Land Resource Study

25 The land capability classification of Sabah Volume 3 The West Coast and Kudat Residencies

Land Resources Division, Ministry of Overseas Development

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The West Coast and Kudat Residencies

P Thomas, F K C Lo and A J Hepburn

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Land Resources Division, Ministry of Overseas Development
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ABSTRACT

This volume contains a brief description of the physical and human environment of the area now covered by the West Coast and Kudat Residencies, formerly the West Coast Residency (Sabah, Malaysia),covering an area of some 12 139 km^2 (4 687 mi^2). The various resource surveys carried out in the area are noted and the methodology of the land capability classification which is based on these surveys is briefly outlined. This classification is shown on the 1:250 000 scale land capability classification map sheets enclosed with the report. The various resources are then separately described in some detail in simplified terms. Development opportunities in relation to the various land resources are outlined and attention drawn to conflicting resource potentials. General opportunities for land development are discussed bearing in mind land tenure, present land use, population and accessibility. In conclusion, recommendations are made for further studies to assist development planning. The report indicates that only some 19% of the land is suited for agriculture while some 20% has a possible potential for commercial forestry.

RÉSUMÉ

Ce volume comporte une description succincte de l'environnement physique et humain de la zone comprenant actuellement les Résidences de la Côte Occidentale et de Kudat, anciennement la Résidence de la Côte Occidentale (Sabah, Malaysie), couvrant une région de quelque 12.139 km^2 (4.687 mi^2). Les diverses études des ressources effectué dans la zone sont notées et la méthodologie de la classification qui est basée sur ces études est esquissée brièvement. Les cartes de la productivité potentielle à l'échelle de 1:250.000 attachées au rapport montrent cette classification. Ensuite, les diverses ressources sont décrites séparément de manière assez détaillée en termes simplifiés. Un aperçu est donné des possibilités de mise en valeur par rapport aux diverses ressources terrestres et l'attention est attirée sur les potentiels contradictoires des ressources. Les possibilités d'exploitation des terres sont discutées compte tenu du régime foncier, de l'utilisation actuelle des terres, de la population et de l'accessibilité. En conclusion, des recommandations sont formulées au sujet d'études ultérieures susceptibles de contribuer aux plans d'exploitation. Le rapport indique que 19% des terres conviennent à l'agriculture et 20% à l'exploitation commerciale des forêts.

DESCRIPTORS FOR COORDINATE INDEXING

Climate, geology, geomorphology, mineral resources, water resources, land capability, land resources, vegetation, forest resources, grassland, animal husbandry, game management, land tenure, demography, rural settlement, tourism, Sabah, Malaysia.

Glossaries

1. TECHNICAL TERMS

Alienated land	Land for which a title, lease or provisional lease has been issued
Annual licence	A licence to cut and extract timber from a specific area of land which is valid initially for a period no longer than one year
Field register	A list of land titles maintained by the District Surveyor which have not yet been entered in the central land register
Gazettement	The publication of a notice in the Government Gazette, in this case referring to specific use of land for official purposes
Lease	A form of title to land
Licence agreement	An agreement giving the right to cut and extract timber from a given area of forest reserve for a period in excess of ten years
Native title	A form of title to land which can only be held by a native of the State
Provisional lease	A form of provisional title to land which gives the holder the right to occupy the land
Settlement scheme	A form of land development scheme where people are encouraged to settle on and develop areas of land. In return for developing the land, settlers are given the title to a smallholding and in addition may receive other benefits both in cash and kind
Sheet lalang	An extensive area of virtually pure *lalang (Imperata cylindrica)*
Special licence	A licence to cut and extract timber from a specific area of land which may be valid for a period of from one to ten years
Tamu ground	A place where rural markets are held
Village reserve	Land reserved for use by native villagers for various purposes and gazetted as such

2. MALAY WORDS COMMONLY USED IN PLACE NAMES

Batu	rock	Laut	sea
Besar	large	Padang	field
Bukit	hill	Pantai	beach
Gunong	mountain	Pangkalan	landing place
Hutan	forest	Pulau	island
Kampong	village	Sungai	river
Kechil	small	Tamu	rural market
Kuala	river mouth	Tanjong	cape
Ladang	clearing	Trusan	channel
		Ulu	upper reaches of river

3. COMMON (MALAY) AND BOTANICAL NAMES OF TREES

Api Api	*Avicennia* spp.
Bakau	*Rhizophora mucronata*
Bangkita	*Rhizophora apiculata*
Belian	*Eusideroxylon zwageri*
Beus	*Bruguiera cylindrica*
Bintangor	*Calophyllum* spp.
Binuang	*Octomeles sumatrana*
Buta Buta	*Excoecaria agallocha*
Durian	*Durio* spp.
Gagil	*Hopea sangal*
Geriting	*Lumnitzera* spp.
Jelutong	*Dyera* spp.
Kapur	*Dryobalanops* spp.
Karai	*Meiogyne virgata* *Mezzetia leptopoda* *Sageraea lanceolata* also *Polyalthia* and other *Annonaceae*
Kayu malam	*Diospyros* spp.
Kedongdong	*Burseraceae* i.e. *Canarium* spp., *Dacryodes* spp., *Santiria* spp.
Kembang	*Heritiera simplicifolia* and other spp. of *Heritiera*
Keranji	*Dialium* spp.
Keruing	*Dipterocarpus* spp.
Laran	*Anthocephalus chinensis*
Layang layang	*Parishia insignis*
Limpaga	*Azadirachta excelsa* *Toona sureni* and other *Meliaceae*
Majau	*Shorea leptoclados*
Medang	*Lauraceae* spp. especially *Litsea*
Melapi	*Anthoshorea* section of *Shorea*
Mengaris	*Koompassia excelsa*
Merbau	*Intsia palembanica*
Nyatoh	*Sapotaceae* e.e. *Ganua, Madhuca, Palaquium, Payena* spp.
Obah suluk	*Shorea pauciflora*
Pengiran	*Anisoptera* spp.
Prepat	*Sonneratia alba*
Pulai	*Alstonia* spp.
Putat paya	*Planchonia valida*
Ranggu	*Koordersiodendron pinnatum*
Red seraya	*Rubroshorea* section of *Shorea*
Resak	*Vatica* or *Cotylelobium* spp.
Selangan batu	*Shorea* section of *Shorea*
Sengkuang	*Dracontomelon puberulum*
Sepetir	*Sindora* spp.

Melapi	*Anthoshorea* group of *Shorea*
Serungan	*Cratoxylum arborescens*
Takalis	*Pentace* spp.
Tengar	*Ceriops tagal*
Urat mata	*Parashorea* spp.
Yellow seraya	*Richetia* section of *Shorea*

4. COMMON (ENGLISH OR MALAY) AND BOTANICAL NAMES OF GRASSES AND FORAGE PLANTS

African star grass	*Cynodon dactylon*
Buffalo grass	*Paspalum conjugatum*
Carpet grass	*Axonopus compressus*
Centipede grass	*Ischaemium barbatum*
Centro	*Centrosema pubescens*
Coast grass	*Cynodon plectostachyus*
Guinea grass	*Panicum maximum*
Kazungulu	*Setaria sphacelata*
Lalang	*Imperata cylindrica*
Lotonosis	*Lotonosis bainesii*
Para grass	*Brachiaria mutica*
Paspalum	*Paspalum dilatatum*
Signal grass	*Brachiaria decumbens*
Siratro	*Phaseolus atropurpurens*
Stylo	*Stylosanthes gracilis*

Parts 1-6

Part 1

Preface

This is the third of a series of four volumes dealing with the land capability of the State of Sabah, Malaysia. Each covers one of the four original residencies of the State, in this case the West Coast Residency. The Kudat Residency, comprising the Kudat and Kota Marudu Districts of the old West Coast Residency, was constituted during the period of this report's compilation. The volume is published with the permission of the Government of Sabah, to whom a draft was submitted in 1975.

Readers are referred to the introductory sections of Volume 1 for a history of the study, a description of the procedures used, the composition of the project team and a summary of findings.

The help extended by the many persons and organisations in producing this volume is gratefully acknowledged; full details are given in the introduction to Volume 1.

Part 2

Geographical background

LOCATION

The West Coast and Kudat Residencies are situated in the north-western part of the State of Sabah (Text Map 3-1) with a coastline stretching from Kimanis Bay in the south-west round to Paitan Bay on the east coast. They are bounded by latitudes 5° 32'N and 7° 18'N and longitudes 115° 48'E and 117° 17'E. Included in the West Coast Residency are the offshore islands of Gaya, Mengalum and Mantanani and other smaller islands off the west coast, while Balambangan, Banggi, Malawali and a number of less important islands off the northern tip form part of the Kudat Residency.

The West Coast Residency comprises the administrative districts of Papar, Penampang, Kota Kinabalu, Tuaran, Ranau and Kota Belud, while the Kudat Residency comprises those of Kota Marudu and Kudat. The town of Kudat is the administrative centre of the Kudat Residency and Kota Marudu is the only other town of any size. The two residencies have a total land area of approximately 12 139 km^2 (4 687 mi^2). The State Capital, Kota Kinabalu, is the administrative centre of the West Coast Residency, other towns of importance being Papar, Tuaran, Ranau and Kota Belud.

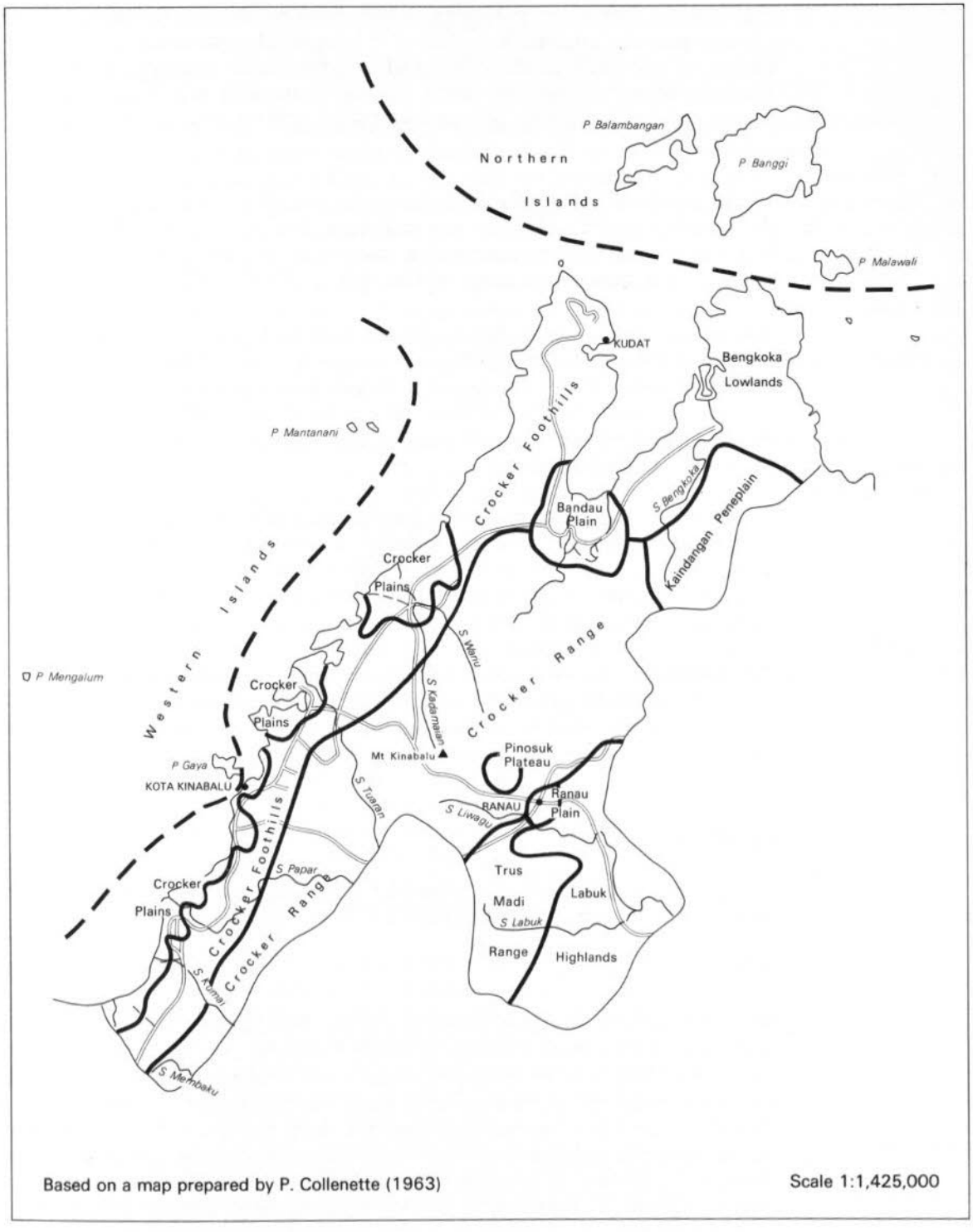
TOPOGRAPHY AND GEOLOGY

The oustanding topographical features of the residencies are narrow coastal plains and high mountain ranges. The most important range is the Crocker Range, which runs more or less parallel with the coast, reaching its highest point on Gunong Kinabalu at 4 101 m (13 455 ft), and then continuing in a more easterly direction. The main regions have been described by Collenette (1963) in his Physiographic Classification of North Borneo, which is used as a basis for this narrative. The regions which fall in the West Coast and Kudat Residencies are shown on Text Map 3-2.

Along the western seaboard and Marudu Bay there is a discontinuous belt of flat low-lying land, the Crocker Plains, which are alluvial in origin. Inland from the Crocker Plains, a long narrow belt of land (the Crocker Foothills) extends up into the Kudat Peninsula as the Sir James Brooke Range. These are composed of the sandstones, siltstones, mudstones and shales of the Crocker Formation and in places mark a deeply indented shoreline. These foothills rise into the Crocker Range above about 300 m (1 000 ft) as a series of steep parallel-sided ridges formed from similar rocks, giving rise to rugged mountainous country with peaks generally rising to 1 200-1 800 m (4 000-6 000 ft). However, Gunong Kinabalu, the highest peak, is a granodiorite batholith with associated ultrabasic rocks which has been thrust up through the sedimentary rocks of the Crocker Formation.

South of Ranau, the north-eastern section of the Trus Madi Range is included in the West Coast Residency, where it is largely composed of regionally metamorphosed argillaceous rocks of the Trus Madi Formation. The country is rugged and mountainous with peaks rising to 1 200-1 500 m (4 000-5 000 ft) and occasionally to 1 800 m (6 000 ft).

TEXT MAP 3-1 Location of the West Coast and Kudat Residencies and their administrative districts



TEXT MAP 3-2 Physiography

Prepared by the Directorate of Overseas Surveys 1976

The Labuk Highlands extend into the south-east corner of the West Coast Residency. They are mainly formed by the sedimentary rocks of the Crocker Formation, and are deeply dissected, with peaks generally rising to 600-900 m (2 000-3 000 ft). At the eastern boundary basaltic rocks occur, giving rise to Gunong Mentapok (1 448 m, 4 750 ft).

The Pinosuk Plateau on the south-eastern flank of Gunong Kinabalu is a deeply dissec inclined plain of some 60 km^2 (23 mi^2) lying at a height of between 1 200 m (4 000 ft) and 1 800 m (6 000 ft) a.s.l. It is formed of coarse rock debris from the Kinabalu Massif (Collenette 1963). Further to the east, and closely related, lies the Ranau Plain at an altitude of about 500 m (1 600 ft). This is formed of terraced alluvium.

To the north-east of the Crocker Range lies part of the Kaindangan peneplain. Here the country, which is deeply dissected, has a general north-west to south-west trend and is formed of massive sandstones, mudstones and shales of the Crocker Formation with summit areas in the range of 450-750 m (1 500-2 500 ft).

The Bengkoka Lowlands occupy the north-eastern tip of the Kudat Residency, the Bangkoka Peninsula. The relief is predominantly marked by long, generally low, sandstone ridges of the Bongaya Formation, interspersed by rolling plains composed of raised alluvium. In the Taritipan-Pitas area the hills rise to more elevated (some 450 m (1 500 ft))mountainous country composed of the lava, chert and sandstone of the Chert-Spilite Formation.

The offshore islands to the north, the Northern Islands, are composed of a mixture of igneous and sedimentary rocks. Relief is generally moderate though the northern part of Banggi rises to over 510 m (1 700 ft) and is composed of basic and intermedi igneous rocks. At the south western tip of Balambangan there are prominent limeston cliffs, while Malawali is formed almost entirely of ultrabasic rock.

The islands off the west coast, including Gaya, Mengalum and Mantanani are part of t Western Islands. Gaya and the nearby small islands are composed of rocks of the Crocker Formation with low to moderate relief. Mengalum and Mantanani are formed mainly by flat beach strands with some localised hills.

CLIMATE

The climate may be generally described as hot and wet, but there are considerable variations in the amount and pattern of rainfall and temperature.

