Indonesia in 1972, decipherment of the Vegetation and present land use was taken place on the land of the area of about 20,000 ha., shown in the framework of Fig. 31.

In addition, a land type classification survey table was provided on the basis of vegetation and condition of land use, supposed from the investigation on land of the Sebulu district and its surrounding area. From the interpretation result of the aerial photo, the accuracy of constituent elements of the aerial photo that was the content of the land type classification survey table was studied.

Table 12 Data of Soil Tests

Soil sample	pH H_2O	pH KCl	NO_2-N mg/100g	NO_3-N mg/100g	NH_4-N mg/100g	Available K_2O mg/100g	Ex.Ca %	Ex.Mg mg/100g	Ex.Mn ppm	Al_2O_3 mg/100g	Available P_2O_5 mg/100g	Fe^{3+} mg/100g	Fe^{2+} mg/100g
Primeval Forest													
A_0 0 - 2cm	4.5	4.5	1.0	1.0	2.5	0	<0.07	35	>25	30	1.0	25	25
A_1 2 - 5cm	5.5	4.0	0.1	1.0	1.0	0	<0.07	5	>10	30	1.0	25	<25
A_2 5 - 20cm	5.0	5.0	0.1	1.0	1.0	3	<0.07	10	>10	30	0.1	0	<25
B_1 20 - 50cm	5.5	4.0	0.1	1.0	0	0	<0.07	5	>10	30	0.1	25	<25
B_2 50cm	6.5	4.0	0.1	1.0	0	3	<0.07	5	>10	30	0.1	0	<25
Heath Forest													
A_0 0 - 2cm	4.0	4.0	0	0	5.0	8	<0.07	35	> 10	10	2.5	25	<25
A 2 - 5cm	4.0	4.0	0	0	1.0	3	<0.07	5	> 10	10	5.0	25	<25
B_1 5 - 20cm	6.5	4.5	0.1	0	0	8	<0.07	5	> 10	10	0.1	0	<25
B_2 20 - 50cm	6.5	4.5	1.0	1.0	1.0	8	<0.07	5	> 10	20	1.0	25	<25
Selection Forest													
A_0 0 - 2cm	4.0	4.5	0.1	1.0	2.5	0	<0.07	10	> 25	15	0.1	25	25
A_1 2 - 13cm	5.0	5.0	0.1	4.0	1.0	3	<0.07	35	> 50	30	0.1	25	25
A_2 13 - 64cm	5.5	5.0	0.1	1.0	1.0	8	<0.07	5	> 10	30	1.0	25	<25
B_1 64 -118cm	5.5	4.0	0	1.0	1.0	3	<0.07	5	> 10	30	0.1	25	<25
B_2 118-150cm	6.5	4.0	0.1	0	0	3	<0.07	5	> 10	30	0.1	25	<25
B_2 150cm	5.5	5.5	0	1.0	1.0	3	<0.07	5	> 10	30	0.1	25	<25
Tall Grass													
A_0 0 - 2cm	5.5	4.5	0	0	1.0	8	<0.07	5	>10	20	0.1	25	75
A_1 2 - 5cm	5.5	5.5	0	0	1.0	0	<0.07	20	>10	30	1.0	25	25
B_1 5 - 36cm	5.5	4.0	0	0	1.0	3	<0.07	35	>10	30	0.1	25	25
B_2 36cm	5.5	5.5	0	0	1.0	8	<0.07	20	>10	20	0.1	0	25
Selection Forest Plot 1													
A	4.5	4.0	0.1	<1.0	10-25	0-3	0.07	5	>10	15-20	10-25	150-250	25
B_1	45-50	4.0	<0.1	<1.0	1.0	0-3	0.07	5	>10	15-20	1.0	< 25-75	<25
B_2	45-50	40-45	<0.1	<1.0	1.0	0-3	0.07	5	>10	15-20	0.1	<25	<25
Selection Forest Plot 3													
A	5.0	4.0	0.1	<1.0	1.0	0	0.07	5	> 10	>30	1.0	250	25
B_1	5.0	4.5	<0.1	<1.0	<1.0	0	0.07	5	> 10	20	1.0	75	25
B_2	5.0	4.0	<0.1	<1.0	<1.0	3	0.07	5	> 10	20	0.1	25	25
Heath Forest													
A	4.0	4.0	<0.1	<1.0	1.0	3	0.07	5	> 10	10	> 20.0	<25	25
B	4.5	4.0	<0.1	1.0	<1.0	0	0.07	5	> 10	5	0.1	<25	25
Artificial Forest													
A	5.5	4.5	<0.1	<1.0	2.5	3	0.07	5	> 10	>30	0.1	250	25
Virgin Forest													
A	5.0	4.0	4.0	<1.0	1.0	3	0.07	5	> 10	15	15.0	250	75
B	4.5	4.0	<0.1	<1.0	<1.0	0	0.07	5	> 10	15	0.1	75	<25