Rainfall

With their general westerly aspect to the sea, the Crocker Plains, the Crocker Foothil and the western side of the main Crocker Range are usually more affected by the South-West Monsoon from April to November. These areas therefore tend to be drier in the early part of the year with February the driest month at nearly half of the recording stations shown on Text Map 3-3. With the onset of the South-West Monsoo rainfall tends to increase from April and the period September to November is on average the wettest. The heaviest rainfall occurs in the south-west part of the Residen (see histograms on Text Map 3-3). The highest average annual rainfall (4 928 mm) w recorded at Tonggol at 1 500 m (5 000 ft) on the western slope of the Crocker Rang close to the water-shed. Kambarangan has the second highest average (4 267 mm) an is situated on a southern spur of Gunong Kinabalu at an altitude of 2 250 m (7 400 ft

In the Bengkoka and Kudat Peninsulas the rainfall pattern is more affected by the North-East Monsoon. Rainfall is generally heaviest in December and January, with April usually the driest month, though at Langkon July and August have the least ra

The eastern flank of the Crocker Range lies in a slight rain-shadow in relation to the South-West Monsoon, and like the Kudat area is affected by the North-East Monsoon. Kundasan, situated just to the east of the main watershed at an altitude of 1 300 m (4 300 ft) and in the shadow of Kinabalu, has the lowest recorded average annual rainfall (2 032 mm 80 in.). Average monthly rainfall figures are given in the histograms on Text Map 3-3, but it must be emphasised that there is considerable variation between years.

Temperature

There are only five climatologic stations, all of which are in the West Coast Residency (see Text Map 3-3). Mean monthly maximum and mean monthly minimum temperatures are given in Table 1. The land in the southern part of the coastal belt has a mean annual daily maximum temperature of about 31° C (88° F) and a mean annual daily minimum temperature of about 22° C (72° F) with a diurnal variation of 7-11° C (9-14° F). There is little monthly variation. Data are not available for the Kudat Residency but it is likely that a similar temperature occurs in the lower areas, particularly around the coast. Temperatures fall with increasing altitude, as shown by the figures for Kundasan and Kambarangan, but annual variations remain low, particularly at Kambarangan. It may be noted that the climate at Kundasan is a little unusual,perhaps, because of its situation.

From the data available it would seem that the climate of all areas lying below about 1 500 m (5 000 ft) may be considered to be the Tropical Rainy Climate (Af) according to Koppen's system (Trewartha, 1954). At higher altitudes, the mean temperature of the coolest month is likely to be below the minimum for climate (Af).

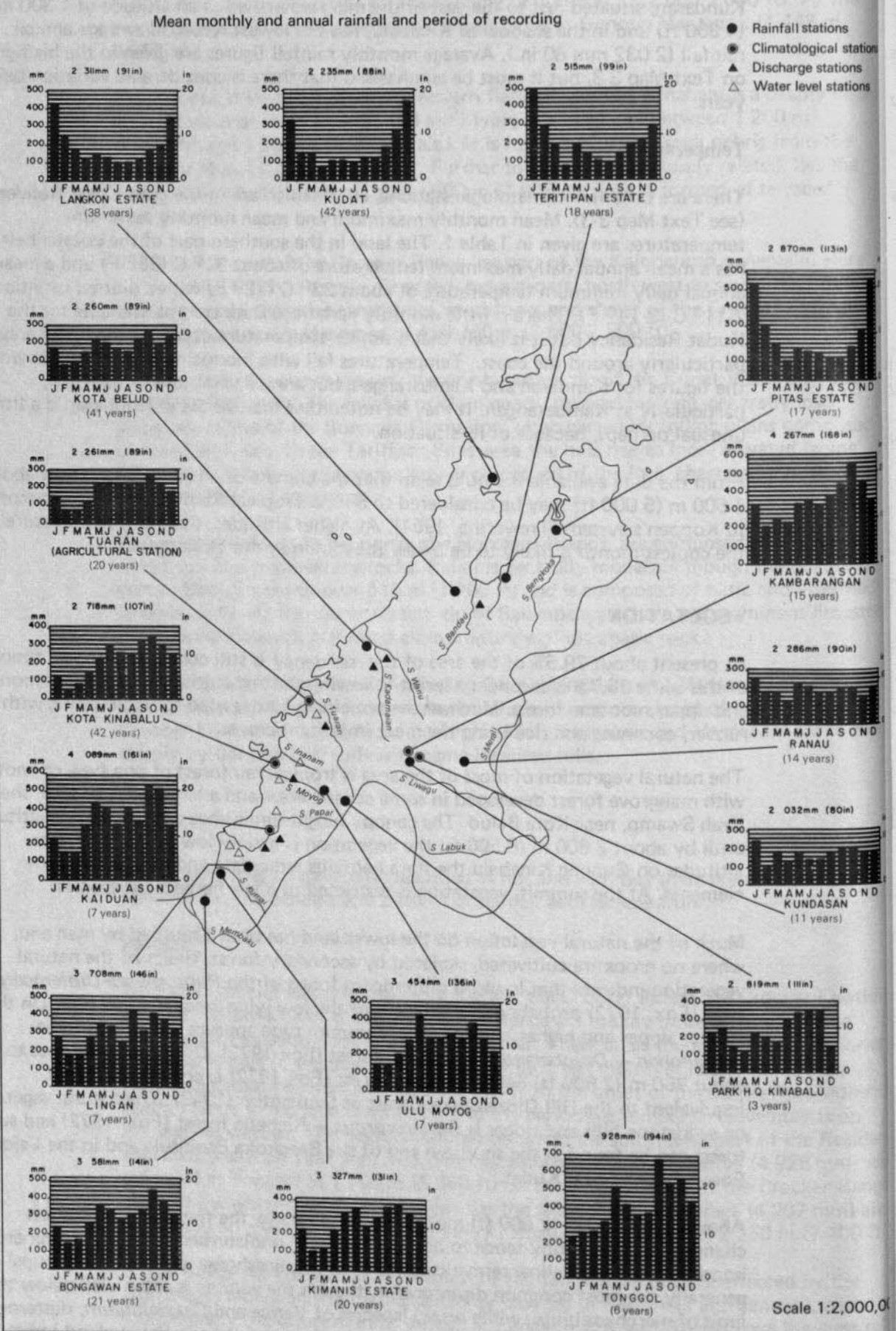
VEGETATION

At present about 79.5% of the area of the residency is still covered by forest, though of this some 36.7% is secondary forest following shifting cultivation and 4% is montane and upper montane forest. Much of the remaining land is used for agriculture, with rubber, coconuts and rice being the most important crops.

The natural vegetation of most of the area is tropical rainforest of one type or another, with mangrove forest developed in some coastal areas and a large sedge swamp, the Krah Swamp, near Kota Belud. The canopy height diminishes with increasing altitude until by about 2 600 m (8 500 ft) the vegetation is mainly low scrub. At higher altitudes on Gunong Kinabalu the flora contains temperate and near alpine zone elements. At the summit, vegetation is restricted to a few herbaceous species.

Much of the natural vegetation on the lower land has been disturbed by man and, where no crops are cultivated, replaced by secondary forest. Relics of the natural vegetation indicate that lowland dipterocarp forest of the *Rubroshorea-Dipterocarpus* type (Fox, 1972) probably covered most of the low lying areas and low hills. On the steeper slopes and higher hills the most common type appears to be *Parashorea malaanonan — Dryobalanops lanceolata* forest (Fox,1972). On the upper slopes to about 750 m (2 500 ft) Selangan Batu Forest (Fox,1972) is commonly found (equivalent to the Hill Dipterocarp Forest of Symington (1943). The natural vegetation on sandstone hills and ridges is *Dipterocarpus* — Richetia forest (Fox, 1972) and such forest can be found at the southern end of the Bengkoka Peninsula and in the Lajong Forest Reserve near Kudat.

Above about 750 m (2 500 ft) most forest is montane, the floristic composition changes and the canopy tends to become lower. In undisturbed forest the commercially important red and yellow seraya (species of the Rubroshorea and Richetia groups) are generally the most common dipterocarps, though the volume is often well below the limit of merchantibility; while *resak*, (species of *Vatica* and *Cotylelobium*, dipterocarps of doubtful commercial value), becomes more common than in the lowland forest. Commercial species other than dipterocarps tend to form a higher proportion of the stand in this zone.



TEXT MAP 3-3 Selected rainfall, climatological and hydrometric stations

TABLE 1 **Monthly and annual mean daily maximum and minimum air temperatures, °C (°F)**

Station and altitude a.s.l.	Mean daily temp.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.
Kota Kinabalu 3 m (9 ft)	Max.	29.6 (85.3)	29.7 (85.5)	30.4 (86.7)	31.1 (88.0)	31.3 (88.3)	31.10 (87.8)	30.8 (87.4)	30.7 (87.3)	30.6 (87.1)	30.4 (86.7)
	Min.	22.5 (72.5)	22.6 (72.7)	22.9 (73.2)	23.6 (74.5)	23.9 (75.0)	23.6 (74.5)	23.3 (73.9)	23.4 (74.1)	23.3 (73.9)	23.2 (73.8)
Kaiduan 107 m (350 ft)	Max.	30.5 (86.9)	30.7 (87.3)	31.5 (88.7)	31.9 (89.4)	31.7 (89.1)	32.0 (89.6)	31.7 (89.1)	31.8 (89.2)	31.7 (89.1)	31.5 (88.7)
	Min.	20.1 (68.2)	19.9 (67.8)	20.3 (68.5)	20.8 (69.4)	21.2 (70.2)	21.1 (70.0)	20.6 (69.1)	20.6 (69.1)	20.8 (69.4)	20.8 (69.4)
Tuaran agric-ulture station 6 m (20 ft)	Max.	30.6 (87.1)	30.8 (87.4)	31.4 (88.5)	31.4 (88.6)	31.1 (88.1)	31.3 (88.3)	30.8 (87.4)	30.8 (87.4)	30.8 (87.4)	30.7 (87.2)
	Min.	22.5 (72.6)	22.8 (73.1)	22.6 (72.7)	23.5 (74.3)	23.9 (75.0)	23.5 (74.3)	23.2 (73.7)	23.0 (73.4)	23.4 (74.1)	23.1 (73.6)
Kundasan 4 311 m (4 300 ft)	Max.	22.5 (72.5)	22.8 (73.0)	24.0 (75.2)	24.8 (76.6)	25.7 (78.3)	25.1 (77.2)	24.7 (76.5)	24.5 (76.1)	24.5 (76.1)	24.3 (75.7)
	Min.	15.1 (59.2)	14.6 (58.3)	15.2 (59.4)	15.5 (59.9)	16.2 (61.2)	16.6 (61.9)	16.5 (61.7)	16.1 (61.0)	16.3 (61.3)	16.2 (61.2)
Kambarangan 2 220 m (7 040 ft)	Max.	16.9 (62.4)	17.2 (63.0)	17.5 (63.5)	17.6 (63.7)	17.4 (63.3)	17.4 (63.3)	17.0 (62.6)	17.1 (62.8)	16.6 (61.9)	16.7 (62.1)
	Min.	10.9 (51.6)	11.0 (51.8)	11.1 (52.0)	11.3 (52.3)	11.7 (53.1)	11.6 (52.9)	11.5 (52.7)	11.4 (52.5)	11.3 (52.3)	11.4 (52.5)

Station and altitude a.s.l.		Nov.	Dec.	Annual average	Annual variation	Years of record
Kota Kinabalu 3 m (9 ft)	Max.	30.1 (86.2)	29.9 (85.8)	30.5 (86.9)	1.7 (3.0)	23
	Min.	23.1 (73.6)	22.9 (73.2)	23.2 (73.8)	1.4 (2.5)	
Kaiduan 107 m (350 ft)	Max.	31.2 (88.2)	31.1 (88.0)	31.4 (88.5)	1.5 (2.7)	9
	Min.	20.8 (69.4)	20.3 (68.5)	20.6 (69.1)	1.3 (2.4)	
Tuaran agric-ulture station 6 m (20 ft)	Max.	30.4 (86.8)	30.3 (86.5)	30.9 (87.5)	1.1 (2.1)	4
	Min.	23.0 (73.5)	22.8 (73.1)	23.1 (73.6)	1.4 (2.4)	
Kundasan 4 311 m (4 300 ft)	Max.	24.0 (75.2)	23.3 (73.9)	24.2 (75.6)	3.2 (5.8)	7
	Min.	15.9 (60.6)	15.2 (59.4)	15.8 (60.4)	2.0 (3.6)	
Kambarangan 2 220 m (7 040 ft)	Max.	16.9 (62.4)	17.3 (63.1)	17.1 (62.8)	1.0 (2.8)	4
	Min.	11.3 (52.3)	11.5 (52.7)	11.3 (52.3)	.8 (1.5)	

Above about 1 500 m (5 000 ft) the forest shows further changes in floristic composition and with increasing altitude the canopy becomes still lower. All dipterocarps except *resak* have disappeared. *Nyatoh* (species of Sapotaceae) and *medang* (species of Lauraceae), are the most common of the non-dipterocarp commercial species, though the total commercial volume is low or very low. Genera of the Fagaceae, in particular *Lithocarpus* and *Quercus* ('oaks'), form a significant part of the total volume.

Other important forest types are tidal mangrove forests and freshwater swamp forests. Other forest types associated with specialised edaphic conditions do occur but are not extensive, e.g. beach forest, strand forest, heath (Kerengas) forest and forest on limestone.

SETTLEMENT AND POPULATION

The population is mainly concentrated on the Crocker and Ranau Plains, where it is relatively dense and based on well established farming communities. The remaining land is very sparsely populated, with small scattered communities of shifting cultivato However,small permanent settlements do occur in many of the valleys and some are found at relatively high altitudes. Bundu Tuhan, a fair size settlement close to Kinaba can claim to be the highest in the State at an altitude of between 900 m (3 000 ft) and 1 200 m (4 000 ft).

The population of the West Coast and Kudat Residencies, according to the 1970 censu (Sabah, Malaysia, Department of Statistics 1973), was 287 087, an average of 24 per km^2 (61 per mi^2). Table 2 gives a breakdown by districts and major community groups.

TABLE 2 Population by districts and major community groups

Community group	Kudat	Ranau	Kota Belud	Tuaran	Kota Kina-balu	Penam-pang	Papar	Residency	
								Total	%
Kadazan	26 614	21 905	17 508	23 637	11 707	16 249	11 388	129 008	44.
Murut	37	12	292	68	347	87	61	904	0.
Bajau	6 647	60	15 942	10 642	7 725	2 609	4 665	48 290	16.
Malay	446	38	256	365	2 384	788	659	4 936	1.
Other Indigenous*	20 681	308	770	1 422	5 301	1 830	10 055	40 367	14.
Total indigenous	54 425	22 323	34 768	36 134	27 464	21 563	26 828	223 505	77.
Chinese	9 480	230	1 009	3 899	28 576	4 145	5 415	52 754	18.
Indonesian	685	26	62	367	1 236	362	1 254	3 992	1.
Others**	1 667	95	96	288	3 470	432	788	6 836	2.
Total	66 257	22 674	35 935	40 688	60 746	26 502	34 285	287 087	100

* The most important community groups are Brunei 11 201, Rungus 10 570 and Sino-Native 6 873.

** The most important community groups are Filipina 3 340 and Indians 1 715.

It may be noted that 77.8% of the population is indigenous with the Kadazan community group,by far the largest,accounting for 44.9% of the total. This group is well distributed throughout the residencies making up more than 33% of the popula tion in all districts except Kota Kinabalu where it forms 17%. In the Ranau District 96.6% of the population is Kadazan and in Penampang 61.3%.

The Bajau community group is the next most important of the indigenous people, with 16.8% of the total population. This group is centred on Kota Belud, but it is reasonably well distributed except for the Ranau District.

Among the other indigenous groups the Brunei and Rungus are most numerous. In th case of the former,72.8% live in the Paper District,while in the case of the latter practically all live in the Kudat District.

The largest non-indigenous group is the Chinese, which is in fact the second largest overall. This group is reasonably well distributed throughout the residencies though poorly represented in Ranau District. 54% live in Kota Kinabalu District and of these 86% live in Kota Kinabalu Town. Table 3 shows that the Chinese community as a wh tends to be more urban than rural and accounts for 56% of the population in the six major towns. This 56% is equal to 59.6% of the total Chinese community group. Other non-indigenous community groups are of little importance though it may be noted that they are more numerous in Kudat, Kota Kinabalu and Papar Districts whi there are very few in Ranau and Kota Belud Districts.

TABLE 3 The Chinese community group in towns and townships (Dept. of Statistics, 1972)

Town		Kota Kinabalu	Kudat	Tuaran	Kota Belud	Ranau	Papar	Total
Total population		40 939	5 089	3 358	2 211	2 024	1 855	55 476
Chinese community group	Number	24 591	2 922	1 577	904	185	1 168	31 347
	Pecentage	60.0	57.4	46.9	40.8	9.1	62.9	56.5

COMMUNICATIONS

The major features of the communications system are shown in Text Map 3-4. There is an extensive internal road network and a railway linking with the Interior Residency. Water transport plays little part in internal communications. Air, sea and land transport provide external links.

Road

The towns along the coastal strip, Kudat and the settlements in the Kota Marudu area are linked by a road network. Ranau is linked to the coastal strip via the East-West Highway to Tamparuli and has an additional link with Kota Kinabalu via the Tambunan Valley. In all there are an estimated 1 360 km (850 mi) of all weather roads maintained by the Public Works Department.

Rail

There is a narrow gauge railway running south from Kota Kinabalu to Beaufort in the Interior Residency. There are regular passenger and goods train services as well as small light rail cars for passengers only. To some extent the railway has been superceded by the advent of road communications.

Water

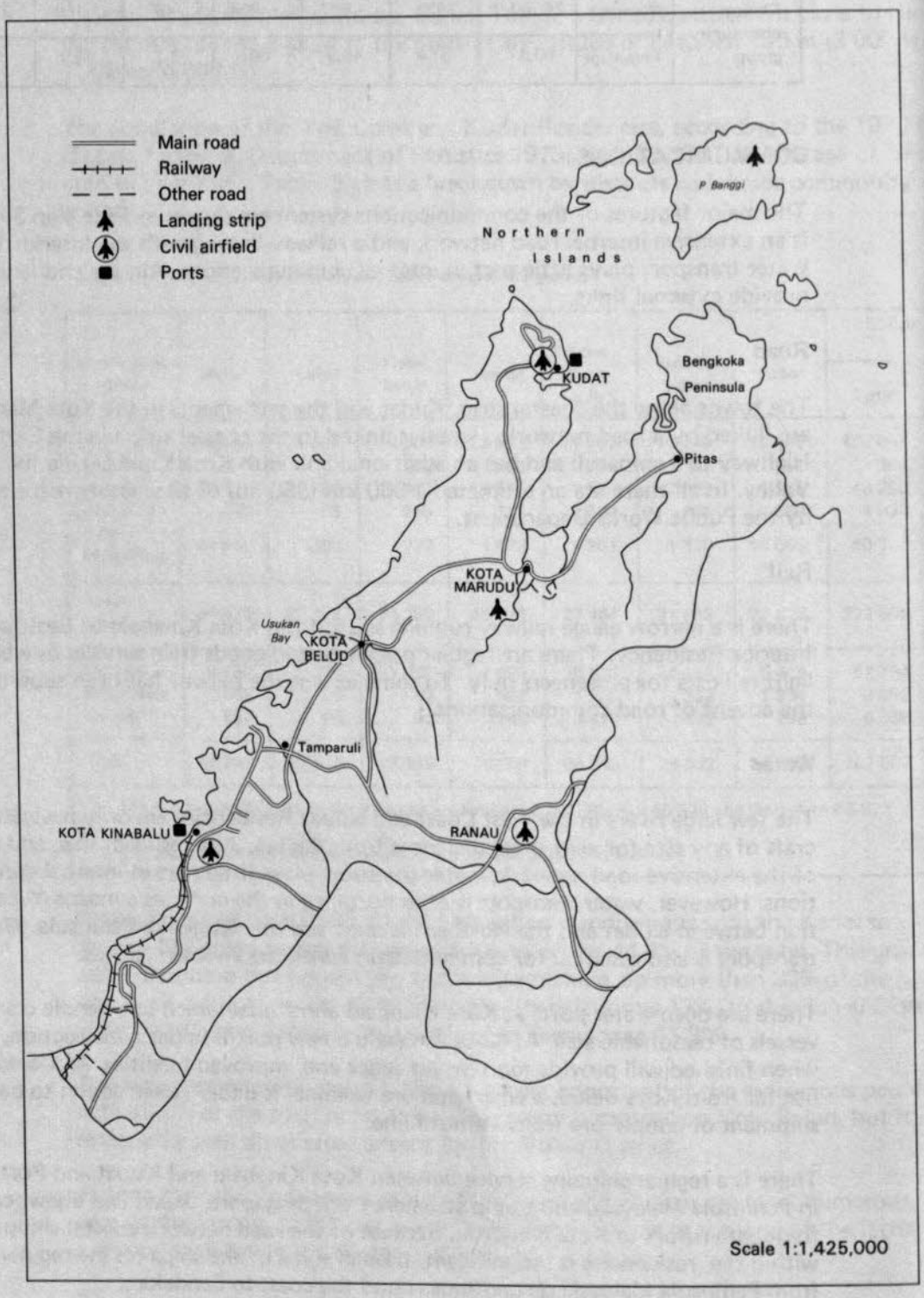
The few large rivers in the West Coast and Kudat Residencies are only navigable by craft of any size for very short distances from the sea. As a result of this, and because of the extensive road network, water transport plays little part in internal communications. However, water transport is of importance in the north as a means of communication between Kudat and the Northern Islands and the Bengkoka Peninsula. Water transport is also essential for communication with the Western Islands.

There are deep water ports at Kota Kinabalu and Kudat which can handle ocean-going vessels of reasonable size. At Kota Kinabalu a new port is under construction, which when finished will provide more wharf space and improved facilities. At Usukan Bay not far from Kota Belud, a wharf and ore terminal is under construction to handle the shipment of copper ore from Mamut Mine.

There is a regular shipping service between Kota Kinabalu and Kudat and Port Klang in Peninsula Malaysia, and tramp steamers from Singapore, Japan and elsewhere are frequent visitors to Kota Kinabalu. Because of the road network coastal shipping trade within the residencies is insignificant, though some of the ships on the regular service from Peninsula Malaysia do continue round the coast to Sandakan.

Air

Kota Kinabalu is the centre for air communications in the State with regular services to Hong Kong, Manila, Singapore, Brunei, Sarawak, and Peninsula Malaysia and the major towns in Sabah. There are local services using small piston engined aircraft to Kudat, Ranau, Keningau and Sapulut. Small fixed-wing aircraft and helicopters are available for charter at Kota Kinabalu.



TEXT MAP 3-4 Communications

ECONOMY

The economy is based on agriculture with timber and light industries playing minor roles. There is an external trade deficit as shown by the 1973 import and export figures for Kota Kinabalu and Kudat ports given in Table 4.

TABLE 4 Port trade figures for 1973 (Dept. of Statistics, 1974)

Port	M$ million		
	Imports	Exports	Balance
Kota Kinabalu	236.9	52.5	- 184.4
Kudat	9.1	9.3	+ .2
Total	246.0	61.8	- 184.2

Table 5 gives the volume and value of the main export commodities in 1973.

It should be noted that the export figures for rubber and other agricultural produce will include some of the production from the Interior Residency, which is brought down by rail or road and shipped from Kota Kinabalu.

TABLE 5 Exports, 1973 (Dept. of Statistics, 1974)

Commodity	Volume	Value $M million	% of total value
Rubber	25 164 tons	40.6	65.7
Timber	34 999 tons	4.9	7.9
Copra	6 071 tons	3.4	5.5
Prawns	98 tons	.5	.08
Palm oil	461 tons	.4	.06
Palm kernels	492 tons	.2	.03
Re-exports (machinery and other manufactures)		9.1	16.33
Others		2.7	4.4
		61.8	100.00

Agriculture

The agricultural sector plays a very important part in both the internal and external economy. Much of the agriculture in the residencies is subsistence agriculture which although providing a means of livelihood for a large proportion of the population, has very little effect on the cash economy. On the coastal plains and around Kudat much of the subsistence agriculture is permanent with wet rice as the main crop, but in the Ranau District and parts of the Bengkoka Peninsula shifting cultivation based on hill rice, tapioca, maize and tobacco, is widely practised.

Rubber is the main tree crop, much of which is grown on smallholdings and, as can be seen from Table 5, it is by far the most important export commodity. In the north in the Kudat Peninsula, coconuts are an important crop, but many of the palms are old and somewhat neglected with the result that in general yields are declining.

In the high country at Kundasan and Bundu Tuhan temperate vegetables are an important crop being widely grown on smallholdings (Plate 3-1). The produce is marketed throughout the coastal strip and in Sandakan on the east coast, and also exported by air to Brunei and Sarawak.

Fisheries

The fishing industry contributes little towards the external trade economy, but plays a important part in the internal economy by supplying a major source of food.

Timber

The timber industry is of little importance in the economy at present and the only larg scale log exporting operation is in the Bengkoka Peninsula; which is really part of the extensive east coast timber industry. However, it is expected that there will be some expansion of the industry in the near future. Throughout the residencies there are a number of small and medium sized sawmills cutting timber for local requirements.

Industry

The only industry which at present makes any significant contribution to the external economy is that concerned with the processing of rubber. There is a small coconut oil industry in Kudat which produces crude oil for export and locally grown rice is milled for domestic consumption. Apart from these there is little or no industry concerned with the processing of agricultural produce. There is a small match making factory and some secondary processing of timber in the form of furniture-making for local use. Light manufacturing industries are being developed particularly in the Kota Kinabalu area, but at present none of these make any significant contribution to external trade.

Bricks are manufactured in the Tuaran and Papar Districts for local building and construction work, together with pottery on a small scale. Quarrying of hard sandston for road making and construction work is carried on mainly at Kudat, Kota Kinabalu and Papar.

Part 3

Survey and classification of resources

Part 3 reviews the various investigations of land resources leading to the systematic surveys recently undertaken. It describes how the results of these surveys have been used to produce a land capability classification, fully described in the monograph on *Land Capability Classification* (Sabah, Malaysia, State Development Planning Committee, 1972), parts of which are reproduced in the following text.

Survey and classification of specific resources

The earliest known account of the resources was made by Spencer St. John (1862) in his report on his journeys to Gunong Kinabalu from Labuan in 1858. This contains general references to the physical and human environment of the various places along the coastline and the Kota Belud-Gunong Kinabalu area.

It was not until the early 1880s that thorough investigations were undertaken, with important journeys of exploration being made to assess the mineral and agricultural potential of the inland areas (Donop, von, 1883). During the first decade of this century a number of mineral occurrences were investigated in the Kudat and Kota Marudu Districts. These were followed in 1913-15 by reconnaissance geological surveys by oil exploration companies marking the first resource surveys, albeit of a cursory nature.

A land classification was started by Government in 1915, the aim being to compile a map of the State showing 'all areas of forest.... as well as areas which can at once be thrown open for agriculture' (State of North Borneo, 1919). Work in the residencies started in 1919 in the Pitas area (State of North Borneo, 1920) but, even though this was to be followed in the succeeding two decades by similar surveys, the ultimate goal was never reached and no records survived.

The modern era of resource surveys started in the early 1950's. During this time a number of specific surveys have been undertaken, which have now made it possible to compile the inventory of the main resources described in Part 4. Of these, minerals, soils and forest resources have been classified into groups according to their economic importance.

GEOLOGICAL SURVEYS AND MINERAL RESOURCE GROUPS

The first mention of mineral occurrences was made by Spencer St. John (St. John, 1862), where he reports iron associated with ultrabasic rocks in the Kinabalu area, and being informed that copper was to be found in the Kadamaian Valley. The latter probably refers to the copper deposits which have subsequently been discovered on G. Sadok Sadok (G. Nungkok).

The first known geological observations were not to start until 1880. By 1882 two Government mineralogists were prospecting in the area between Kudat and the

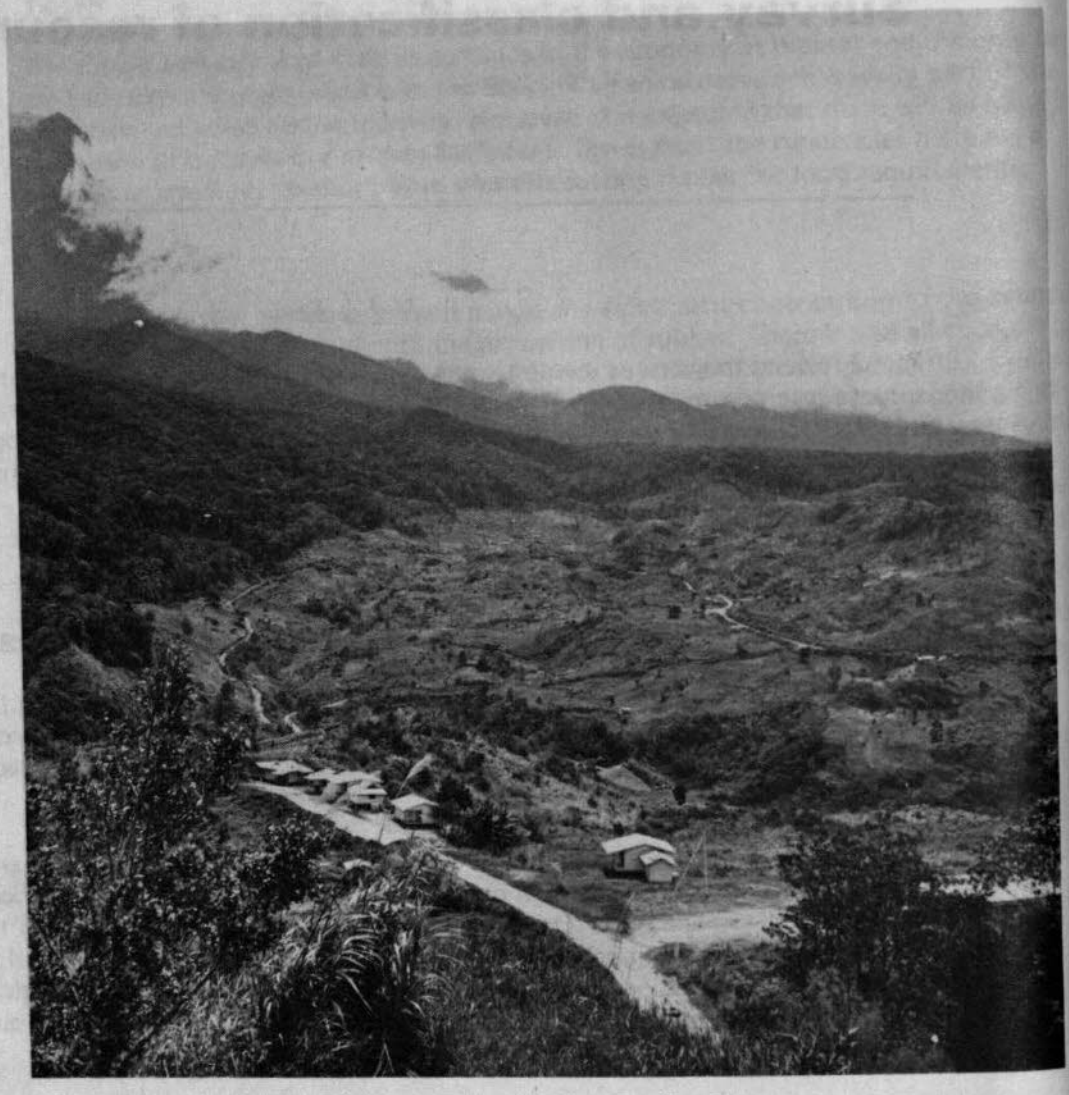


PLATE 3.1 The main temperate vegetable growing area at Kundasan

northern slopes of G. Tambuykon (Donop, von, 1883). Manganese was discovered at Taritipan on Marudu Bay in 1902 (Tregonning, 1958), and mined from 1903 to 1908 (Stephens, 1956). This was to be the only mining operation, and it ended in complete failure. During the same period there was considerable prospecting interest. Iron was reported in 'sizeable quantities in Marudu Bay' in 1905 (Tregonning, 1958), and in 1909-10 chromium was discovered on the Bengkoka Peninsula (Stephens, 1956), on Banggi Island (Tregonning, 1958) and near Paranchangan (Collenette, 1958).

This period of essentially *ad hoc* mineral prospecting was followed in 1913-15 by the first geological surveys. This work was undertaken by various oil exploration companies, and gave rise to the first overall picture of the geology of the Residencies (Stephens, 1956; Collenette, 1958; Wilson, 1961). During the mid-1930's the coastal tract between Kudat and Paitan Bay was re-surveyed (Stephens, 1956), and this was to be followed in 1954-58 with that of a 64 km (40 mi) wide strip of the south-west seaboard; again by oil interests (Collenette, 1958).

The year 1954 saw the start of surveys by the newly instituted Geological Survey of the then British Borneo Territories. These were of the Kota Belud-Kudat and the Jesselton (now Kota Kinabalu)-Kinabalu areas, which were followed by that of the Bengkoka Peninsula and the northern islands. By 1961 the two Residencies had been completely covered. Text Map 3-5 shows the areas covered by the three surveys, resulting in the production of geological maps at the scale of 1:125 000, and with the Taritipan area covered by a 1:50 000 scale map.