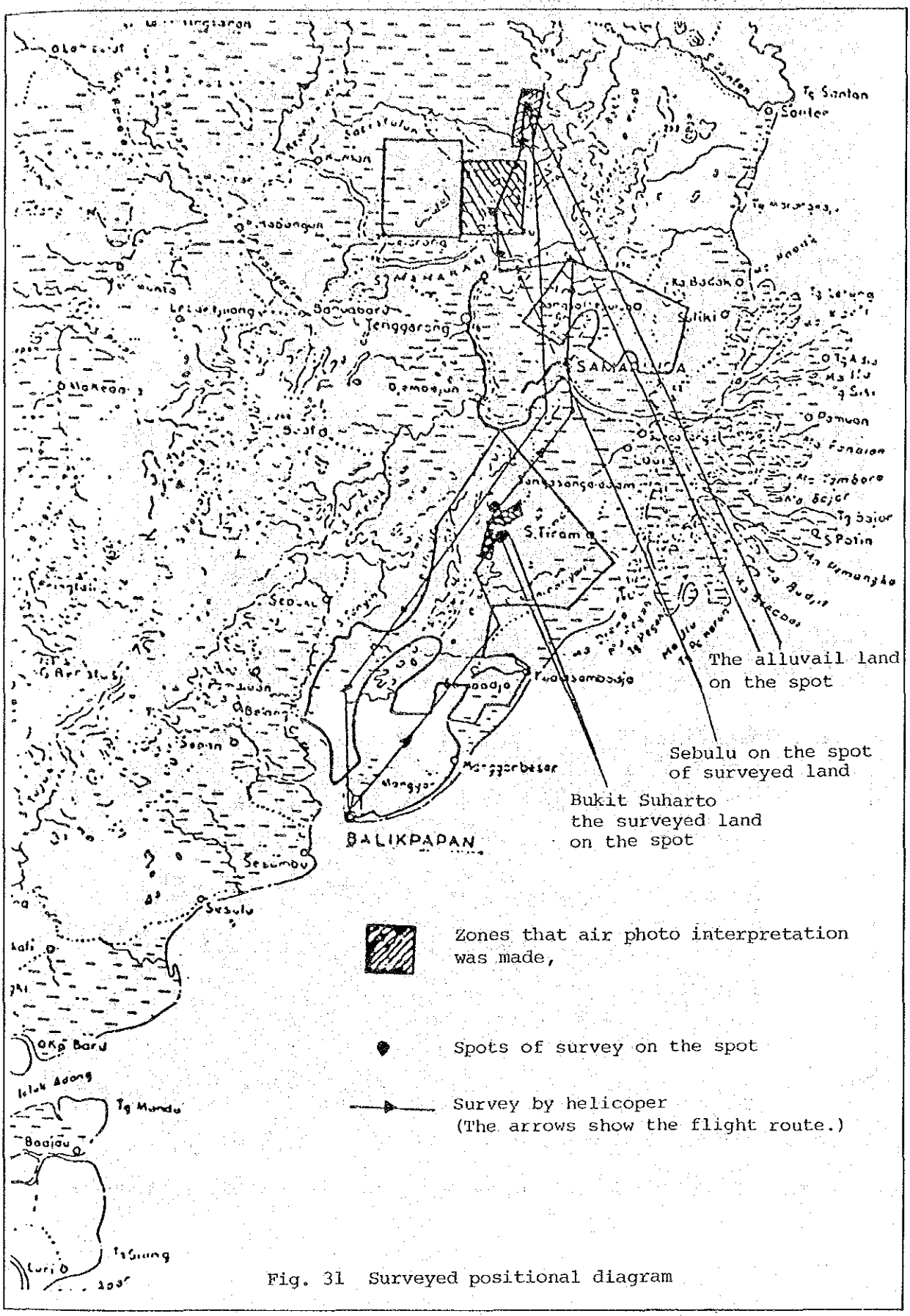


Fig. 31 Surveyed positional diagram

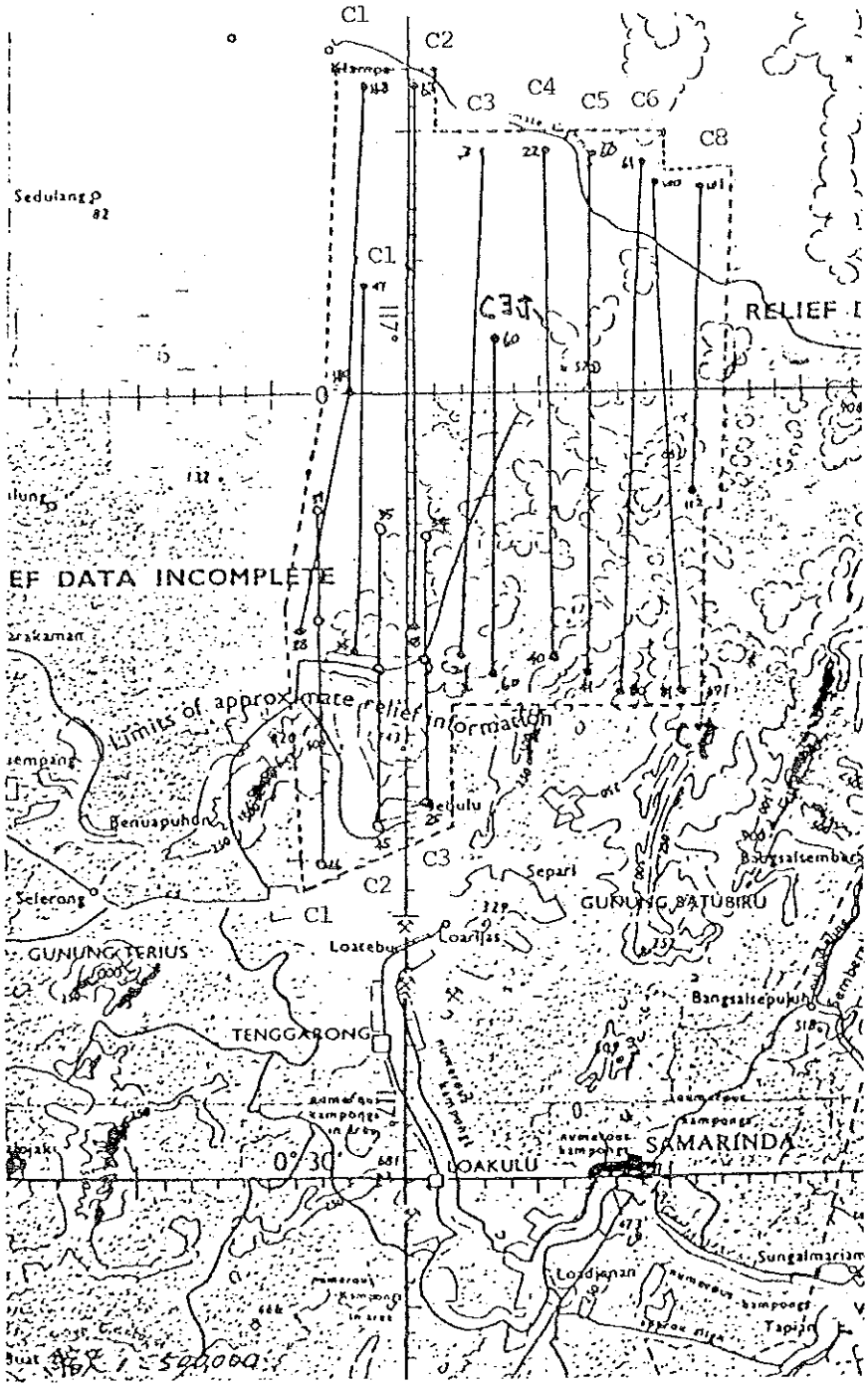


Fig. 32 The orientated diagram of aerial photo of Sebulu district

The enlarged photo of the neighborhood of Sebulu Base Camp.
(The arrow indicates the directions of photos taken.)

Further, the reduced scale of the aerial photo is 1:20,000 and its oriented diagram is as in Fig. 32.

ii. Interpretation of Vegetation

The decipherment of forest (The virgin forest)

The forests were divided by the interpretation elements of diameter of crown of tree, density and height of tree that can be measured by the aerial photo.

The measurement was firstly carried out with the Typification of uniform forest and next, diameter of crown of tree and height of tree of the average tree were measured according to different type of each forest and further, the densities of standing trees, supposed to be of the same type of forest, were measured. The classification of measurement was as shown below and respective element was divided into three steps.

The classification of tree size and stand density at Sebulu area

H1	Trees height 19 m and less
H2	Trees height 20 - 30 m
H3	Trees height 30 m and up
C1	Crown diameter 10 m and less
C2	Crown diameter 10 - 20 m
C3	Crown diameter 20 m and up
D1	Crown density (Dominant) 40% and less
D2	Crown density (Dominant) 41% - 69%
D3	Crown density (Dominant) 70% and up

As a result combinations by stages of height of tree, diameter of crown of tree and density were provided and tree size and stand density and forest types were separated as follows:

The forest types that appear
in the Sebulu area

Forest type	Tree size and Stand density
Forest of large diameter tree	H_3 C_3 D_3 H_3 C_3 D_2 H_3 C_3 D_1 H_3 C_2 D_3 H_3 C_2 D_2
Forest of medium diameter tree	H_2 C_3 D_3 H_2 C_3 D_2 H_2 C_3 D_1 H_2 C_2 D_3 H_2 C_2 D_2 H_2 C_2 D_1
Forest of small diameter tree	H_2 C_1 D_3 H_2 C_1 D_2 H_2 C_1 D_1 H_1 C_2 D_3 H_1 C_2 D_2 H_1 C_1 D_3 H_1 C_1 D_2 H_1 C_1 D_1

Land decipherment besides forest (virgin forest)

The land other than forests are divided into the next 14 kinds on the basis of plant growing and forms of use.

C_1	Selection forest
C_2	Clear cutting forest
SF	Shifting cultivation
P	Paddy field
G_1	Grass (Low)

G_2	Grass (High)
G_3	Grass (Natural)
S_1	Young secondary forest
S_2	Old secondary forest
WF_1	Wet Low land forest
WF_2	Wet Low land forest (Swamp)
V	Village
LF	Levee forest
RF	Rubber plantation
P	Pure forest

The comparison of the land type classification survey table and interpretation result:

Comparisons between the vegetation and the constituent elements of the land type classification survey table on the present land use and the result of decipherment of air photo are as follows:

Result of interpretation of air photo		Land type classification survey table
Forest of large dia. tree	≠	Virgin forest of huge tree
Forest of medium dia. tree	≠	Virgin forest
°Forest of small ida. tree		Forest of low tree
*Old secondary forest Secondary forest *New secondary forest	≠	Secondary forest
Forest of embankment	≠	Forest of embankment
Low humid forest	≠	Forest of peat humid land

	°Humid forest		Forest of flooded peat humid land
			Bamboo forest
			Palm forest
			Mangrove forest
			Shrub tree forest
*Natural grassland ←	High cauline grassland	⇄	High cauline grassland
	Low stalk grassland		Low stalk grassland
			High stalk wide leaves glass
			Glassland of high cauline and wide leaves
			Grass land of low stalk and wide leaves
			Aqueous grassland
			Glass land of wide leaves and water
			Undeveloped forest
			Selective cutting forest
			Artificial forest
*Burnt field ←	Clear cutted area	⇄	Clear cutted area
			Fixed agricultural land
			Field of upland rice
	Paddy field	⇄	Paddy field
	Gum planting land	⇄	Road of cultivation land of tree for particular use
	Village	⇄	Dwelling land and others

Remarks: ° Constituent element, not shown in the survey table.

* Contituent element of the same content as the survey table.

As shown above, the result of interpretation of aerial photo coincided approximately with the constituent elements regarding the vegetation in the land type classification survey table, provided by literature, information and preparatory survey except special ones, and so these contituent elements shall be adopted as they are. In addition, as for the relation between the burnt field and the all clear cutted area shall be studied separately.

Further, the number of vegetation type is interpretated by the aerial photo, is considerably less than that in the land type classification survey table, but this is caused by a small interpretation area of the aerial photo.

iii. Natural vegetation

1) The Primeval Forest of Huge Trees

Photo 14 The primeval forest

The trees that have developed the plate roots around in the virgin forest which huge trees of the family of height of tree about 50 m and diameters of crowns of trees surpassing over 20 m appear. There are much plant of vine nature and epiphyte. There are generally little forest floor plants and surface layer of crowns of trees has become lacking of uniformity due to appearance of huge trees. These forests do not appear continuously over a large area, but exist locally.