During these surveys sites of the mineral deposits were recorded and this information, together with the results of the work undertaken by private prospecting companies during the same period and up to the present in the Kinabalu area and on Pulau Malawali, has provided the basis for determining the location, extent and value of the geological resources and their classification. In so doing, special emphasis has been placed on the occurrence of metalliferous deposits such as copper, silver, manganese, etc, which are workable by an open-cast system of mining, i.e. which may have an appreciable long-term effect on the use of the land and thereby land capability. Four mineral resource groups are defined as follows:

Mineral Resource Group 1 Current mining land

Mineral Resource Group 2 Proven mining land, where economic mineral deposits have been ascertained as the result of geological prospecting

Mineral Resource Group 3 Possible mining land, where geological evidence of a cursory nature indicates that mineralisation of economic importance might occur

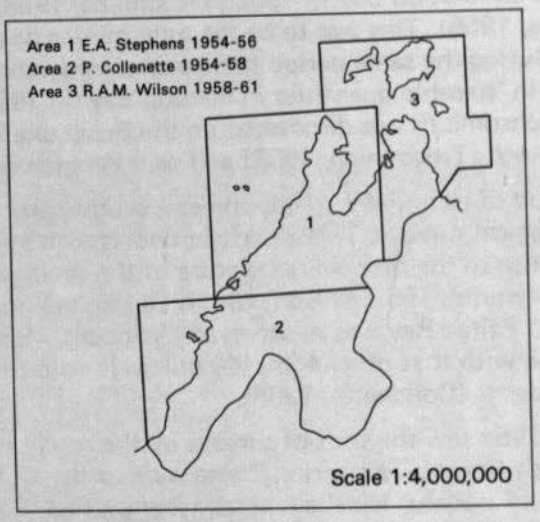
Mineral Resource Group 4 Land with no mining potential, where there is no evidence of mineral deposits

SOIL SURVEYS AND SOIL SUITABILITY (FOR AGRICULTURE) GROUPS

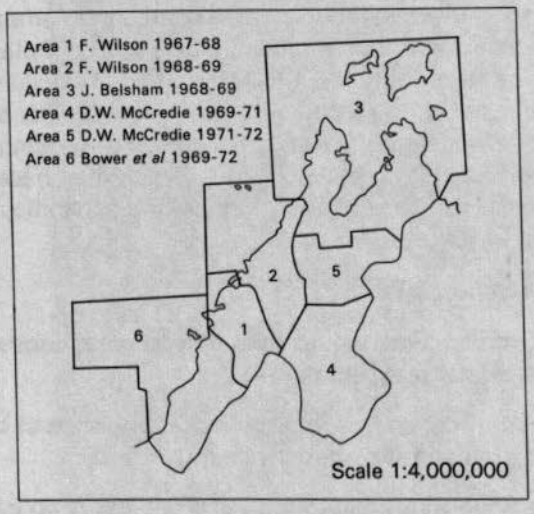
The first recorded observations of land and soil in the residencies were made by St. John in 1858 (St. John, 1862), where he described the Kadamaiman Valley being endowed with 'land... of the richest description - far superior.... to that used in Ceylon for coffee plantations', and on the slopes of Gunong Kinabalu he relates stunted vegetation with iron-rich soils derived from peridotite.

The first soil survey was undertaken in 1878 by T S Dobree who collected soil samples near Papar, and pronounced the soils as being 'fair' (Dobree, 1878 in Bower *et al.*, 1975).

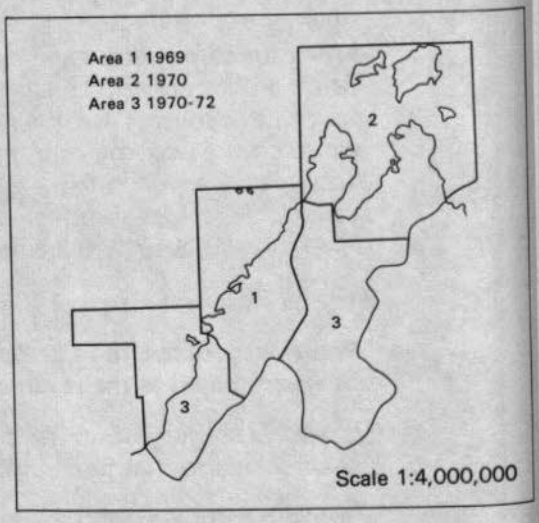
The most comprehensive early account of the land and soils was given by the Government agriculturalist L S von Donop who in 1882 visited the Kota Belud, Ranau, Upper Sugut and Kota Marudu areas (Donop, von, 1883). He collected a number of soil samples for analysis and described good soils occurring in the Kiau, Ranau, and Upper Sugut areas and on the eastern extremity of the Crocker Range; but his views on soils of other parts were less encouraging. He described, for example, 'exhausted land' near Kota Belud, which is probably thelalang -covered hills, and the Bandau Plain as being flat but 'rather sandy'. His report contains a number of recommendations for agricultural development, and he seems to have been particularly impressed with the soils of the highlands lying to the south of Marudu Bay, advocating tea, cinchona,



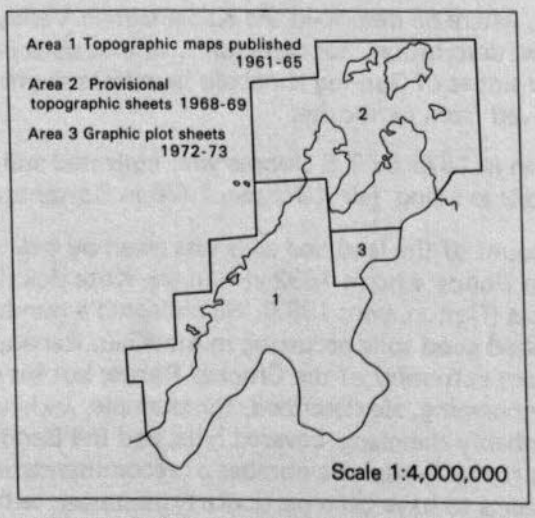
TEXT MAP 3-5 Geological surveys



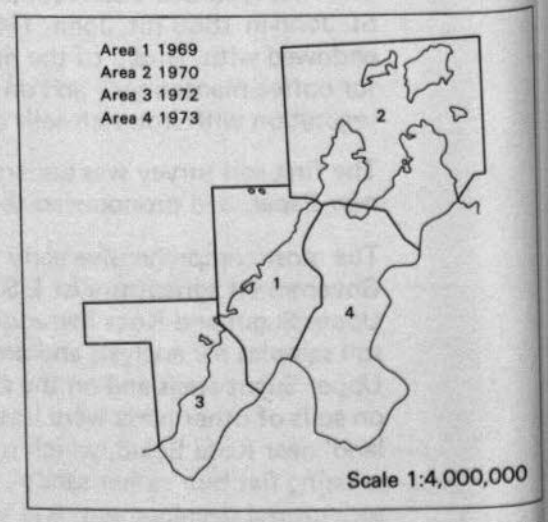
TEXT MAP 3-6 Soil surveys



TEXT MAP 3-7 Forest surveys



TEXT MAP 3-8 Topographic and planimetric mapping (1:50,000 scale)



TEXT MAP 3-9 Alienation and gazettement mapping

cardamoms and arabica coffee at higher altitudes, and crops such as cocoa, pepper and liberica coffee on the lower slopes. He saw a particularly bright future for the Ranau Plain with its 'soil very rich and irrigated for rice', and anticipates its development as a large settlement connected by road with Marudu Bay.

During the last few years of the century the soils of much of the western coastline were probably investigated, because Tregonnong (1958) states that the Government in 1899 pronounced the land next to the newly constructed railway as being suited for rubber.

The soil investigations carried out between 1919 and 1937 as part of the land classification were made mainly to assess the suitability for agriculture of areas which were to be opened-up by new roads. No significant discoveries were made, except for Banggi Island. There, in 1923, some 15 500 ha (38 500 ac) were declared suited for cultivation (State of North Borneo, 1923).

During the late 1940s there was considerable interest by the Colonial Development Corporation in developing the Bandau Plain for widespread mechanised wetrice cultivation, and a soil survey was conducted with the view of developing the crop with irrigation. The soils were declared too coarsely textured for the purpose and interest waned.

It was not until 1952, however, that Government took an active hand in soil surveys; and during the next 15 years a number of areas were investigated, mainly in conjunction with rice cultivation. These were essentially *ad hoc* surveys and scanty records were made. No systematic pedological work was undertaken in the residencies until 1967 when a reconnaissance soil survey of the Tuaran District was begun. This was followed by similar surveys of the other districts, resulting in complete 1:50 000 scale soil map coverage by 1972 (Text Map 3-6), but it should be noted that these maps were not published in *Land Resource Study 20, The soils of Sabah* (Acres *et al.* 1975) where the soil maps are at a scale of 1:250 000.

These surveys provide the basic data from which the soils have been classified into groups according to agricultural suitability. The steps involved are as follows. The basic 1:50 000 scale soil maps show the nature, location and extent of the soils either as soil associations, families or phases. These maps form the basis for the soil suitability maps of the same scale which group the soils according to suitability for agricultural use. The suitability is assessed according to limitations to agricultural use associated with various soil characteristics. For the purpose of this classification it has been assumed that a moderate standard of agriculture can be practised, that is, one which is practical and within the capability of the average farmer.

Five soil suitability groups * are recognised:

Soil Suitability Group 1 Soils with no limitations to agricultural development

These are generally deep, permeable and well aerated soils with good reserves for moisture; and they are either well supplied with plant nutrients or readily responsive to fertilisers. They are developed on level or almost level land where the upper slope limit is 5°. Having no limitations to agricultural development, the soils are capable of growing a wide range of crops.

Soil Suitability Group 2 Soils with few minor limitations to agricultural development

The limitations may include, alone or in combination, imperfect or poor drainage with a watertable occuring for a significant proportion of the year within 120 cm (48 in) of the surface, rock or similar impenetrable materials occurring between 50 cm (20 in) and 120 cm (48 in) of the surface, extreme coarse textures, or moderate slopes generally falling within the 5-15° range which would not require any expensive form of anti-erosion control, or shallow peat deposits never more than 50 cm (20 in) in depth. Although a wide range of crops can be grown on such soils the choice is generally more restricted and yields can be expected to be less than from Group 1 soils.

* Note that in *Land Resource Study* 20, *The soils of Sabah* (Acres *et al.*, 1975) only three categories of soil suitability were recognised. They broadly conform with the five groups described here and shown on the 1:50 000 scale suitability maps as follows: Category 1 ('suitable land') corresponding to Soil Suitability Groups 1 and 2, Category 2 ('marginal land') to Group 3, and Category 3 ('unsuitable land') to Groups 4 and 5. The more detailed five-tier system employed on the 1:50 000 scale soil suitability maps is considered more appropriate for the purpose of this report; inevitably, however, some differences in detail have resulted.

Soil Suitability Group 3 Soils with one serious limitation to agricultural development

This includes soils which are limited for agricultural development because they are on strongly sloping land in the 15 – 25° range, soils on deposits of peat varying in depth from 50 cm (20 in) to 120 cm (48 in), very poorly drained soils in which swamp conditions sometimes prevail, very poorly structured soils, or soils with a very restricted rooting space due to rocks at shallow depths i.e., within 50 cm (20 in) of the soil surface, or soils showing acute plant nutrient deficiencies. To thrive on this group of soils crops must be specifically adapted to the adverse soil conditions. The group is therefore unsuited to diversified agriculture, and the success of any agricultural enterprise would depend on careful selection of crops and good management.

Soil Suitability Group 4 Soils with more than one serious limitation to agricultural development

This group would commonly include, for example, shallow soils developed on strongly sloping sites, or shallow soils with acute mineral deficiencies and strongly indurated subsurface horizons such as found in many podzols, very poorly drained and saline soils in which permanent swamp conditions prevail. These disadvantages greatly restrict the range and yield of crops, and result in a strong risk element for agricultural enterprise even with a high standard of management.

Soil Suitability Group 5 Soils with at least one very serious limitation to agricultural development

This would include soils developed on steeplands in which slopes greater than 25° predominate, extremely stony, rocky and boulder-strewn soils or bare rocks, soils with toxic levels of certain elements, and peat deeper than 120 cm (48 in). Agriculture on such soils would generally be inadvisable or even impossible, but they may have a wide range of capability for forestry, hydrological or wildlife purposes.

NATURAL VEGETATION AND TIMBER RESOURCE GROUPS

The early explorers of the 19th century made a number of interesting observations o the natural vegetation, describing mangrove and nipah swamps on the coast, the vegetation zones on the Crocker Range, and von Donop in 1882 described a number 'very good timber stands' in the forests south of Marudu Bay (Donop, von, 1883). Bu none of these accounts were particularly relevant to the development of a timber industry.

Forest investigations in connection with the land classification were carried out betw 1918 and 1938. Little attention was given to the dry-land forests; work being concentrated on the mangrove swamps of the western coastline. An exception to thi appears to be the survey of Banggi Island in 1923.

The first step towards undertaking a comprehensive forest inventory was proclaimed as early as 1948, when it was proposed that the vegetation cover should be mapped, largely as the result of the interpretation of aerial photographs, on standard 1:50 00 scale map sheets.

Even though a number of selected areas were surveyed, it was not until some two decades later that a start was made by the Forest Department on the systematic sur of the forest resources of the two residencies. This was initially based on aerial photographs taken in 1961-2, and the results depicted on 1:50 000 scale maps.

By 1970 the Tuaran, Kota Belud and Kudat Districts had been surveyed. The maps provide the data on the forest resources for those districts in this report. During the period 1970-2 the whole area of the two residencies was, as part of a State-wide coverage, subjected to an aerial photographic survey and forest inventory; and the results, again on 1:50 000 scale maps, have provided the basis for the data used for the remaining parts of the residencies. The various surveys are shown in Text Map 3-7.

The various forest maps, and the *Forest Inventory Report* (Forestal International Limited, 1973) give an account of the location and extent of forest land; its type and size, and the volume of timber available for logging. All this information, except volume, is shown on the forest maps. Also shown are the terrain and drainage conditions of the land, factors important in timber extraction. The volume data are derived exclusively from the *Forest Inventory Report.* For land capability classification purposes the information relative to the timber production potential is rearranged in order to give an estimate of the present and future productivity of the land, and in so doing commercial aspects are brought in. In cases where the timber has been felled and records exist of the volume of timber realised, such figures are used to estimate the capability of the land. The rating employed relates essentially to the crown size and density of the trees and the volume of merchantable timber, and emphasis is laid on the inherent forest potential of the land. Crown sizes are differentiated into large (over 18 m (60 ft) diameter), medium sized (between 9 to 18 m (30 to 60 ft), and small (less than 9 m (30 ft) in diameter). Eight timber resource groups are recognised (Sabah, Malaysia, State Development Planning Committee, 1973).

Timber Resource Group 1

This comprises the most productive forests and typically consists of trees with large crowns which are close together forming over 60% of the canopy; the commercial value is high and yields based on current standards can be expected to exceed 89 m^3 of timber/ha (1 000 Hft^3/ac).

Timber Resource Group 2

These forests contain either fewer trees with large crowns or consist of trees with medium-sized crowns which are close together. If composed of large crowns they form between 30 and 60% of the canopy, if mediumsized over 90%. These are considered to be of average commercial value, and yields can be expected to be 62-89 m^3 of timber/ha (700 1 000 Hft^3/ac).

Timber Resource Group 3

Forests falling in this group have a more open canopy formed by large to medium crowns, or if small crowns they are close together. Areas with large crowns have a density less than 30%, those with medium crowns between 30 and 90%, and those with small crowns over 60%. By current standards such forests are considered to be commercially marginal, and may be expected to yield between 35 to 62 m^3 per ha (400 to 700 Hft^3/ac).

Timber Resource Group 4

Here the forest canopy is generally open, consisting of a few trees with medium to small sized crowns. Such forests would not be considered of commercial value; yields based on present market trends would be expected to be below 35 m^3/ha (400 Hft^3/ac).

Timber Resource Group 5

The forests which form this group are non-commercial consisting of montane forests and forests on hills with soils derived from ultrabasic rocks, which because of their species distribution and small size are of no present commercial value. They might, however, be used for timber production in the future.

Timber Resource Group 6

This group comprises other non-commercial forests, which include coastal forests, swamp forests and areas of *nipah (Nipa fruticans)* all of which have no market value at present and no potential value in the foreseeable future.

Timber Resource Group 7

This group consists of mangrove forests which are commercially exploitable having a reasonable volume of pole sized timber.

Timber Resource Group 8

This group covers forest plantations, previously logged immature forests for which timber yields cannot be predicted, and all non-forested land including cultivated, urban and derelict land.

HYDROLOGY AND WATER RESOURCES

Some of the rainfall records span over 80 years, with the first stations being established at Kudat and Papar in the late 1880s. These were followed in the early part of this century by records being kept at Kota Belud, Langkon, Kota Kinabalu, Penampang and Tuaran; around 50 years of records. These stations are all located in the lowlands, but in the early 1930s the first high altitude station was established, at Bundu Tuhan. It was not until the 1950s, however, that hydrological investigations were started in earnest with a rapid increase in the number of stations. By 1968 34 were fully operational and a network of recording stations had been established (in records published in Sabah, Malaysia, Drainage and Irrigation Dept., 1970). The location of the main hydrometric stations is shown in Text Map 3-3.