2) The Premeval Forest

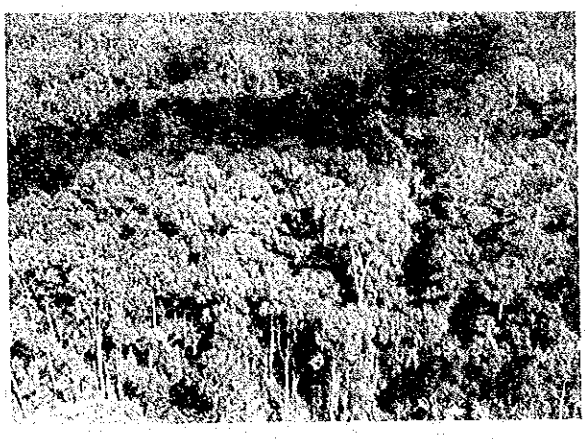
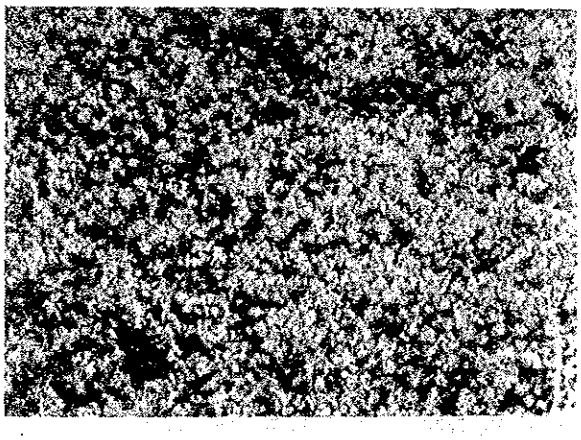


Photo 15 The primeval forest

The palm and the like are rarely found in the virgin forest in which tress of the family of dipterocarpaceae height of trees being 25 - 30 m and of dia. of crown of trees being 10 - 20 m appear abundantly. The layers of crowns of trees are approximately uniform.

These forests became in a condition like surrounding the huge trees in the virgin forest and exist continuously over a considerable area.

3) Low Forest



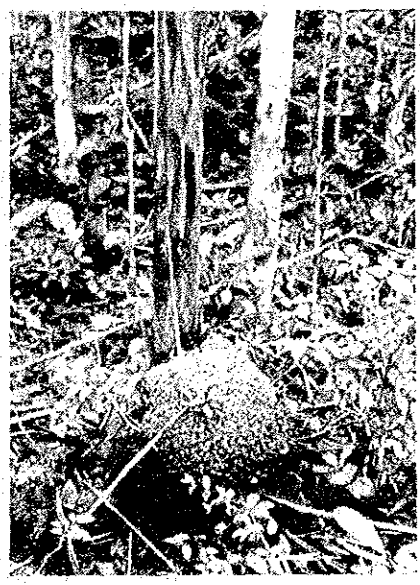


Photo 16 Low tree forest

In the trees of small diameter at height of trees being about 15 m and of the diameters of crowns of trees being 5 - 6 m,

trees of the family of dipterocarpaceae of the height of 17 - 18 m and of the dia. of the crown of trees being 10 - 15 m appear rarely. There is, in the forest, a shrub layer mixed with vine palm trees and the floor of forest is much humid with the sphagnum and the like that cannot be seen in the other tropical rain forest, covering often the crevice of earth of standing trees and surface of the fallen tree. There are, in the forest, a number of such insect catching plants as the pitcher plant, and parasitic orchids, protected as rare plants, sedge and the like and a kind of small appear in the fringe of forest appear, presenting a scenery like the subalpine zone, but such a forest is called in the tropical zone as the heath forest. These forests are scattered not only in the virgin soil, but also locally in a considerably wide range.

4) The Secondary Forest

Photo 18 The secondary forest

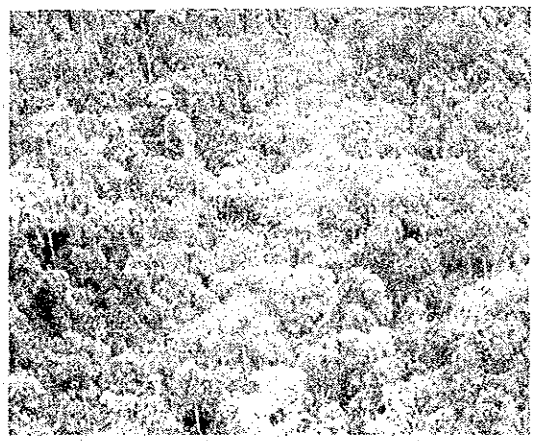


Photo 19 The remains of forest road

This is an artificially destroyed remains of the virgin forest and is groups of forests halfway in plant succession. The height of trees is 5 - 15 m and the diameters of crowns of trees are in the extent of 3 - 8 m. It is composed of trees that differ greatly according to a secular change after the destruction of virgin forest. These forests exist locally as the clear cutted area remains, forest road site remains and burnt field land remains.

5) The Natural Levee Forest

The small scale forest of trees of height of 15 - 20 m and of diameters of trees being approximately 5 - 10 m ranging in lines. These forests exist locally along rivers or former flowing routes.

Photo 20 The natural levee forest

6) The Peat Land Forest

The forest that appears in the humid plain where water flows in by rain water and from small rivers and is stored. Centering the zone of high underground water level, there exists the zone of trees and forest area that have different stepped layers structure of a concentric circle.

Photo 21 Peat humid forest

The trees that compose trees and forest zone of the center part are 8 - 10 m high and about 5 - 8 m wide of diameters of crowns of trees. As the tree and forest zone goes toward the outer fringe, the height of trees, diameters of crowns of trees become larger and huge trees rarely appear, but the tree and forest zone in the outer fringe area becomes again to have smaller height of trees and diameters of crowns of trees. Features of peat humid land forest are that the forest floor becomes covered with dark brown color. These forests exist locally in a comparatively large area.

Photo 22 In the peat land forest

7) The Flooded Peat Land Forest

The forest that is flooded regularly or irregularly during a year by flowing water by increasing water levels of rivers. The forest, flooded during a year, has low density of standing trees and is a thin wood of height of trees being 8 - 15 m. The forests, flooded regularly or irregularly, reach the height of trees of about 15 - 20 m, but their life span is short and has a number of dead trees. These forests exist locally and slenderly along rivers.

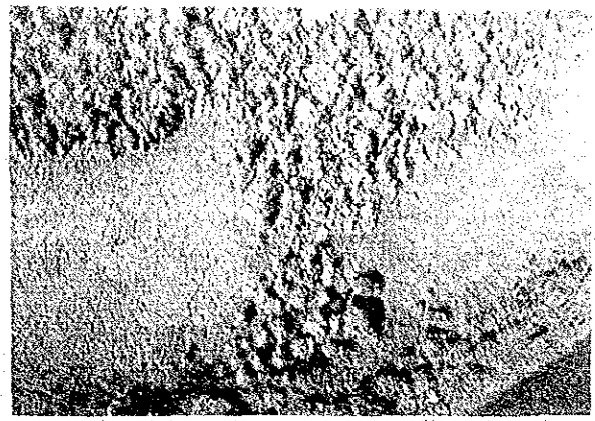


Photo 23 The flooded peat humid land forest

8) The High Cauline Grassland

The humid plain of mixingly grown with plants like the rice plants plants, of about 1.5 m high, ferns, sometimes with vine plants such as smilaxes and the like. There are also the land where shrubs of about 3 - 5 m are scattered. These plains appear locally in the hinterland of the natural levee.

Photo 24 The high cauline grassland

9) The Low Stalked Grassland

The grassland, covered with plants like rice plants, supposed to be below 50 m in height.

The land appears in the humid land where rain water and water, flowed in from the small rivers, are stored, or in the flooded humid land with flowed in water from rivers. The low shrubs, etc. are almost not found. This land exists between the peaty, humid forests and the flooded humid land forest or along rivers.

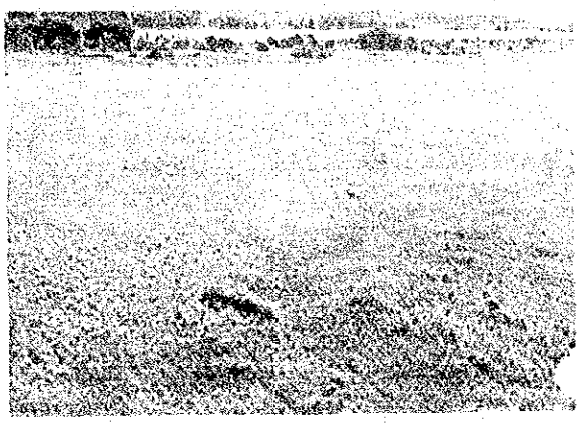


Photo 25 Low stalk grassland

10) Water Plant Area

This area locally exists in a large area along the grassland and riverside, covered with plants like reeds that emerge almost all through a year on the riverside and marshes.

Photo 26 The water plant area

11) The Grassy Water Plants and Wide Leaves Wet Land

These plains are scattered in a small area, adjacent to the glassland and marshes and grassland of water plant in the state of floating plants that appear in the stagnent water surface of the riverside.

Photo 27 The grassy water plants and wide leaves wet plant

iv. Present Land Use

1) Undeveloped Forest

This is a forest, belonging to the virgin forest of huge trees and the virgin forest by the land type classification subject of the natural vegetation and is composed of the kinds of trees of Meranti and the like, Kapur, Bangkirai, Nyorakat, Keruing, Nyatoh, Anggi, Ulin, Durian, Asam, Gerunggang, Medang, etc.

Photo 28 The Virgin forest of huge trees

Photo 29 The Virgin forest

The standing trees of diameter at breast height having the breast of over 35 cm are exist, as shown in Fig. 33, as 14 - 28 individuals per ha., but the peak can be seen at 18 and 24 individuals per ha. according to the distribution of relative frequency with the portion of plant No. 63 forest at Sebulu.