There are no records of stream discharge prior to 1959, when Government established water-level stations on the Papar, Moyog and Inanam Rivers. A number of river discharge stations became operational in the Bandau, Tampasuk, Tuaran, Putatan and Papar River Basins between 1965 and 1967 (Sabah, Malaysia, Drainage and Irrigation Dept., 1970), thus providing data on the main river catchments lying to the west of the Croker Range.

Between 1961 and 1963 an appraisal was made of the hydroelectric potential (Snowy Mountains Hydroelectric Authority, 1963), and sites investigated on the Papar, Moyog, Tuaran, Inanam, Kolopis (near Kambarangan) and Liwagu Rivers.

During the period 1969-73 the Drainage and Irrigation Department produced 1:50 000 scale maps showing the location of the main water catchments used for water supply purposes, and also those considered worthy of future reservation. The maps also show land which comes under the authority of the Department, together with the location of its hydrological stations.

TOPOGRAPHY AND PLANIMETRY

Text Map 3-8 shows the areas covered by the various forms of maps used for the production of the basic 1:50 000 scale maps.

LAND TENURE

The earliest known title issued on land in the West Coast and Kudat Residencies was made in 1891, which was a country lease to a place at Kudat. In the following years a number of areas were alienated for agricultural purposes; the records being maintained at the Land Registry Office in Sandakan, then the State-capital. This Office was also responsible for gazetting land for specific government or communal purposes; and the first of such reserves, in this case for a barracks, was established in Kota Kinabalu in 1916. The first forest reserve, on Gaya Island, was constituted in 1923, and the first grazing reserve, located near Tuaran, was established in 1930.

After the last war the land records were transferred and maintained at the Lands and Surveys Department headquarters at Kota Kinabalu. The task of systematically depicting the information on the standard 1:50 000 scale map sheets of the residencies started in 1969 and was completed in 1973. This is shown in Text Map 3-9. The various forms of alienation and gazettement shown on these maps are given in Table 6.

TABLE 6 The classification of the alienation and gazettement units

Land category	Alienation and gazettement units
Alienated land	Land alienated under leases and provisional leases, native titles and on field registers, settlement schemes, village reserves and areas proposed for alienation
Forest reserve	Land gazetted as protection, commercial, domestic, amenity, and mangrove forest reserves; also game reserves and the national parks
Government reserve	Land allocated as state, airport, cemetry, educational, military, police station, quarry, tamu-ground, agricultural, veterinary, bird sanctuary and water supply reserves
Drainage and irrigation area	Land coming under supervision of drainage and irrigation authorities
Grazing reserve	Land allocated for communal pastoral purposes
Stateland	Land not allocated for government or private use

GAME AND RECREATIONAL RESOURCES

Although systematic work began on the fauna as long ago as the middle part of the nineteenth century (Davis, 1962; Medway, 1965), there has been no formal overall survey of the game resources of the two residencies.

Much of the interest has been centred on Gunong Kinabalu on which a number of prolonged zoological surveys have been conducted. The first was made by J Whitehead in 1887-8, during which a number of new species, mainly birds, were described (Medway, 1965). Other important expeditions were conducted, in 1937 by the Harvard Asiatic Primate Expedition, and in 1961 and 1964 by the Royal Society (Davis, 1962; Medway, 1965).

The only important collection of animals in the lowlands is that of the Raffles Museum, Singapore, in 1927. This was made on the islands lying to the north of Marudu Bay (Davis, 1962). A small collection was made by R Kuntz in the Kota Kinabalu and Ranau areas in 1960 (Medway, 1965).

Survey of the lowland avifauna is restricted to that undertaken by the Forest Department in the Kota Belud Bird Sanctuary in 1965 (Sabah Forest Department, 1966). This list includes a number of game species.

It will be seen, therefore, that the game resource of much of the coastal areas and interior has not yet been investigated and that the fauna is inadequately known.

Little or no attention has been given to the recreational resources. The knowledge which is available is contained in Part 4 of this report.

PRESENT LAND USE

Even though a census of the main agricultural crops was undertaken, the first comprehensive survey of land use was only made in 1972. This survey was based on the interpretation of the aerial photographs taken as part of the forest inventory. The results are incorporated in a report for the residencies (Wong, 1973), and maps drawn to the scale of 1:50 000, 1:250 000 amd 1:500 000 have been compiled. The information is presented according to the form recommended by the International Geographic Union with the identification of individual crops as they occur. The present land use categories, ranging from the most intense use to the least intense, are:

Category 1 Urban and associated land

Category 2 Horticultural land

Category 3 Permanent crops, commonly tree crops in plantations and orchards

Category 4 Shifting cultivation

Category 5 Permanent improved pasture

Category 6 Natural grassland

Category 7 Forest land

Category 8 Swamp, marshland and wetland forests

Category 9 Unused land

The land capability classification

This section is devoted to describing how the results of the various surveys and investigations described in the previous account are processed in order to arrive at a land capability classification. The classification employed is that of the *Land Capabili Classification* (Sabah, State Development Planning Committee, 1973) and is based on the earlier work undertaken in peninsular Malaysia (Panton, 1966).

Factual economic data concerning land use are not available and the approach to land capability therefore, rests on the basic assumption, which is supported generally in practice throughout Malaysia, that mining is more profitable than agriculture and that both are more profitable than forestry.

The groupings involved in the classification essentially indicate the most profitable us to be made of the land. It is an attempt to interpret and express to the best advantage current knowledge on its use, and as new experience is acquired revision will be neede The classification is based solely on the probable economic gains which can be obtain from the land under a moderately high level of management, and not necessarily upo current usage. Such factors as accessibility, social benefit, and the pattern of land

ownership and current land use, although affecting decisions about development, do not influence the grading. The system employed does not attempt to indicate the specific nature of the resource type, i.e. nature of the mineral reserve, agricultural and forest crop.

LAND CAPABILITY CLASSES

The various natural resource groups are interpreted into five land capability classes, and these are set up so that land having the greatest number of theoretical alternative uses, but always giving the highest monetary return on development, is in Class I and land having the least number of uses is in Class V, with the number of uses becoming progressively smaller between these two classes. This indicates, for example, that although recreation and wildlife areas can be established theoretically in all five classes, the optimum use of the land will depend for economic reasons on the existence of adequate levels of minerals, or its agricultural crop potential or timber exploitation capacity, always in that order of importance, thus determining the form of land use which is likely to provide the maximum economic benefit. It should be noted that the Class I land in the residencies possesses a mining potential only and that agricultural and forestry prospects on such land are low. The classes are defined thus:

Class I **Land with a high potential for mineral development and therefore best suited for mining**

Class II **Land with a high potential for agriculture with a wide range of crops and therefore best suited for a diversified form of agriculture**

Class III **Land processing a moderate potential for agriculture with a restricted range of crops, and therefore best suited for a limited variety of crops with a high level of tolerance to a range of soil conditions**

Class IV **Land with no mining or agricultural potential, but a potential for forest resource exploitation and best suited for this purpose**

Class V **Land with no potential for mining, agriculture or forest exploitation and generally best suited for conservation or recreational purposes**

LAND EXPLOITATION UNITS

Any one area of land may have one or more resource which may be economically exploitable. It follows, therefore, that on a broader scale natural groupings of land occur with similar qualities and uses; each having the same kinds of natural resource potential. These are defined as land exploitation units and are essentially complementary to, and fall within, the five land capability classes which have been recognised. Falling in a lower order in the classification, these units serve the purpose of providing a comprehensive range of information on the capability of the land, and thus any alternative uses. The overall recommendation, however, as to the future use of the land is defined at the class level. The relationship between the resource groups and the other elements employed in the classification is set out in Table 7. Each unit has a class connotation followed by a suffix indicating the assigned unit. The following land exploitation units are recognised:

Unit IA **Land possessing a high potential for mineral development and therefore best suited for mining**

Unit IIA **A high potential for agriculture only**

Unit IIB **A high potential for agriculture and timber exploitation**

Unit IIC **A high potential for agriculture and a marginal potential for timber exploitation**

Unit IID A high potential for agriculture and also a possible mining potential

Unit IIE A high potential for both agriculture and timber exploitation and also a possible mining potential

Unit IIF A high potential for agriculture, a marginal potential for timber exploitation and also a possible mining potential

Unit IIIA A moderate potential for agriculture only

Unit IIIB A moderate potential for agriculture and also a high potential for timber exploitation

Unit IIIC Moderate potential for agriculture and also a marginal potential for timber exploitation

Unit IIID Moderate potential for agriculture and also a possible mining potential

Unit IIIE Moderate potential for agriculture, a high potential for timber exploitation, and also a possible mining potential

Unit IIIF Moderate potential for agriculture, a marginal potential for timber exploitation and also a possible mining potential

Unit IVA High potential for timber exploitation only

Unit IVB Marginal potential for timber exploitation only

Unit IVC High potential for timber exploitation and a possible mining potential

Unit IVD Marginal potential for timber exploitation and a possible mining potential

Unit IVE Productive mangrove resources only

Unit VA Little or no potential for agriculture or forest resource exploitation, and best suited for protective or recreational purposes

Unit VB Little or no potential for agriculture or forest resource exploitation, but with a possible mining potential

TABLE 7 The relationships between resource suitability groups, land capability classes and land exploitation

Land capability class	Land exploitation unit	Resource suitability groups *		
		Mineral	Soil	Timber
I	IA	1-2	4-5	4-6, 8
II	IIA	4	1-2	4-6, 8
	IIB	4	1-2	1-2
	IIC	4	1-2	3
	IID	3	1-2	4-6, 8
	IIE	3	1-2	1-2
	IIF	3	1-2	3
III	IIIA	4	3	4-6, 8
	IIIB	4	3	1-2
	IIIC	4	3	3
	IIID	3	3	4-6, 8
	IIIE	3	3	1-2
	IIIF	3	3	3
IV	IVA	4	4-5	1-2
	IVB	4	4-5	3
	IVC	3	4-5	1-2
	IVD	3	4-5	3
	IVE	4	4-5	7
V	VA	4	4-5	4-6, 8
	VB	3	4-5	4-6, 8

* For definitions see previous text.

These units are recognised in order to provide a framework for developmental planning of the resources of the land. This then lends itself with ease to multiple land-use planning which will be of future importance, because alternative choices of land-use must always be considered from time to time and frequently from one region to another owing to changes occurring in the economic or social structure.

CARTOGRAPHY, AREA MEASUREMENT AND DATA TABULATION

Using 1:50 000 scale topographic, graphic plots, or planimetric maps as a base, the information obtained from the surveys is correlated by overlaying the various maps so as to enable the boundaries of the land exploitation units to be drawn. In this way the basic land capability classification maps are compiled. The land exploitation units are shown on 1:50 000 scale maps, and are grouped together as land capability classes on the 1:250 000 scale maps which are published with this report. The land capability maps also show the main geographical features. The location of present and potential quarry sites are shown on the 1:50 000 scale maps. The different land categories are shown in various colours on the maps.

In order to assist land development planning at the local administrative level all the 1:50 000 scale thematic, topographic and land tenure maps are arranged to cover each district. Twelve loose bound volumes are produced for each, with all the materials lying flat. These provide the minimum essential information for local planning, and copies are held at the main district and headquarters office of the relevant department for the purpose.

All area measurement was made in acres on the 1:50 000 scale maps by using dot-counting planimeters. Translucent copies of the present land use maps were superimposed on the land capability maps, and the various forms of land use were measured with the land exploitation units and alienation and gazettement categories. Sheet acreages were first tabulated, and cumulative totals were then compiled to arrive at the district and then residency figures. The acre figures were then converted to hectares.

Part 4

The resources and their distribution

The West Coast and Kudat Residencies have far fewer land resources than the Tawau and Sandakan Residencies described in Volumes 1 and 2. Much of it is mountainous, and the greater part of the timber has been destroyed by shifting cultivators. Most of the remaining timber is in the more remote highlands where widespread logging is incompatible with soil and water conservation. Much of the shoreline and hinterland are of exceptional scenic value. Highly mineralised zones occur in a number of areas and copper-mining operations have begun at Mamut. A general account of the types, extent and location of the land resources is given below.

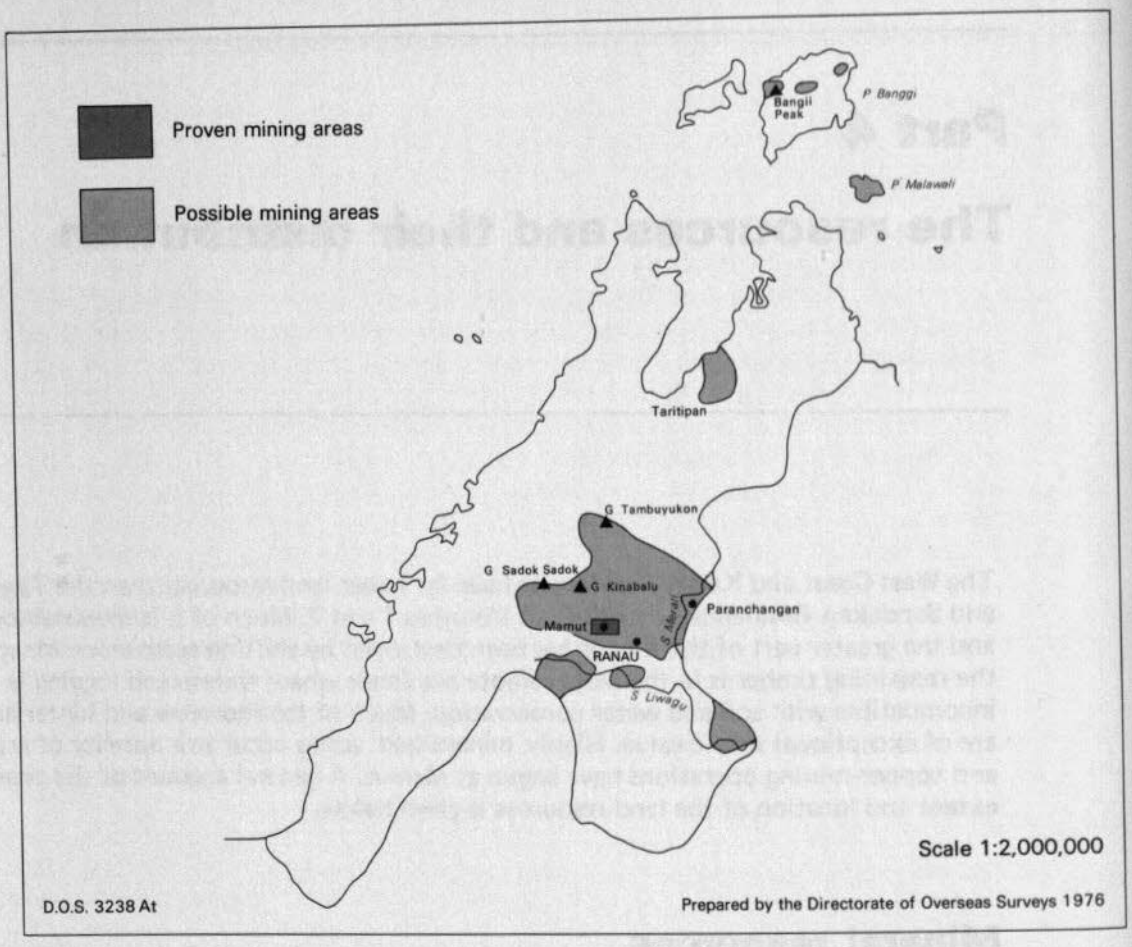
Mineral resources

Geological surveys and prospecting have revealed that mineralisation of economic interest is mainly related to the occurrence of igneous rocks; with the Kinabalu pluton, basic effusive rocks in the Taritipan area, and ultrabasic rocks on Banggi and Malawali Islands. Kirk (1968) has shown that hydrothermal mineralisation has been the main process operative in the Kinabalu area, giving rise to copper-gold deposits, while magmatic segregation has resulted in concentrations of chromite in the Banggi, Malawali and Paranchangan areas. Weathering process has resulted in residual deposits of manganese at Taritipan.

Even though mineralisation has been shown to occur in a number of places, mining has been restricted to two locations only: an abortive attempt at Taritipan in the early part of this century, and at Mamut, to the east of Gunong Kinabalu, where operations commenced in 1972.

Mining has not been more widespread for a number of factors, particularly low grade, small tonnage, remoteness and market prices. The areas where mineralisation has been proved or considered possible are shown on Text Map 3-10.