In addition, when comparing the distribution of diameter at breast height structural ratio of tree species, and ratio of timber volume, the result becomes as per Fig. 34 - 37.

Provided that the standing trees in the virgin forest are 2,231 individuals per 100 ha. and 13,325 m^3 of their timber volume. The standing trees in the virgin forest are 1,543 individuals per 100 ha. and 8,337 m^3 of their timber volume.

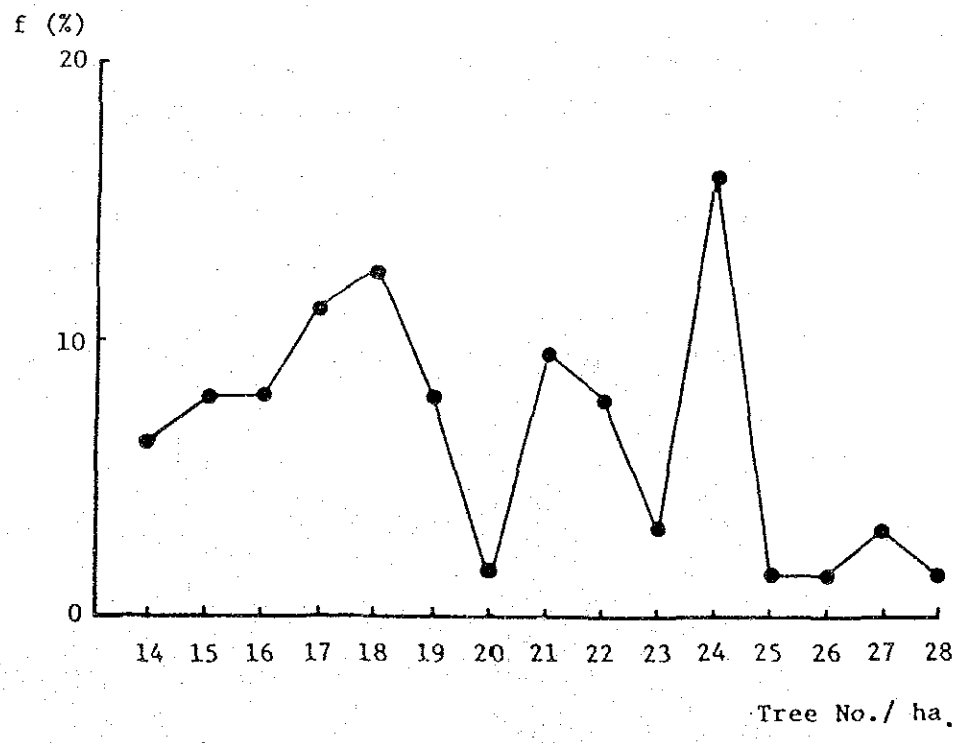


Fig. 33 Frequency distribution of Tree Number per ha.

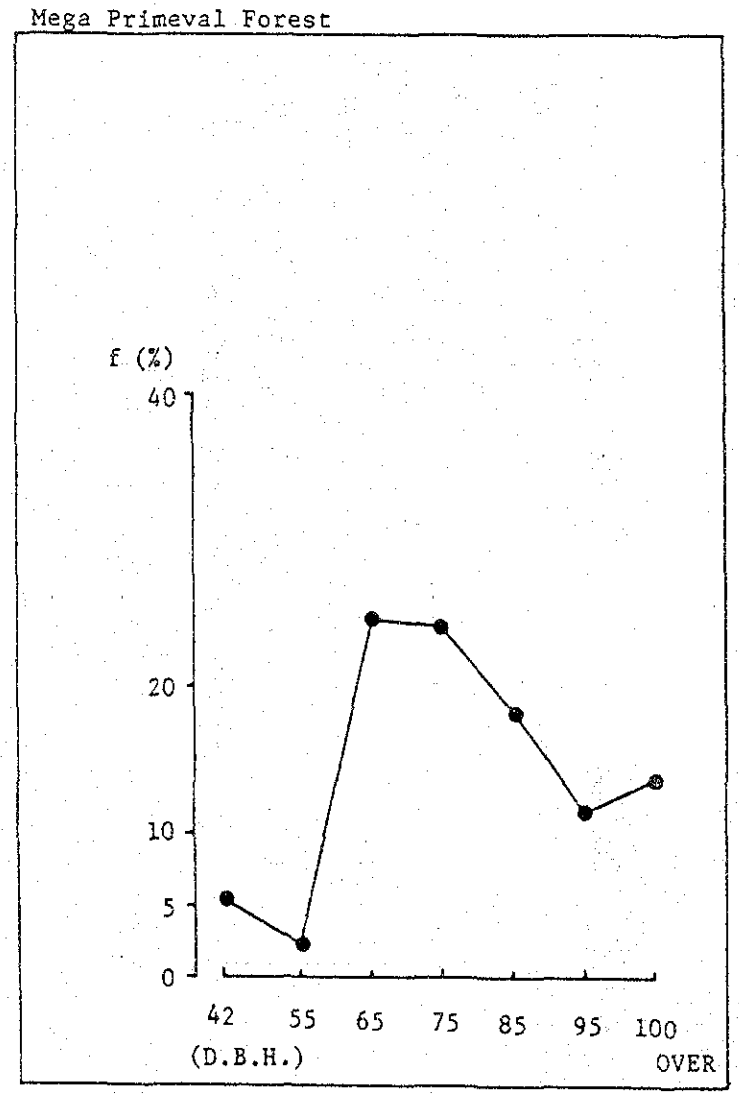


Fig. 34 Frequency distribution of D.B.H.

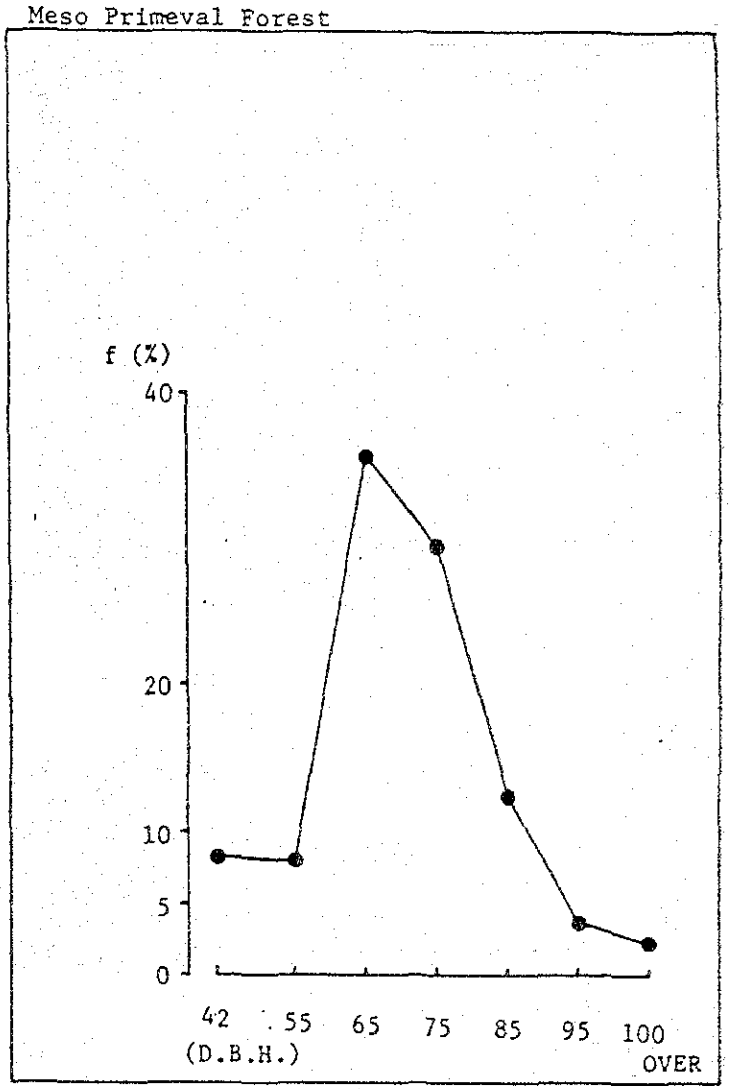


Fig. 35 Frequency distribution of D.B.H.