From Table 60 it can be deduced that land proven for mining, Land Capability Class I (Mineral Resource Group 2), has been mapped over an area of 2 768 ha (6 840 ac). Such land is restricted to the Mamut area. The table also shows that some 138 107 ha (341 251 ac), which is calculated by the sum of Land Exploitation Units IID, E, F, IIID, E, F, IVC, D, and VB, are thought to have a possible mining potential (Mineral Resource Group 3). Further survey and prospecting work will be required over these areas. The following is a synopsis of the information at present available on the more important minerals.



TEXT MAP 3-10 Proven and possible mining areas

MINERAL RESOURCE GROUP 2 PROVEN MINING LAND

Group 2 land occurs only in the Mamut area and, according to the specifications used in the classification of the mineral resources contained in Part 3, will shortly become Group 1, Current mining land, when production commences. The land chosen for the purpose covers a contiguous area of some 2 768 ha (6 840 ac). The minerals which will be gained as the result of mining operations are as follows:

Copper

Lee (1971) in his account of the mineral deposits of Sabah states that the copper occurs as sulphides in the form of low-grade disseminations in porphyry; the porphyry being associated with Tertiary adamellite – granodiorite intrusions. The average Cu value is given as 0.608% and the reserves of mineable ore are assessed at 77 million t.

Gold and Silver

The copper-bearing ore at Mamut also contains small amounts of gold and silver which are expected to be recovered as by-products of the copper mining (Lee, 1971)

MINERAL RESOURCE GROUP 3 POSSIBLE MINING LAND

Copper

Copper mineralisation has been recorded in a number of places as follows:

Nungkok Prospect

This is located on Gunong Sadok Sadok which lies immediately to the west of Gunong Kinabalu, and is at present (1974) being subject to detailed prospecting. Kirk (1968) describes the copper as occurring in the form of low-grade sulphide disseminations which are found in granodiorite intruded into highly silicified sediments. Earlier prospecting revealed a copper-anomalous zone some 3 600 m (12 000 ft) long and 900 m (3 000 ft) wide (Lee, 1971).

Bambangan Valley

Jacobson (1970) during his survey described three weak anomalous copper zones in this valley which lies to the west of the Mamut mining area. A small zone of copper sulphide mineralisation was investigated in the upper part of the valley, and this revealed that it occurs in a faulted contact zone between porphyry and serpentinite. Kirk (1968) states that the porphyry also contains copper, but in a weakly disseminated form.

Mesilau, Kilambuan and Panataran Valleys

These run directly east and west from the summit zone of Gunong Kinabalu, and a number of copper anomalies have been described by Jacobson (1970) in these areas. In the Kilambuan and Panataran Valleys, which lie to the west, copper assays of stream sediments ranged from 5—125 ppm. He describes the mineralisation in the former valley as being associated with sheared ultrabasic rocks, and in the other two with quartz.

Power station

This is situated on the southern slope of Gunong Kinabalu and the copper occurs in faulted sedimentary rocks (Jacobson, 1970). Its quantity and quality is not known.

Tambuyukon area

Native copper was discovered in the Kinarom Valley in 1882, together with copper sulphides on the eastern slopes of Gunong Tambuyukon associated with quartz (Stephens, 1956). The copper may be related to intrusions of ultrabasic rocks.

Taritipan area

Stephens (1956) describes traces of copper being discovered in basalt on the Manjupanju River, and in the Pinggan Pinggan area near ultrabasic intrusions.

Ranau area

An aeromagnetic survey of the Kinabalu-Tambuyukon area was undertaken in 1970 (Hunting Geology and Geophysics Ltd., 1970). The primary objective was to locate intrusions of acid rocks which may contain copper-porphyry deposits. A number of magnetic anomalies were discovered in a broad zone, some 25 km (16 mi) wide, running from the Kinabalu Massif south-east to the residency boundary, which broadly defines the eastern limit of the survey. The most promising anomalous area lies immediately to the west of the Mamut mineralisation. Significant results were also obtained for the Paranchangan-Ranau and Merali areas.

Pulau Banggi

Copper mineralisation has been described in the north-west of the island (Collenette, 1964). On the northern slopes of Banggi Peak chalcopyrite and malachite occur disseminated in quartzite and spilite over a 1 mi^2 area. Malachite has also been described in the Bengkinit and Bitara Valleys.

Chromite

Chromite mineralisation has been described at a number of locations in ultrabasic rocks. Its origin is thought by Kirk (1968), in his account of the igneous rocks of Sabah and Sarawak, to be due to magmatic segregation. It has been described to the east of Gunong Kinabalu, on the northern islands, and on the eastern shoreline of Marudu Bay, as follows:

Paranchangan

Here a small chromite-bearing lens was described by Collenette (1958) during his survey. It occurs at the junction of an ultrabasic intrusion into sandstone and shale country rock. The assayed values were as follows: Cr 21.5%, Cr_2O_3 31.4%, Al_2O_3 28.4%, FeO 12.8% and SiO_2 4.4%. These figures indicate that the deposit is not suitable as a source for chromium but that it could be used for refractory purposes. However, only 110 m^3 (150 yd^3) of reserves were assessed, indicating that mining operations would not be profitable, but further occurrences were thought to be likely in the area.

Pulau Banggi

A number of relatively small ultrabasic outcrops occur on this island, but the known chromite mineralisation is restricted to the north-western part. Prospecting in the Kapitangan Valley has revealed thin lenses in serpentinite (Kirk, 1968), which in places were sufficiently rich in chromite to be of ore-grade. The deposits so far discovered, however, would seem to be too small and scattered to be worthy of mining. Chromite has also been described in the nearby Bengkinit river area by Wilson (1961), where it occurs disseminated in ultrabasic rocks. Small deposits of beach sands in the area, probably derived from these rocks, have been assayed as containing 34.6% Cr (50.58% Cr_2O_3), which again indicates their suitability for refractory purposes only.

Pulau Malawali

Here boulders of chromite occur on the hillsides in the north-western and southern parts (Kirk, 1968). They have been investigated by Wilson (1961) who found the Cr_2O_3 content to be 54.5%, indicating that the mineral is likely to be of refractory grade only. Its origin was thought to be in the form of lenses in serpentinite which have been faulted and brecciated, making mining a difficult proposition.

Taritipan area

Thin layers of low grade chromite on Marasimsim Beach have been investigated by Stephens (1956). The deposit was assessed at 485 t, consisting of low-grade chromite with a Cr_2O_3 content of 45%. The known deposit is too small for mining, but its origin is thought to be from ultrabasic rocks which occur in the area.

Manganese

The sole recorded occurrence of manganese mineralisation is that of the Taritipan area. It has been investigated by Stephens (1956). The manganese is thought to have its origin in basic or ultrabasic rocks found in the Chert-Spilite Formation of the area. The weathering of these rocks has resulted in residual concentrations in the soil mantle. These are found as nodules or encrustations around chert material with the

Mn value ranging from 25.85% to 50.15%. The known mineralised zone covers an area of about 5 km^2 (2 mi^2), but most of the reserves were mined during the period 1903-08. What remains of the known deposit would not be worthy of further mining operations.

Asbestos

The occurrence of this mineral is restricted to areas of ultrabasic rocks found on Pulau Malawali, to the east of Gunong Kinabalu, and also associated with the Chert-Spilite Formation of the Taritipan area. It occurs as thin veins.

The deposit on Pulau Malawali has been investigated by Wilson (1961) who showed that it is in the form of short-fibred chrysotile, and that it occurs commonly in brecciated serpentinite in the southern part of the island. Even though a great number of veins were found, they were considered too thin to be of economic value.

There is very little information available on the asbestos mineralisation in the other two areas. In both it is described by Lee (1971) as occurring in the form of thin veins in ultrabasic rocks.

Antimony

Antimony in the form of stibnite occurs in the Rendagong area some 16 km (10 mi) south-west of Ranau Town. The deposit has been described by Collenette (1958). The mineral is found in thin quartz veins which run through sandstones and shales. The deposit gave an assay value of 33.1% Sb, but the tonnage available was considered to be too small to be of economic interest.

Mercury

Mercury, as grains of cinnabar, has been found in alluvium near Paginatan and in the upper reaches of the Liwagu river to the southwest of Ranau Town (Kirk, 1962). Lee (1970) states that the alluvium of a number of valleys in the latter area was systematically panned during 1969 in order to determine the source and economic value of the mercury. It is thought that pockets of mercury mineralisation occur in the country rocks which consist of strongly folded sandstone, siltstone, shale and mudstone. The source has not been discovered, but the highest quantity recorded was associated with the antimony deposit near Rendagong where it comprised 'about 1% of the concentrate' (Lee, 1970).

Gold and silver

Small quantities of gold and silver are known to occur in association with the copper mineralisation which has been described in the Nungkok, Bambangan and Tambuyukon areas. Rock material in the latter area has yielded 17 dwt/t Au and 9 dwt/t Ag (Stephens, 1956).

Molybdenum

Small quantities of molybdenum are known to occur as molybdite in the Nungkok area; also associated with the copper mineralisation (Lee, 1971).

Soil resources

It will have been noted in Part 3 of this volume, when the physiography of the residencies was described, that the overall landscape is dominated by a series of mountains and steeplands. The main elements are found in the Crocker Range and Crocker Foothills, but considerable areas also occur in the Bengkoka Lowlands and Kaindangan Peneplain. The soils developed on such terrain are generally unstable and prone to rapid erosion, and are therefore not considered suited for agricultural development.

As a result, by far the greater part of the residencies are considered unsuited for agriculture. This is shown in Table 8, where some 984 308 ha (2 432 250 ac) or 81% (Soil Suitability Groups 4 and 5) are given as unsuited for the purpose.

TABLE 8 Estimated areas of the soil suitability groups *

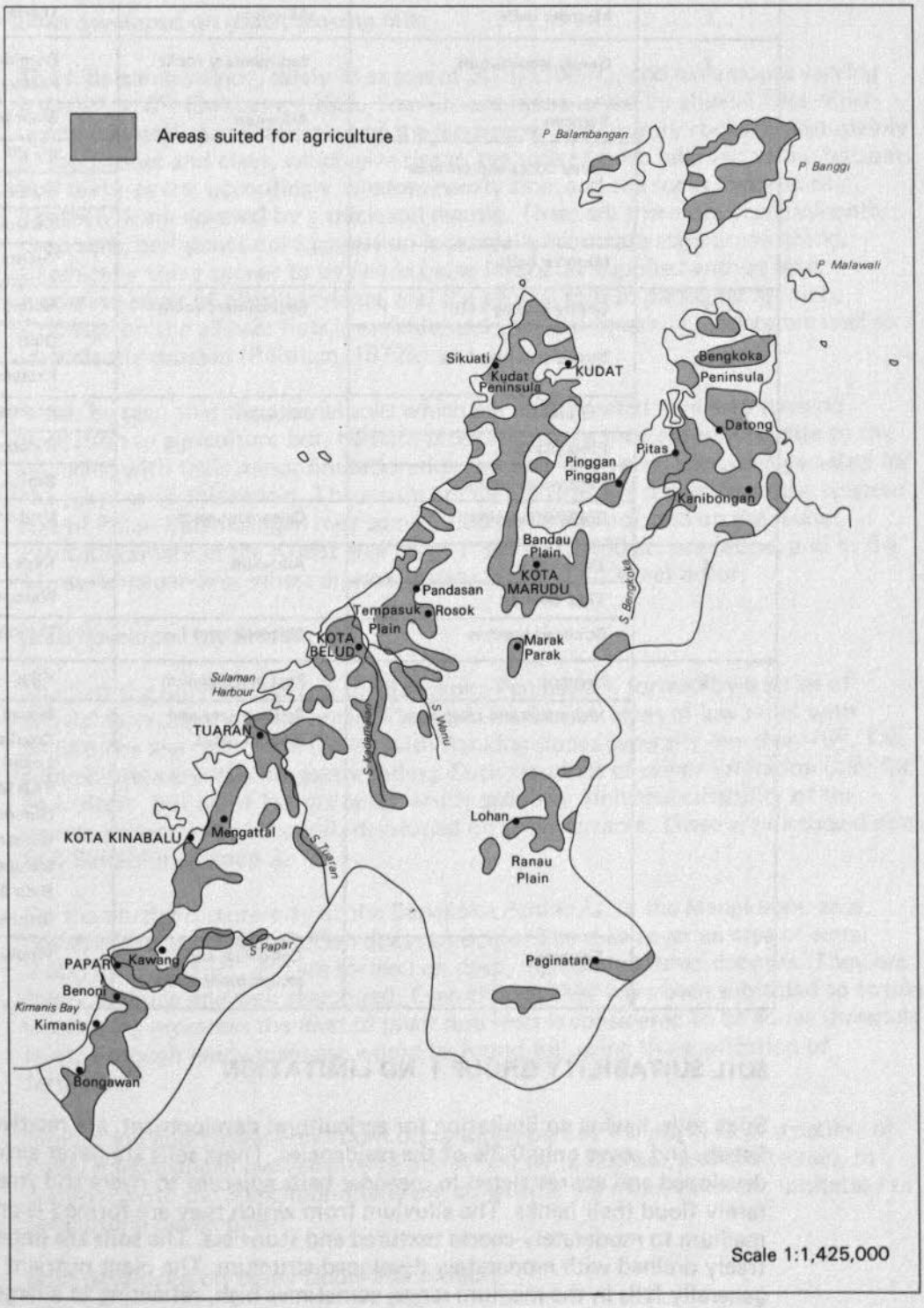
Soil suitability group	Degree of limitation for agriculture	ha	ac	%
1	No limitation	4 079	10 078	0.3
2	Few minor limitations	56 115	138 662	4.6
3	One serious limitation	169 477	418 782	14.0
4	More than one serious limitation	173 500	428 722	14.3
5	Very serious limitation	810 808	2 003 528	66.8
Residency total		1 213 979	2 999 772	100.0

* Groups defined in *Land Capability Classification* (Sabah, Malaysia, State Development Planning Committee, 1973).

Text Map 3-11 shows that the soils suited for agriculture (Soil Suitability Groups 1, 2 and 3) occur mainly on the Crocker Plains, the Bengkoka Lowlands and Banggi Island. This is shown in more detail on the land capability classification map.

Text Map 3-6 (in Part 3) shows the various soil survey areas. The reports and maps of the surveys have been the main source from which the following narrative has been drawn. The full details are given in the bibliography and reference list, and it should be particularly noted that Area 6 shown on the map is reported on in Volume 4 of the companion *Land Resource Study 20, The Soils of Sabah* (Acres *et al.*, 1975).

Table 9 gives the main characteristics of the soil associations mapped in the residencies and the soil suitability groups. The soil associations are described in *Land Resource Study 20, The Soils of Sabah.* The table shows that three of the associations occur in two soil suitability groups. This is because the classification is based on data obtained from reconnaissance-level surveys and many of the mapping units, particularly soil associations, have a wide range of soil variability with some soils being dominant for an association in one area but subordinate to related soils of the same association elsewhere. Hence, it can be seen that soils of the Tuaran Association occur in Groups 1 and 2, and those of the Rumidi and Brantian Associations in Groups 2 and 3.



TEXT MAP 3-11 Areas suited for agriculture (Soil Suitability Groups 1, 2 and 3)

D.O.S. 3238 Au

Prepared by the Directorate of Overseas Surveys 1976

TABLE 9 Soil suitability classification and soil associations

Soil suitability group	Soils		
	Landform	Parent material	Soil association
1	Meander belts	Alluvium	Tuaran
2	Gently sloping hills	Sedimentary rocks	Rumidi Silabukan
	Terraces	Alluvium	Brantian
	Valley floors and terraces		Binalik
			Labau
			Karamuak
	Meander belts		Tuaran
3	Gently sloping hills	Sedimentary rocks	Rumidi
	Strongly sloping hills		Dalit
			Kretam
	Terraces	Alluvium	Brantian
	Floodplains		Kinabatangan
	Freshwater swamps		Sapi
	Stranded beaches	Calcareous sand	Usukan
4	Terraces	Alluvium	Kepayan
	Tidal swamps		Weston
	Stranded beaches	Siliceous sand	Tanjong Aru
5	Swamps	Peat and alluvium	Klias
	Mountains and steeplands	Sedimentary and igneous rocks	Maliau Crocker Lokan Trus Madi Gumpal Gomantong Malubok Bidu Bidu Mentapok
	Terraces	Colluvium and sedimentary rocks	Pinosuk

SOIL SUITABILITY GROUP 1 NO LIMITATION

Such soils, having no limitation for agricultural development, are relatively rare in th Sabah, and cover only 0.3% of the residencies. These soils are never extensively developed and are restricted to meander belts adjacent to rivers and streams which rarely flood their banks. The alluvium from which they are formed is predominantly medium to moderately-coarse textured and stoneless. The soils are imperfectly to freely drained with moderately developed structure. The plant nutrient status generally falls in the medium range, sometimes high, reflecting to a large degree the effect of mineral detrital deposition. Such soils are suited for a wide range of crops.