Mega Primeval Forest

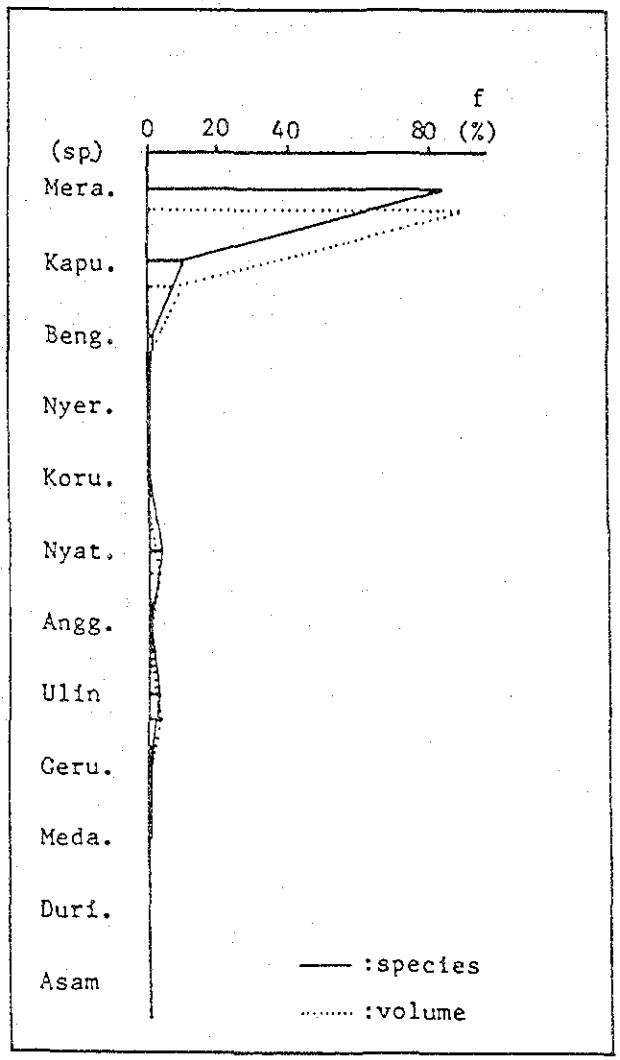


Fig. 36 Frequency distribution of Tree species and volume

Meso Primeval Forest

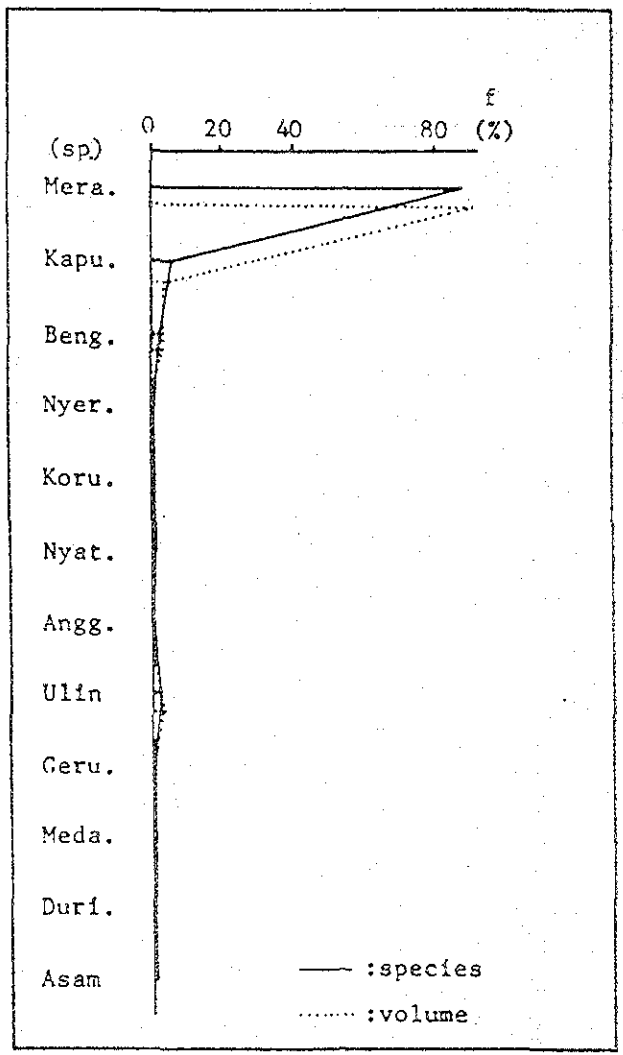


Fig. 37 Frequency distribution of Tree species and volume

2) Selective Cutting Forest

This is the forest in which huge diameter trees of mainly elected meranti and the like were cutover. The selective cutting forest is originally the forest in which it is to be possible to produce woods in the stablest continuation. In the tropical rain forest, however, damage in the remaining wood owing to

Photo 30 Forest under selective cutting

Photo 33 Remaining trees after selective cutting

Photo 31 Selective cutover remains land area after selective cutting

cutting down, gathering and transport of woods is great and further, by dispersion of circumference, plants of vine nature grow thick, cover the remaining trees and decrease vitality of trees, having much influence in making people easy to enter a

large area. The selective cutting forest is enlarging the primeval forest of huge trees and primeval forest.

3) The Artificial Forest

The artificial forest of Merkusi pine exists, though just a little, near the Camp ground of Kutai Timber Indonesia.

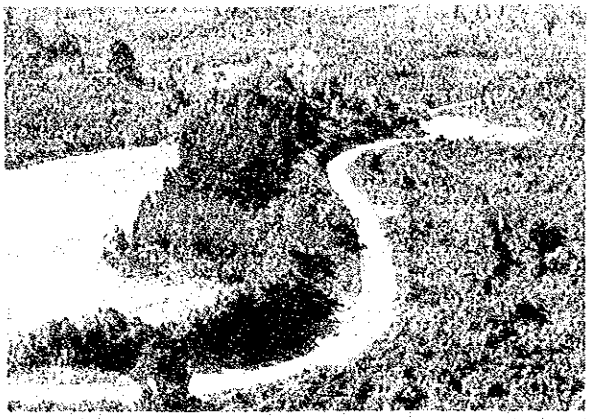


Photo 33 The artificial forest

4) Area After Clear Cutted

There exist the clear cutted area that was intended to make the agricultural field by burning out of the low tree forest, secondary forest and selective cutting forest.

Photo 34 Area after clear cutted

5) The Cultivation Field for Arboriculture

The cultivation land of gum tree and durian for picking fruit exist in an area, though extremely small.

6) Wild Land

This is the land, not yet utilized, including the high stalked grass, low stalked grass, low forest, peat wet forest and flooded humid land forest and occupies the widest area.

7) The Road

There is a general traffic road along the Mahakam River and the forest roads of Kutai Timber Indonesia. That has been installed up to the interior of about 50 km the riverside.

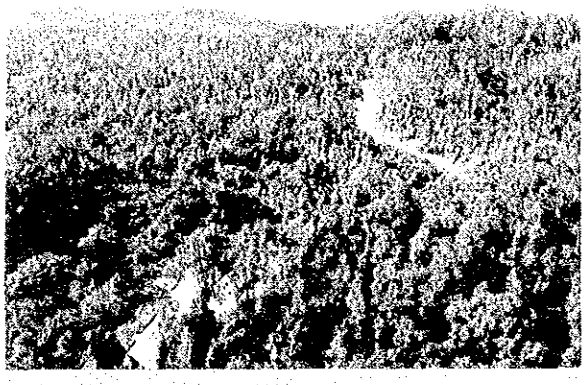


Photo 35 The road

8) The Dwelling Land and Others

There exist along the Mahakam River the village of Sebulu, fish farming pond, landing place, underwater log yard or log pond, etc.

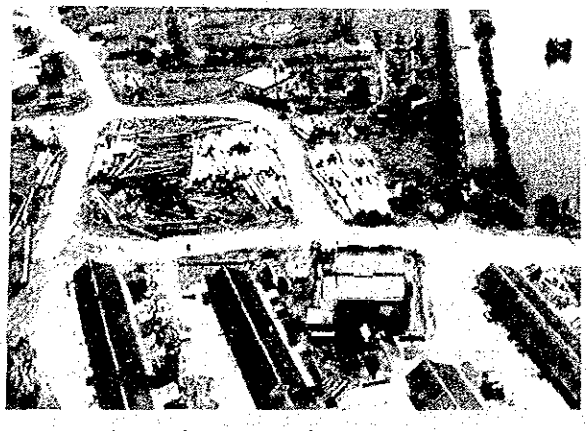


Photo 36 The dwelling land and others

6. The Land Use Classification on the Basis of Geological Features, Topography, Soil and Vegetation

(1) The Land Type Classification

The land characteristic item and its categories necessary for the land classification from the mouth of river of the Mahakam River to the middle stream area on the basis of geological features, topography, soil and vegetation from the survey results so far carried out, were examined.

As a result, it was decided that the land characteristic item and respective constituent categories concerning the geological features, topography, soil and vegetation shall be as follows:

i) The Characteristic Item and Its Categories on the Geological Features

There are as targets, surface layer rock and stone, bedrock and structure of geological features, but as there is close relation of the structure of geological features with the topography, to be stated next, the surface layer rock and stone, and bedrock shall be only named in order to avoid overlapping with the topography.

When dividing the surface layer rock and stone, bedrock that have been so far made clear, into igneous rocks, sedimentary rocks and metamorphic rocks, the result is as follows:

Igneous rocks:	Granite, Diorite, Peridotite	Plutonic rocks
	Serpentine	Half plutonic rock
	Porphyrite	Half plutonic rock
	Andesite, Basalt	Volcanic rocks
	Volcanic ash	Volcanic rock (Erupted rock)
Sedimentary rocks	: Shale, limerock, quartz sand rock of lime quality, quartz sand rock, sand rock, marlaceous sand rock, loamy sand rock, marlstone, agglomerate rock, alluvial clay, alluvial sand and soil, and alluvial soil of pebble quality.	