Some 4 079 ha (10 078 ac) have been mapped. They occur mainly on the Bandau Plain where some 3 600 ha (9 000 ac) have been delineated. These occur in a numbe of locations, which are individually rarely more than 400 ha (1 000 ac) in extent. A number of smaller areas have been described on the Tuaran Plain and along the middle reaches of the Tuaran River. An aggregate total of some 400 ha (1 000 ac) have been mapped in the Tuaran area.

SOIL SUITABILITY GROUP 2 ONE OR MORE MINOR LIMITATIONS

Soils with only minor limitations for agriculture are generally associated with alluvial areas, and only rarely developed on rock parent material. The limiting factors may be due to terrain, drainage or nutrient status, alone or in combination.

Soils developed on gently sloping hills

The hills are low lying, rarely in excess of 30 m (100 ft), and have slopes varying from 4° to 9° (Belsham, 1969). The hills are interspersed by alluvial flats which occupy a significant proportion of the landscape. The country rocks consist mainly of mudstones and clays, which give rise to the soils of both hills and valley bottoms. Soil textures are, accordingly, predominantly fine; and the rocks, being easily weathered, are covered by a thick soil mantle. These are therefore predominantly deep soils, and structural aggregation is generally moderate sometimes strong. Chemically these appear to be fertile being invariably supplied with at least moderate levels of plant nutrients, and the alluvial soils in particular are rich. Drainage on the alluvial flats is variable, and they are generally moderately-well to imperfectly drained (Belsham, 1972).

It can be seen that the alluvial soils which are incorporated here may have no limitation to agriculture but, because proportionately they are subordinate to the hill soils, with their minor limitation due to slope, both have been amalgamated for the purpose of this report. These soils are inextensive and restricted to the western end of Pulau Balambangan over some 1 000 ha (2 500 ac), and on the Kudat Peninsula where in the Kudat area some 1 380 ha (3 400 ac) are found, and in the Limau Limauan area where approximately 800 ha (2 000 ac) occur.

Soils developed on terraces

Much of the northern part of the Bengkoka Peninsula is formed by a series of alluvial terraces of marine origin. These are marked by areas of low relief with amplitudes less than 15 m (50 ft) with flanking slopes generally less than 15°. The summit areas are level to gently rolling. Such terrain is of minor limitation only for agriculture, but other factors occur which seriously limit the suitability of the greater proportion of the soils developed on these terraces. These are discussed under Soil Suitability Group 3.

On the northern extremity of the Bengkoka Peninsula, in the Mangkubou area, however, the serious limitation does not occur. The soils cover an area of some 3 000 ha (7 400 ac), and are formed on deep, medium textured deposits. They are freely draining and well structured. Even though they have been subjected to strong weathering processes the level of plant nutrients is considered to be above threshold level; although ready response would be found following the application of fertilisers.

Similar soil and terrain conditions occur along part of the north-west coastline of Pulau Balambangan over an area of about 800 ha (2 000 ac), and the terrain, in common with the Mangkubou terraces, constitute the main, if minor, limitation to agricultural development.

Soils developed on valley floors and terraces

A number of valleys are marked by fast flowing streams and rivers where aggregation has resulted in the formation of a series of terraces, and with the present drainage channels interspersed by eyots and narrow floodplains. In some areas rapid discharge from streams emerging from the mountains has given rise to alluvial fans and narrow floodplains.

The soils formed as the result of these processes are variable. They are, however, predominantly well drained and, being composed of alluvium of recent origin, are relatively unweathered; their plant nutrient status is therefore medium to high, largely dependent on the mineralogy of the rocks from which the alluvium is derived. The soil textures range from fine to medium, sometimes coarse, and may contain pebbles and, in cases where the alluvium has been derived from ultrabasic or basic rocks, may contain concretions.

Toxicity problems have been described, by Folland and Acres (1975) during their soil survey of the Sandakan and Kinabatangan Districts, on soils developed on alluvial fans derived from ultrabasic rocks. In the West Coast and Kudat Residencies, however, no such problems have been reported.

In general, therefore, it can be seen that the soil conditions are favourable for most agricultural plants. Minor limitations prevail from place to place e.g. the terrace edges may be dissected so as to impose a minor limitation to development, or certain parts of the floodplains may be poorly drained, or soil depth may be moderately shallow because of pebbles. These soils are never extensive in one area. Their main occurrences are given in Table 10.

TABLE 10 Main occurrence of Group 2 soils developed on valley floors and terraces

Region	Area	Extent	
		ha	ac
Ranau Plain	Lohan-Mirali valleys	2 950	7 300
	Ranau	1 600	3 900
Bengkoka	Pinggan-Pinggan	1 800	4 500
Labuk Highlands	Paginatan	1 600	3 900
	Kegibangan	900	2 200
Crocker Range	Marak-Parak	1 400	3 500
	Kadamaian valley	1 100	2 700
	Panataran	850	2 100
	Merungin	750	1 800
Northern Islands	Banggi	1 250	3 100
Kota Belud Plain	Rosok	1 050	2 600
Bandau Plain	Taritipan	600	1 500

Soils developed on meander belts

The Group 1 soils developed on meander belts have been discussed above; it will have been noted that the soils with no limitations to agriculture are of very limited extent. The soils found on the other stretches of the meander belts have much the same characteristics as those described for the Group 1 soils, but their agricultural suitability is decreased by a greater tendency for poor drainage to occur. Their distribution is given in Table 11.

TABLE 11 The main occurrences of Group 2 soils developed on meander belts

Region	Area	Extent	
		ha	ac
Crocker Plains	Kota Marudu	4 700	11 600
	Papar	2 450	6 000
	Kota Belud	2 300	5 100
	Tuaran	1 400	3 400
	Kimanis	1 050	2 000
Bengkoka Peninsula	Pitas	4 150	10 200
	*Bengkoka Peninsula	3 650	9 000
Kaindangan Peneplain	Kanibongan	1 250	3 100
Crocker Foothills	Matunggong	1 100	2 700
*A number of relatively small, scattered areas.			

SOIL SUITABILITY GROUP 3 ONE SERIOUS LIMITATION

The Group 3 soils described in the West Coast and Kudat Residencies are of wide variety and developed on a distinctive range of landforms and parent materials. The limiting factors found in these soils are due to shallowness, or a strongly sloping land surface, or drainage.

Soils developed on gently sloping hills

Belsham (1969) during his survey of the Kudat District has described extensive areas (21 050 ha, 52 700 ac) of low hills on Pulau Banggi, formed on basic to ultrabasic rocks which occur at about 30 cm (12 in) below the surface. These are described as essentially shallow soils which have a very restricted rooting space and, therefore, a serious limitation to agricultural development. Otherwise the soils would be suited to a wide range of crops, with predominantly high plant nutrient levels, fine textures, moderately to strongly developed structure, and by being developed on an easy rolling terrain.

It should be noted, however, that the reported shallowness of these soils is based on a relatively small number of observations, and further investigations might well reveal that the problem is not as extensive as at present thought; in which case the soils over much of the area will be up-graded to Group 2, with a minor limitation due to terrain factors.

Soils developed on strongly sloping hills

The hills are formed on sedimentary formations composed predominantly of sandstone and mudstone, but on Pulau Banggi an assortment of other rocks, e.g. tuffs and chert, which are associated with geological slumping, are also to be found. The landform typically consists of a series of moderate ridges with amplitudes generally up to 75 m (250 ft) and slopes between 10 and 20°.

Clearing and the cultivation of such slopes would involve a strong erosion risk. The terrain, therefore, gives rise to a serious limitation to agricultural development. Otherwise the soils are moderately suited for a range of crops, being typically developed on well drained sites, they are deep, medium to fine textured, moderately structured, and have medium levels of plant nutrients. Their main occurrences are given in Table 12.

TABLE 12 The major occurrences of Group 3 soils developed on strongly sloping hills

Region	Area	Extent	
		ha	ac
Crocker Foothills	Kota Kinabalu	7 100	17 600
	Bongawan-Kimanis	7 100	17 600
	Papar-Kinarut	5 250	13 000
	Pinawantai	1 950	4 700
Bengkoka Lowlands	Middle Bengkoka Valley	810	2 000
Kaindangan Peneplain	Kanibongan Valley	1 170	2 900

Soils developed on terraces

These occur on marine and coastal terraces, or terrace remnants, composed of predominantly medium textured alluvial deposits. They are most common on the Bengkoka Peninsula (Plate 3-2). The terraces have been described; it will have been noted that soils with minor limitations also occur.

The group 3 soils are predominantly well drained and deep. They have, however, been subject to strong leaching processes which are particularly marked in some summit areas by the development of almost sterile bleached sands (podzols). Accordingly, the plant nutrient status of these soils is in general low, imposing a serious limitation to agricultural development. Their potential is further limited as a result of intensive shifting cultivation in the past; erosion giving rise to the partial or complete loss of top-soils, and exposure to sun and rain producing compact surface layers.

These soils then mark the end-stage of the degradation, through agricultural mis-use, of the closely related Group 2 soils described on page 37.

Similar soils are also found on a number of terraces which flank the middle and upper reaches of the main rivers, and the same soil factors related to agricultural development operate. These terraces are, however, never extensive in any one place, normally occurring as narrow discontinuous features. Their main occurrences, together with those associated with the marine terraces are given in Table 13.

TABLE 13 The major occurrences of Group 3 soils developed on terraces

Region	Area	Extent	
		ha	ac
Bengkoka Lowlands	Kanibongan	9 390	23 200
	Datong	9 270	22 900
	Bengkoka Peninsular (North)	7 890	19 500
	Pitas	1 340	3 300
	Telaga	1 010	2 500
Bandau Plain	Kota Marudu	5 100	12 600
Crocker Range	Wariu Valley	3 970	9 800
	Papar Valley	2 060	5 100
	Kadamaian Valley	1 460	3 600
	Tuaran Valley	1 090	2 700
Crocker Foothills	Pinawantai	890	2 200

PLATE 3.2 Degraded terrace soils on the Bengkoka Peninsula, Mangkubou area

Soils developed on floodplains

These are associated with the larger rivers of the seaboard. Inundation by floodwaters happens rarely but the soils are predominantly very poorly to poorly drained, constituting a serious limitation to agriculture. Much of the land is used for wet padi cultivation.

Soil parent materials are predominantly medium to fine textured alluvium. In some places the riverine alluvium overlies at depth old beach sands and sometimes peat deposits.

Without their inferior drainage, these soils would offer a good substratum for most agricultural plants, being deep, stoneless, medium to fine textured and with moderate levels of plant nutrients. An account of their general distribution is given in Table 14.

TABLE 14 The major occurrences of Group 3 soils developed on floodplains

Region	Area	Extent	
		ha	ac
Crocker Plains	Kota Marudu	6 720	16 600
	Kota Belud	5 220	12 900
	Pandasan	3 800	9 400
	Papar	2 630	6 500
	Penampang	2 140	5 300
	Tuaran	2 140	5 300
	Bongawan	2 100	5 200
	Mengattal	970	2 400
	Tenghilan	930	2 300
Bengkoka Lowlands	Pitas	5 620	13 900

Soils developed in freshwater swamps

In the low-lying tributary valleys between the floodplains and hills, and sometimes between the tidal swamps and hills, small areas of back-swamps are found. These are never extensive, a total of 4 800 ha (11 200 ac) only being found in the residencies. By far the largest area, and the only one warranting special mention, forms the Gana Plain south-east of Kota Marudu, where some 1 400 ha (3 500 ac) have been mapped.

The soils are very poorly drained, and swamp conditions prevail except during exceptionally dry periods; their generally low physiographic position makes drainage works frequently difficult. The soils are formed predominantly of medium to fine textured alluvium although very localised peat deposits may occur. Otherwise they have the same general characteristics as the related floodplain soils.

Soils developed on stranded beaches

These consist of coral and shell debris in the form of stranded ridges and swales, and are restricted to relatively small beach areas on Pulau Mengalum and Pulau Mantanani Besar, where they occupy some 300 ha (700 ac) and 150 ha (400 ac) respectively.

The soils consist of calcareous sand, and the soil drainage depends on the local topography; poor in the swales and imperfect on the strand ridges.

The main factors limiting agricultural development of these soils are their extremely coarse texture, a serious limitation, together with the poor drainage of the swales. Otherwise, being developed on an easy terrain and endowed with high levels of plant nutrients, they afford a favourable medium for most agricultural crops.

SOIL SUITABILITY GROUP 4 MORE THAN ONE SERIOUS LIMITATION

Soils developed on terraces

Stretches of the seaboard on the Kudat and Bengkoka peninsulas and much of the eastern part of Pulau Balambangan are marked by marine terraces with extensive areas of podzols. Their surfaces are generally flat to slightly concave and are bounded by short sharp slopes rarely more than 15 m (50 ft) in amplitude. Similar terraces, but of riverine origin, occur inland, particularly on the Ranau Plain; but they are far less extensive.

The podzols consist essentially of layers of white, almost sterile, sand which may reach a thickness of 6 – 9 m (20 – 30 ft), e.g. on Pulau Balambangan, overlying dark, frequently hard, horizons (Plate 3-3). The underlying alluvium is generally composed of sand on the coastal terraces, and is fine to medium textured inland. Soil drainage is variable, predominantly poor except in depressions where it may be very poor.

It will be seen, therefore, that the factors seriously limiting these soils with regard to agriculture are the low plant nutrient status and coarse texture. Shallowness, due to the presence of an indurated layer, and very poor drainage may be additional serious limitations in certain areas.

The largest areas of such soils are to be found on Pulau Balambangan where they occupy some 3 550 ha (8 800 ac), and on the Ranau Plain, 400 ha (1 000 ac).

Soils developed in tidal swamps

These are most extensive in the deltaic regions, although much of the littoral, particularly that of the Bengkoka Peninsula and Pulau Banggi, is marked by narrow strips of such soils.

Being close to sea-level they are very poorly drained, and periodic flooding by tidal waters frequently gives rise to saline soil conditions. The salinity and very poor drainage give rise to two serious limitations. In addition, extensive areas may contain high levels of sulphur; and it is likely that in many cases attempts to reclaim such land by draining will lead to excessive acidity levels. Agricultural development is not, therefore, recommended. The main areas are given in Table 15.

TABLE 15 The main occurrence of Group 4 soils developed in tidal swamps

Region	Area	Extent	
		ha	ac
Bengkoka Lowlands	Paitan Bay	11 330	28 000
	Kuala Bengkoka	7 970	19 700
	Bengkoka Peninsula (North)	3 240	8 000
Northern Islands	Pulau Banggi	9 710	24 000
	Pulau Malawali	1 010	2 500
	Pulau Balambangan	970	2 400
Crocker Plains	Kota Marudu	7 360	18 200
	Gaya Bay	5 990	14 800
	Sulaman Harbour	3 660	8 200
	Mengkabong	2 670	6 600
	Kota Belud	2 510	6 200
	Kawang-Kota Kinabalu	2 060	5 100
	Kudat Harbour	2 020	5 000
	Agal Bay	1 620	4 000
	Papar	1 250	3 100

PLATE 3.3 The sparse vegetation indicates the poor soil conditions of the podzols on Pulau Balambangan

PLATE 3.4 Stranded beaches and peat swamps on Pulau Balambangan

Soils developed on stranded beaches

These soils are related to the Group 3 stranded beach soils, but they differ mainly as the result of the mineralogy of the parent material; which in this case is quartz-sand.

The beaches include both those of the present day and relic features in the form of strands and swales some 1-3 m (3-9 ft) above sea level. Because of the low lying nature of these beaches the soils are affected by fluctuations in groundwater level. Those formed in the swales are usually poorly drained to swampy, while on the ridges the soils may be well drained (Plate 3-4).

Being composed of quartz the plant nutrient status is low which, together with the extreme coarseness, imposes two serious limitations for agriculture. Very poor drainage in the swales gives rise to an additional limitation. Their main distribution is given in Table 16.

TABLE 16 The main occurrences of Group 4 soils developed on stranded beaches

Region	Area	Extent	
		ha	ac
Crocker Plains	Tempasuk Plain	5 870	14 500
	Kimanis Bay	4 860	12 000
	Tuaran	2 180	5 400
	Sikuati	1 860	4 600
	Mengkabong	1 010	2 500
	Kota Kinabalu	1 010	2 500
Bengkoka Lowlands	Kuala Bengkoka	3 800	9 400
Northern Islands	Pulau Balambangan	2 270	5 600

SOIL SUITABILITY GROUP 5 VERY SERIOUS LIMITATION

Soils developed in peat swamps

These occur intermittently along the seaboard, both in backswamps inland from the stranded sandy beaches and in narrow valleys locked in by hills and riverine alluvial deposits.

Parent materials are dominantly peat with some mixtures of peat and alluvium. Peat depth is variable, generally deep, in excess of 1.2 m (4 ft), which is considered to be a very serious limitation. The peat is predominantly fibrous and is composed of partly decomposed remains of trees and sedges.

Strongly acid in reaction, most of the deep peats are sulphidic and the plant nutrient levels are generally low, giving rise to a serious limitation to agriculture. The main peat swamp areas are given in Table 17.