Further, as stated above, metamorphic rocks were not recognized. When treating these rocks and the like as the categories, the land type classification becomes very difficult, and so, in order to

simplify the above into unifying rocks of similarity, the categories of surface layer rocks and bedrocks were made as follows:

° Land characteristic item: Surface layer rocks and stones, bedrocks

Categories:
(1) Granite
(2) Diorite
(3) Peridotite (Note 1)
(4) Poryhyrite
(5) Andesite
(6) Besalt
(7) Erupted rocks and the like
(8) Marlaceous sand rock (Note 2)
(9) Sand rock
(10) Agglomerate rock
(11) Lime rock
(12) Shale
(13) Marlstone
(14) Sedimentary rock and the like of the alluvial epoch (Note 3)

Note 1: As the serpentine is the rock that is a part of rock dissolved, it was made to belong to the category of the peridotite.

Note 2: Sand rock of marlstone nature and loamy sand rock were made to belong to the category of sand stone.

Note 3: Quartz sand rock of lime quality was made to belong to the category of sand rock of quartz quality.

Note 4: The alluvial clay, alluvial sand and soil, and alluvial soil of pebbles were collectively made to belong to the alluvial epoch heaped rock and the like.

ii. The Land Characteristic Item and Categories Regarding the Topography

As the land characteristic item concerning the topography is much varied, it is divided into the large, medium and small topographies, and the respective categories are concluded as follows:

In addition, as regards what show the relation with the locations of land that become the object of land classification, the land type classification item can be considered to be separately named, but it was made to be treated in the topography as the land characteristic item that shows the altitude, showing the height above the sea level, and the distance from the seashore or riverside.

° The land characteristic items: Large and medium topographies

Contituent categories:
(1) Mountaineous land
(2) Foot of mountain
(3) Hill
(4) Plateau
(5) Basin
(6) Delta
(7) Plain

° Land characteristic item: Small topography

Categories:			
	(1)	Very steel slope	> 30
	(2)	Steep slope	18 - 30°
	(3)	Moderate slope	8 - 18°
	(4)	Gentle slope	4 - 8°
	(5)	Very gentle slope	1 - 4°
	(6)	Flat land	0 - 1°
	(7)	Dip plain	
	(8)	Terrace	
	(9)	Fan-like land or alluvial cone	
	(10)	Natural levee	
	(11)	Flooded plain	
	(12)	Low land of valley bottom	
	(13)	Wet land	
	(14)	Inter levee lowland	
	(15)	Sand beach	
	(16)	Rock and stone beach	

Note 1: There are many ways of classification as to the range of slope angle. Here, the FAO method [10] was decided to be followed.

Note 2: The inter levee lowland indicates the wet land that is a part adjacent to the natural levee, and the wet land designated a wide humid land, not related with the natural embankment.

° The land characteristic item: Degree of altitude

Categories:			
	(1)	Lower lowland	0 - 20m
	(2)	Middle lowland	20 - 50m
	(3)	Higher lowland	50 - 100m
	(4)	Lower highland	100 - 300m
	(5)	Middle highland	> 300m

Note 1: The categories of height above the sea level related with the land use division of Indonesia seem to have been divided into the categories of 0 - 5m, 5 - 25m, 25 - 500m, 500 - 1,000m and over 1,000m. However, as this way of classification seems to be not always suitable to the land type classification that is the object from the mouth of the Mahakam River inclusive of a part of low mountain zone to the natural levee zone of the middle stream area, it was decided to induce the conception of lowland and highland.

° The land characteristic item: Locality

Categories:	(1)	Seashore, riverside zone and linear zone along the highway	0 - 50 km
	(2)	The inland zone of riverside seaside and zone along the highway	50 - 200 km
	(3)	Inland zone	50 - 200 km
	(4)	Riverside coast and inland zone along the line of highway	> 200 km
	(5)	Inland zone	> 200 km

Though not directly related with the topography, as the distance from the highway is also related with exploitation, being the item of the similar quality, it is added herewith.

iii. The Land Characteristic Item and Categories Concerning Soil

As the land characteristic items as to the soil, the type of soil and the degree of depth of effective soil were mentioned.

In addition, the aforesaid result of soil survey was classified subject to the world soils map of the FAO/UNESCO, but as this method of classification brought about the portion that did not sufficiently cope with the categories of small topographies, indicated beforehand, the further minutely viewed classification seems to be necessary. Therefore, the conventional soil classification formula in the U.S. was mainly introduced.

° The land characteristic item: Type of soil

Categoeis:	(1)	Yellow podzol soil
	(2)	Reddish yellow podzol soil
	(3)	Reddish podzol soil
	(4)	Yellowish brown laterite soil
	(5)	Reddish brown laterite soil
	(6)	Glay soil
	(7)	Alluvial soil
	(8)	Peat soil
	(9)	Mud soil
	(10)	Sandy soil
	(11)	Bleached sand soil
	(12)	Gravel sandy soil
	(13)	Volcanic ash soil

° The land characteristic item: Effective depth of soil

Categories:	(1)	Primeval forest of huge trees	> 50m
	(2)	Primeval forest	18 - 50m
	(3)	Low forest	5 - 15m

(4) Shrub forest < 5m
(5) Peat land forest
(6) Humid land forest
(7) Bamboo forest
(8) Secondary forest
(9) Nipa forest
(10) Mangrove forest
(11) Levee forest
(12) High cauline single leaf plant group > 100cm
(13) Low stalk single leaf plant group < 100cm
(14) Twin leaves plant group
(15) Single leaf, twin leaves mixing plant group
(16) Group of Ipomoea pescaprae sweet

° The land characteristic item: Artificial vegetation

Categories:
(1) Selective cutting forest
(2) Artificial forest
(3) Coconut plantation yard
(4) Kapok plantation yard
(5) Gum plantation yard
(6) Orchard
(7) Coffee plantation yard
(8) Pepper plantation yard
(9) Cacao plantation yard
(10) Pineapple plantation yard
(11) Paddy field
(12) Burnt field
(13) Edible roots field
(14) Corn field
(15) Peanut field
(16) Vegetable field

Note 1: All of the edible roots field, corn field, peanut field and vegetable field designate the fixed field as the common field land.

(2) Land Use Capability Classification

As the object of this research lies in the land use capable classification to exploit the agricultural land with maintaining simultaneous harmony with the forest resources, the land use capability classification concerning the agricultural exploitation must be put into practice.

When resorting to execute the land use capability classification with a view to develop the agricultural land, the land characteristic item and its respective categories that have been decided so far from the standpoint of at least the hardness and easiness of exploitation and the latent productive capacity of soil must be necessarily assessed.

i. The Classification of Land Characteristic Item, Relating to the Exploitation of Agricultural land

° The Land Characteristic Item Concerning the Degree of Hardness and Easiness in the Exploitation of Agricultural Land

1) The traffic land characteristic item: Location, degree of height (The land characteristic item that governs the expenditure of transport of materials necessary for exploitation).

2) The land characteristic item of civil engineering works and cultivation: Large and medium topographies, small topography (Items that govern the expenses of dam, water reservoir, floodgate, waterway, road, soil preparation, agricultural change, cable, prevention of land erosion, etc.)

° The Land Characteristic Item Concerning Potential Productivity of Land

Small topography, surface layer rock and stone, bedrock, soil type, effective depth of soil, (forest tree, tree for special use, fruit tree, crop of a long time, soil nourishing substance that governs the productive volume of field products) and land characteristic item that governs the land productive capacity.

ii. The Assessment of Category

As the assessing method ofcategory the degree of suitability is generally used. This method is the assessing suitability of category by scores for the land use capability classification. As regards the land use capability classification with FAO (11), a score of 0 - 5 is given, and it shows that the bigger the value, the higher the suitability.

Here, however, as a method for more clearly showing the suitability, the assessment of category to the system of the score method to be obtained by numericalized analysis was tried.

The score method by this analysis of quantity is the system to give scores of plus or minus, centering 0, i.e., 0 shows the turning point in expectancy phenomena. It shows that bigger the minus value, the bigger the contrary effect of expectancy phenomena and

the bigger the plus value, the bigger the effect of expectancy phenomena.

From the above, the land use capability classification was decided to be taken place by the category of each land characteristic item of one of scoring of 0, ±1 and ±2, i.g., if the score of 0 is given to some category of the land use capability classification concerning hardness and easiness of the agricultural exploitation, the category shows the turning point of the agricultural exploitation, and in the case of -1, it shows hardness of exploitation, in the case of -2, it is very difficult, in the case of 1 it shows possibility of the agricultural exploitation and in the case of 2 sufficiently possible. In the same way in the case of score of the category as to the productivity of land being 0, it shows the turning point, in the case of -1, the landproductivity being scanty and being not suitable for the agricultural land, in the case of -2, very unfit as the agricultural land, in the case of 1, suitable for the agricultural land and in the case of 2, well suited for the agricultural land.

iii. The Score of Category

° The land characteristic item: Surface layer rock and bedrock

Category	Exploitation score	Land score
(1) Granite		-1
(2) Diotite		-1
(3) Peridotite		0
(4) Poryhyrite		0
(5) Andesite		0
(6) Besalt		0
(7) Erupted rock and the like		2
(8) Quartz sand rock		-2
(9) Sand rock		0
(10) Agglomerate rock		-1
(11) Lime rock		-1
(12) Shale		0
(13) Marloceous		0
(14) Alluvial epoch heaped rock and the like		1

Note 1: Regarding the volcanic erupted rock and the like such as volcanic ash, etc., the land productivity is low in the Temperate Zones, but the dissolution is fast in the tropical area, and the land productivity is high.

° The land characteristic item: Large and medium topographies

	Category	Exploitation score	Land score
(1)	Mountaneous land	-2	
(2)	Foot of mountain	-1	
(3)	Hill	0	
(4)	Terrace	0	
(5)	Basin	0	
(6)	Delta	1	
(7)	Plain	2	

° The land characteristic item: Small topography

	Category	Exploitation score	Land score	
(1)	Very steelp slope	-2	-2	
(2)	Steel slope	-1	-1	
(3)	Moderate slope	0	1	
(4)	Gentle slope	1	2	
(5)	Very gentle slope	2	1	
(6)	Flat land	2	0	
(7)	Dip plain	2	1	
(8)	Terrain	1	2	
(9)	Alluvial fan or alluvial drill	1	2	
(10)	Natural levee	2	2	
(11)	Flooded plain	0	1	
(12)	Low land of valley bottom or shallow valley land	-1	0	(1)
(13)	Humid land	-2	-2	(-1)
(14)	Inter levee lowland	-2	0	(2)
(15)	Sandy seashore	-1	-2	
(16)	Rock and stone seashore	-2	-2	

° The land characteristic item: Altitude

	Category	Exploitation score	Land score
(1)	Lower lowland	2	
(2)	Middle lowland	1	
(3)	Higher lowland	0	
(4)	Lower highland	-1	
(5)	Middle highland	-2	

° The characteristic item: Locality

	Category	Exploitation score	Land score
(1)	Seashore, riverside shore and zone along the highway line	2	
(2)	Riverside shore and inland zone along the highway line	1	
(3)	Inland zone	0	
(4)	Riverside shore and hinterland zone along the highway line	-1	
(5)	Hinterland zone	-2	

° The land characteristic item: Soil type

	Category	Exploitation score	Land score
(1)	Yellowish podzol soil	2	
(2)	Reddish yellow podzol soil	2	
(3)	Reddish podzol soil	1	
(4)	Yellowish brown laterite soil	2	
(5)	Reddish brown laterite soil	1	
(6)	Glay soil		1(1)
(7)	Alluvial soil		1(2)
(8)	Peat soil		0
(9)	Mud soil		-1
(10)	Sandy soil		1
(11)	Bleached sand soil		-2
(12)	Sand and pebble soil		-2
(13)	Volcanic ash soil		1

° The land characteristic item: Effective soil depth
Constituent category: exploitation score, land score

	Category	Exploitation score	Land score
(1)	Very shallow		-2
(2)	Shallow		-1
(3)	Slightly shallow		0
(4)	Deep		1
(5)	Very deep		2

Note 1: The score in ( ) concerning the land productivity shows the assessment as the paddy field. As regards the land productivity, the assessment of category must be made with each kind of crop. Here, however, owing to lack of material on the spot crops except paddy rice plant were only made the relative assessment.

Note 2: As regards vegetation it can be assessed by hardness and easiness in the agricultural exploitation and land productivity, but the scoring was omitted in order to make related with the land use capability division.

(3) The Land Use Classification

i. The Survey Table on the Land Use Classification

By concluding the categories of each land characteristic that was given to the land use classification by scoring the following land use classification survey table was provided. The land use classification of survey lands were made by this survey table.

ii. The method of use of land use classification survey table.

1) The Features of the Survey Land

The plant growing can be deemed as indicator of the land use environment, and sowing order to survey the land use classification the features of the survey target land were to be firstly grasped by the vegetation. From the categories of nat natural vegetation of the survey table, the corresponding item shall be marked.

In addition, with the land re-use division survey, the corresponding item shall be selected mainly out of the categories of the artificial vegetation. Secondly, in order of locality, altitude, large and medium topography, small topography, rock and stone of surface layer, bedrock, type of soil and effective depth of soil only one of the respective corresponding categories out of teach of land characteristic item shall be marked.

2) The Assessment of Suitability of Land Use Classification

The score of category selected out of each of land characteristic item shall be divided into "Exploitation" (harness and easiness of exploitation) and "Productivity (land productivity), and the respective score shall be entered in the column of the assessment of suitability. Then, the total value of the former and that of the latter shall be found and the respective total value shall be summed up. Consequently, this combined total

Survey Table of Land Use Classification

Survey Table No. _____ Place of Survey _____

Natural vegetation

(1) Primeval forest of huge trees
(2) Primeval forest
(3) Low forest
(4) Shrub forest
(5) Humid land forest
(6) Humid forest
(7) Peat land forest
(8) Bamboo forest
(9) Mangrove forest
(10) Nipa forest
(11) High cauline single leaf plant group
(12) Low stalk single leaf plant group
(13) High stalk broad leaf plant group
(14) Low stalk broad leaf plant group
(15) Duckweed plant group

Land utilization condition

(1) Artificial forest
(2) Selective cutting forest
(3) Secondary forest
(4) Lower shrub forest
(5) Secondary plant group
(6) Paddy field
(7) Farmland
(8) Burnt field
(9) Gum plantation yard
(10) Coconut plantation yard
(11) Coffee plantation yard
(12) Pepper plantation yeard
(13) Pineapple plantation yard
(14) Orchard
(15) Village
(16) Road

1. Degree of altitude

	Score R	Score L
(1) Lower lowland	2	.
(2) Middle lowland	1	.
(3) Higher lowland	0	.
(4) Lower highland	-1	.
(5) Higher highland	-2	.

(1): 0 - 300m
(2): 300 - 600
(3): 600 - 1000
(4): 1000 - 2000
(5): >2000

2. Location

	Score R	Score L
(1) Seashore, riverside zone and linear zone along the highway	2	.
(2) The inland zone of riverside, seaside, and zone along the highway	1	.
(3) Inland zone	0	.
(4) Riverside coast and inland zone along the line of highway	-1	.
(5) Inland zone	-2	.

(1): 0 - 50 km
(2): 50 - 200
(3): 50 - 200
(4): >200
(5): >200

3. Large and medium topographies

	Score R	Score L
(1) Mountainous land	-2	.
(2) Basin	-1	.
(3) Foot of mountain	0	.
(4) Hill	0	.
(5) Plateau	1	.
(6) Plain	2	.

4. Small topography

	Score R	Score L
(1) Very steep slope	-2	-2
(2) Steep slope	-1	-1
(3) Moderate slope	0	1
(4) Gentle slope	1	2
(5) Very gentle slope	2	1
(6) Flat land	2	0(1)
(7) Dip plain	1	2
(8) Terrace	-2	1
(9) Fan-like or alluvial cone	1	1
(10) Natural levee	2	2
(11) Flooded plain	0	2
(12) Lowland or valley bottom	-1	1(2)
(13) Wet land	-2	-2
(14) Inter levee lowland or delta	-2	0
(15) Sand beach	-2	-2
(16) Rock and stone beach	-2	-2

(1): 30° (3): 8 - 18 (5): 1 - 4
(2): 18 - 30 (4): 4 - 8 (6): 0 - 1

5. Surface layer rock and bedrock	Score R	Score L
(1) Granite	.	-1
(2) Andesite	.	0
(3) Basalt	.	0
(4) Erupted rock and the like	.	2
(5) Shale	.	0
(6) Sand rock	.	1
(7) Quartz sand rock	.	-2
(8) Conglomerate	.	0
(9) Lime rock	.	0
(10) Marloceous	.	0
(11) Mud rock	.	0
(12) Silt rock	.	0
(13) Alluvial epoch heped rock and the like	.	2
(14) Schist	.	2
(15) Gneiss	.	2
(16) Clay slate	.	0
(17) Tuff	.	0
(18) Heaped rock and the like from terrace	.	1

6. Type of soil	Score R	Score L
(1) Yellow podzol soil	.	2
(2) Reddish yellow podzol soil	.	2
(3) Reddish podzol soil	.	1
(4) Yellowish brown laterite soil	.	2
(5) Reddish brown laterite soil	.	1
(6) Glay soil	.	2(1)
(7) Alluvial soil	.	1(2)
(8) Peat soil	.	0
(9) Mud soil	.	-1
(10) Sandy soil	.	1
(11) Bleached sand soil	.	-2
(12) Gravel sandy soil	.	-2
(13) Volcanic ash soil	.	1

7. Effective depth of soil	score R	score L
(1) Very shallow	.	-2
(2) Shallow	.	-1
(3) Slightly shallow	.	0
(4) Deep	.	1
(5) Very deep	.	2

(1): Land surface - 15 cm
(2): 15 - 30
(3): 30 - 60
(4): 60 - 120
(5): 120

Evaluation score

Relative difficulty rate of development (R)	Land production (L)
2	1 (2)
2	2
2	4 (2)
-1	0
total 5	4 (6)

Grand total 9 (11)

sum shall be the score of suitability of the land use classification.

The range that the score of assessment of this suitability can take is ±16, and the actual assessment of suitability shall be divided as follows:

(Score)	(Assessment of suitability)
16	Very suitable for the agricultural land use.
8	Suitable for the agricultural land use.
0	The limit of the agricultural land use possibility.
-8	Unsuitable for the agricultural land use.
-16	Extremely unsuitable for the agricultural land use.

3) The Test Result of Survey Table of the Land Use Classification

The survey result of the land use division of wet land forest of Kuala Samboja near the Samboja River is as per following table. As the total of scores, showing the degree of hardness and easiness of exploitation, is five, it is possible to exploit the land. The total scores, indicating the land productivity, are 4 in the general agricultural land and 6 when made to the paddy field, and therefore, it is clear that the land has the land productivity. The total value of these scores is 9, and when made to the paddy field, the value becomes 11.

Consequently, this wet land is suitable for use of the agricultural land and is deemed to be considerably suitable particularly for use of the paddy field.

On concluding the other survey results, they shall be as in following table, and it seems to considerably grasp the features relative to the land use of each survey land.

In addition, the burnt fields are covered with the primeval forest of huge trees,primeval forest and second forest. Apart from the discussion about agreement or denial of the burnt field, it turned out on examining the agricultural land use suitability that the burnt fields were provided on choosing the land that were of the largest land productivity.

Survey Table of Land Use Classification

Survey Table No. _____ Place of Survey _____

Natural vegetation

(1) Primeval forest of huge trees
(2) Primeval forest
(3) Low forest
(4) Shrub forest
(5) Humid land forest
(6) Humid forest
(7) Peat land forest
(8) Bamboo forest
(9) Mangrove forest
(10) Nipa forest
(11) High cauline single leaf plant group
(12) Low stalk single leaf plant group
(13) High stalk broad leaf plant group
(14) Low stalk broad leaf plant group
(15) Duckweed plant group

Land utilization condition

(1) Artificial forest
(2) Selective cutting forest
(3) Secondary forest
(4) Lower shrub forest
(5) Secondary plant group
(6) Paddy field
(7) Farmland
(8) Burnt field
(9) Gum plantation yard
(10) Coconut plantation yard
(11) Coffee plantation yard
(12) Pepper plantation yard
(13) Pineapple plantation yard
(14) Orchard
(15) Village
(16) Road
(17) Fish farm

1. Degree of altitude

	Score R	Score L
(1) Lower lowland	2	.
(2) Middle lowland	1	.
(3) Higher lowland	0	.
(4) Lower highland	-1	.
(5) Higher highland	-2	.

(1): 0 - 300m
(2): 300 - 600
(3): 600 - 1000
(4): 1000 - 2000
(5): >2000

2. Location

	score R	score L
(1) Seashore, riverside zone and linear zone along the highway	2	.
	1	.
(2) The inland zone of riverside, seaside, and zone along the highway	0	.
	-1	.
	-2	.
(3) Inland zone		
(4) Riverside coast and inland zone along the line of highway		
(5) Inland zone		

(1): 0 - 50 km
(2): 50 - 200
(3): 50 - 200
(4): >200
(5): >200

2. Large and medium topographies

	score R	score L
(1) Mountainous land	-2	.
(2) Basin	-1	.
(3) Foot of mountain	0	.
(4) Hill	0	.
(5) Plateau	1	.
(6) Plain	2	.

4. Small topography

	score R	score L
(1) Very steep slope	-2	-2
(2) Steel slope	-1	-1
(3) Moderate slope	0	1
(4) Gentle slope	1	2
(5) Very gentle slope	2	1
(6) Flat land	2	0(1)
(7) Dip plain	1	2
(8) Terrace	-2	1
(9) Fan-like or alluvial cone	1	1
(10) Natural levee	2	2
(11) Flooded plain	0	2
(12) Lowland or valley bottom	-1	1(2)
(13) Wet land	-2	-2
(14) Inter levee lowland or delta	-2	0
(15) Sand beach	-2	-2
(16) Rock and stone beach	-2	-2

(1): >30° (3): 8 - 18 (5): 1 - 4
(2): 18 - 30 (4): 4 - 8 (6): 0 - 1

5. Surface layer rock and bedrock	score R	L
(1) Granite	.	-1
(2) Andesite	.	0
(3) Basalt	.	0
(4) Erupted rock and the like	.	2
(5) Shale	.	0
(6) Sand rock	.	1
(7) Quartz sand rock	.	-2
(8) Conglomerate	.	0
(9) Lime rock	.	0
(10) Marloceous	.	0
(11) Mud rock	.	0
(12) Silt rock	.	0
(13) Alluvial epoch heaped rock and the like	.	2
(14) Schist	.	2
(15) Gneiss	.	2
(16) Clay slate	.	0
(17) Tuff	.	0
(18) Heaped rock and the like from terrace	.	1

6. Type of soil	score R	L
(1) Yellow podzol soil	.	2
(2) Reddish yellow podzol soil	.	2
(3) Reddish podzol soil	.	1
(4) Yellowish brown laterite soil	.	2
(5) Reddish brown laterite soil	.	1
(6) Glay soil	.	2(1)
(7) Alluvial soil	.	1(2)
(8) Peat soil	.	0
(9) Mud soil	.	-1
(10) Sandy soil	.	1
(11) Bleached sand soil	.	-2
(12) Gravel sandy soil	.	-2
(13) Volcanic ash soil	.	1

7. Effective depth of soil	score R	L
(1) Very shallow	.	-2
(2) Shallow	.	-1
(3) Slightly shallow	.	0
(4) Deep	.	1
(5) Very deep	.	2

(1): Land surface - 15 cm
(2): 15 - 30
(3): 30 - 60
(4): 60 - 120
(5): 120

Evaluation score

Relative difficulty rate of development (R)	Land production (L)
2	1 (2)
2	2
2	1 (2)
-1	0
Total 5	4 (6)

Grand total 9 (11)

The Survey Result of Land Use Classification

Survey land	Vegetation	Exploitation score				Productivity score				Exploit. total	Product. total	Exploit.+ product(total)
Kuala Samboja	Wet land forest	2	2	2	-1	1(2)	(2)	1(2)	0	5	4(6)	9(11)
Kuala Samboja	Mangrove forest	2	2	1	-2	-2	0	1	-1	3	-2	1
Kuala Samboja	Low stalked single leaved plant group	2	2	2	-2	-2	0	0	-2	4	-4	0
Kuala Samboja	Mixing of twin leaves and single leaf	2	2	2	-1	1(2)	1	1(2)	1	5	4(6)	1(11)
Mahakam Delta	Nipa forest	2	2	2	-2	-2	0	-1	-2	4	-5	-1
Sebulu	Virgin forest of huge trees	1	1	0	1	2	-2	2	2	3	7	10
Sebulu	Low tree forest	1	1	0	-2	-2	1	-2	-2	0	-8	-8
Sevelu	Levee forest	1	1	0	2	2	1	1	1	4	5	9
Muara Kaman	Wet land forest	2	1	2	-2	-2	1	0	-2	3	-3	0
Muara Kaman	Peat forest	2	1	0	-2	-2	1	0	-2	1	-3	-2
Muara Kaman	High cauline single leaved plant tree	2	1	2	2	1	1	2(2)	-2	7	2	9(2)
Muara Kaman	Bamboo forest	2	1	0	1	2	1	2	0	4	5	9
Bukit Soehurto	Secondary forest	2	2	0	1	2	1	2	1	5	6	11
Bukit Soehurto	Virgin soil	2	2	0	0	1	1	2	1	4	5	9
Bukit Soehurto	Shrub forest	2	2	0	-1	-1	-1	1	0	3	-1	2

Further, on studying the agricultural land use suitability of artificial vegetation, a result was obtained to the effect that in most cases the rational selection of suitable lands was made.

Consequently, there seems no big error in selection of land characteristic item and the dividing method of category, and in entering the scores into the categories.

At the time of providing this survey table, however, as the survey period on the spot was limited, it is necessary to repeat hereafter much more surveys and studies.

4) Points of Problem in the Land Use Classification Survey Table

° *Dividing way of the categories:* It is necessary for the large and medium topographies to increase the categories furthermore and for the surface layer of rock and stone, and bedrock to simplify the categories.

° The land characteristic items related to the atmospheric phenomena: This survey land belongs to the tropical rain forest area just under the equator, and so the land characteristic items as to the weather is neglected with reference to the land use classification.

As made clear in the previously stated item of weather, it is necessary to add the land characteristic item concerning the rain days, dry days, etc., as the rain condition differs according to districts when the land use capability classification *per each kind of crop is performed.*

° The assessed accuracy of land use capability classification

In order to ascertain whether there is any error in the score, given to each of the categories or not, locations of about 100 spots shall be investigated by use of this survey table, and it shall be confirmed that the good fitting ratio is at least over 80%. If the good fitting is under 80%, the land characteristic item, dividing way of the category, and scoring must be studied again so that the double relative

coefficient of the anticipated value and the actually measured value may become over 0.80.

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