TABLE 17 The main peat swamp areas

Region	Area	Extent	
		ha	ac
Crocker Plains	Bongawan-Benoni	6 270	15 500
	Kota Belud	2 270	5 600
	Kawang	1 740	4 300
	Kota Kinabalu	1 500	3 700
Northern Islands	Pulau Balambangan	1 700	4 200

Soils developed on mountains and steeplands

These cover the Crocker Range, and the steeper parts of the Crocker Foothills, the Bengkoka Lowlands, the Kaindangan Peneplain and the Northern Islands. They are very extensive in the two residencies covering some 797 250 ha (1 970 000 ac) or 65% of the total area.

The soils are very variable, dependent largely on the nature of the parent rock material. They generally occur on slopes in excess of 25° and tend to be shallow; exceptions do occur, particularly with colluvial deposits associated with ultrabasic igneous rocks which may be of considerable depth and developed on gentler slopes. Such soils, however, are associated with toxicity problems for agricultural plants; a very serious limitation. Topographic factors in general, more than any other, very seriously limit their development prospects to such an extent that slopes in excess of 25° are not normally recommended for agriculture. Further, the mountains form the main water-catchments of the larger rivers, and disturbance of their vegetation and soil would be likely to give rise to serious flooding on their plains.

Soils developed on terraces

Group 5 soils of this type are restricted to the Pinosuk Plateau and cover an area of 7 100 ha (17 500 ac). The Plateau is marked by very steep and deep dissection, with slopes more than 25° and with an amplitude of relief frequently in excess of 150 m (500 ft). Parent materials consist of poorly consolidated, unsorted boulders and gravel in a sandy to clayey matrix which overlie sandstone and mudstone which are exposed on some valley sides and gorges.

The flatter areas are marked by podzols which, as described on page 43 are subject to a number of serious limitations; but the dominating feature of the Plateau as far as soil suitability is concerned is the steepness of the flanking slopes, which gives rise to a very serious limitation.

Forests and their timber resources

INTRODUCTION

Some 79.5% of the land is covered by forest but a considerable part of this, approximately 46.2%, is secondary forest of varying age following shifting cultivation and only 29.8% is lowland dipterocarp forest. Approximately 7.1% of the forest area is montane forest growing between 800 m (2 500 ft) and 1 500 m (5 000 ft) while a further 2.5% is upper montane forest growing above 1 500 m (5 000 ft). Where undisturbed by Man the lowland dipterocarp forest usually extends up to about 750 m (2 500 ft). Where structure and species composition begin to change, the commercial volume shows a marked decrease and the forest gradually becomes montane. The actual height at which this change occurs varies from place to place depending on topography, locality, aspect and other factors.

In general the lowland dipterocarp forest is fairly heterogeneous, with dipterocarps accounting for about 70-90% of the volume of commercial timber. However,total volume and species composition do vary,particularly between forest on flat lowland and on steep higher land, the latter generally having a higher volume and higher proportion of dipterocarps. The secondary forest which follows shifting cultivation exhibits considerable variation in composition and structure depending on age and altitude, but very little if any of it has any commercial value at present.

Both on account of species and volume composition and location, montane forest has little commercial value, and this applies even more so to upper montane forest.

Approximately 260 078 ha (642 656 ac) of stateland, forest reserve, national park and alienated land carry lowland dipterocarp forest, which is considered either commercial or having a commercial potential with an expected yield of the preferred dipterocarp species in excess of 35 m^3/ha (400 Hft^3/ac). Of this area some 24 800 ha (61 250 ac) carry Timber Resource Group 1 forest with an expected yield of more than 89 m^3/ha (1 000 Hft^3/ac), a further 155 500 ha (384 300 ac) carry Group 2 forest with an expected yield of 63-89 m^3/ha (700-1 000 Hft^3/ac), while approximately 77 700 ha (192 000 ac) carry Group 3 forest with an expected yield of 35-63 m^3/ha (400-700 Hft^3/ac). The balance of the area is commercial forest which has been logged but cannot be classified into the three groups because information on the yield is not available. Approximately 28 000 ha (69 000 ac) carry undisturbed lowland dipterocarp forest which is at present considered non-commercial on account of the expected low yield of merchantable timber i.e. less than 35 m^3/ha (400 Hft^3/ac). Much of the accessible commercial forest in forest reserves and on stateland is already under licence.

Some 68 800 ha (170 000 ac) in the altitude zone between 750 m and 1 500 m (2 500 ft and 5 000 ft) carry montane forest which is regarded as non-commercial on account of the low volume and species composition, while 25 000 ha (60 800 ac) occurring at altitudes above 1 500 m (5 000 ft) carry non-commercial upper montane forest.

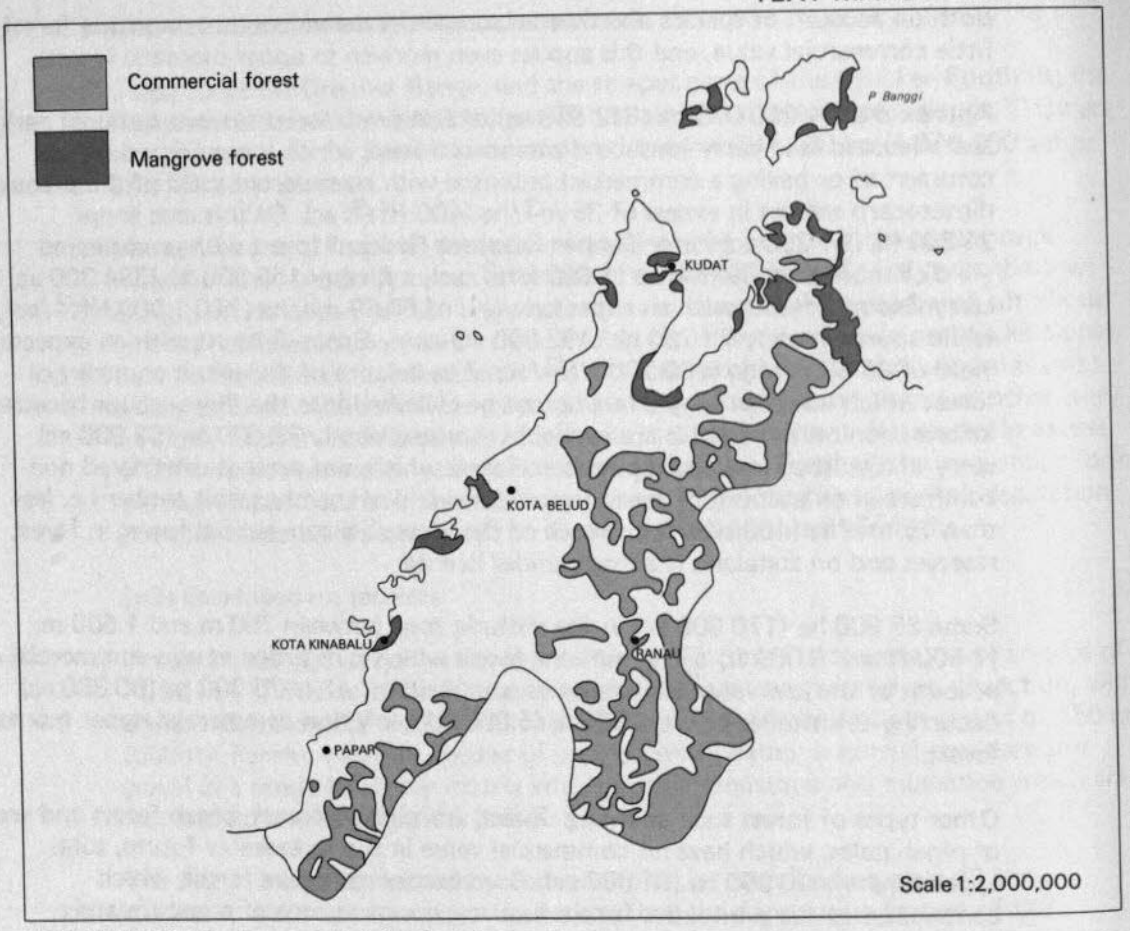
Other types of forest such as swamp forest, transitional forest, beach forest and areas of nipah palm, which have no commercial value in the foreseeable future, total approximately 20 800 ha (51 600 ac). Commercial mangrove forest, which contributes to the productive forest resource, covers an area of approximately 38 650 ha (95 500 ac).

The areas suited for commercial exploitation are shown in Text Map 3-12.

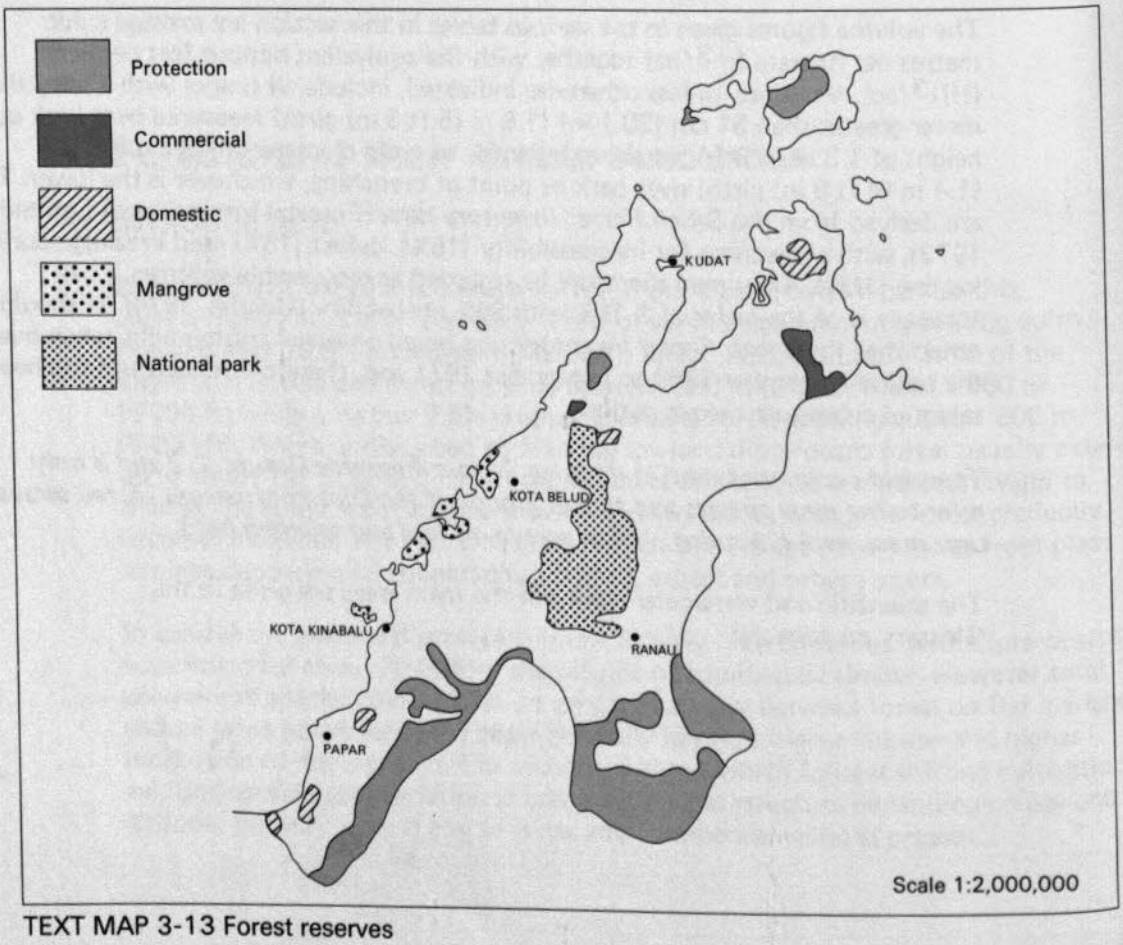
The volume figures given in the various tables in this section are average cubic metres per hectare (m^3/ha) together with the equivalent hoppus feet per acre (Hft^3/ac). Volumes, unless otherwise indicated, include all timber with a basal diameter greater than 51 cm (20.1 in) (1.6 m (5 ft 3 in) girth) measured over bark at a height of 1.3 m (4.3 ft), or above buttress, to a top diameter of 46 cm (18 in) (1.4 m (4 ft 8 in) girth) over bark or point of branching, whichever is the lower. They are derived from the *Sabah Forest Inventory* data (Forestal International Limited, 1973), with allowances for inaccessibility (15%), defect (15%), and breakage during logging (10%). They may therefore be regarded as recoverable volumes. Their accuracy is of the order of ± 15% with 95% probability (Udarbe, 1974). It should be noted that the *Sabah Forest Inventory* was based on aerial photographs taken over the period November 1969 to September 1971 and, therefore no account has been taken of subsequent exploitation.

The yield parameters used in defining Timber Resource Groups 1, 2 and 3 only refer to the main species and timber groups of the Dipterocarpaceae i.e. red seraya, urat mata, kapur, keruing, yellow seraya, melapi and selangan batu.

The scientific and vernacular names of the main trees are given in the Glossary on page xvi.



TEXT MAP 3-12 Areas suited for forestry



TEXT MAP 3-13 Forest reserves

D.O.S. 3238 Av

Prepared by the Directorate of Overseas Surveys

Of the total land area of the residencies, 16.9% is constituted as forest reserve of various classes and forms part of the permanent forest estate. The approximate location of these forest reserves except for the very small ones, is shown on Text Map 3-13,while Table 18 gives their distribution by classes. The forest reserves are classified as follows:

Class I	Protection forest reserves
Class II	Commercial forest reserves
Class III	Domestic forest reserves
Class IV	Amenity forest reserves
Class V	Mangrove forest reserves
V.J.R.	Virgin jungle forest reserves

TABLE 18 Forest reserves by classes in ha (ac)

Forest reserve classes						Total
I	II	III	IV	V	VJR	
168 977 (417 554)	12 340 (30 493)	16 060 (39 686)	0	5 279 (13 044)	134 (330)	202 790 (501 107)

In the remainder of this section the forest resources will be discussed and analysed under three major headings: (a) commercial forest (its composition and distribution); (b) the timber resources of each class of reserve (90% of commercial forest occurs in forest reserves); and (c) the timber resources of the statelands.

COMMERCIAL FORESTS : COMPOSITION AND DISTRIBUTION

From the point of view of timber production, the most important part of the forest resource is the considerable area of commercial lowland dipterocarp forest. Table 19 gives the distribution of this forest in forest reserves, stateland and national parks. Commercial forests also occur on alienated land, but they have not been taken account of as the area involved is very small and the land being alienated is committed for development. The fact that the commercial forest in the national parks is referred to and included in the Table should not be taken to mean that it is available for exploitation or that exploitation is recommended. It may be noted that Timber Resource Group 1 forest accounts for 9.6% of the total, Group 2 60.1%, Group 3 30.0% and unclassified forest 0.3% only. 99.2% of the commercial forest is undisturbed.

TABLE 19 Commercial forest in forest reserves, stateland and national parks

Timber resource group	Forest reserves		Stateland		National parks		Total	
	ha	ac	ha	ac	ha	ac	ha	ac
Group 1								
Undisturbed forest*	14 465	35 743	9 308	23 000	1 008	2 491	24 781	61 234
Group 2								
Undisturbed forest	60 308	149 023	77 887	192 461	15 362	37 959	153 557	379 443
Group 3								
Undisturbed forest	38 999	96 367	33 874	83 704	3 488	8 620	76 361	188 691
Disturbed forest**	19	46	1 324	3 271	4	10	1 347	3 327
Total	39 018	96 413	35 198	86 975	3 492	8 630	77 708	192 018
Groups 1, 2 and 3								
Undisturbed forest	113 772	281 133	121 069	299 165	19 858	49 070	254 699	629 368
Disturbed forest	19	46	1 324	3 271	4	10	1 347	3 327
Regenerating forest†	69	170	704	1 740	65	160	838	2 070
Total	113 860	281 349	123 097	304 176	19 927	49 240	256 884	634 765

*Undisturbed forest is, as far as is known, forest which has not been disturbed by any form of exploitation

**Disturbed forest is forest that has been selectively logged. The result is that while the forest may still carry sufficient volume of commercial timber to be classed in the appropriate resource group, the species composition is likely to be rather different from that of undisturbed forest

† Regenerating forest is forest that has been more intensively logged and is now regenerating. Although at present carrying an insignificant volume of commercial timber it undoubtedly has the potential to be classified as commercial.

Table 20 gives the average volume composition of the undisturbed Group 1, 2 and forest, included in Table 19, by timber resource groups and main species. Apart from Dipterocarpaceae, other timber groups and species with established merchantibility and good potential are included under other commercial species.

TABLE 20 Average composition of the undisturbed commercial forest

Main timber species	Timber resource group											
	1			2			3			Average		
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae												
Red seraya	56.7	636	32.2	25.3	284	28.3	15.8	177	24.3	25.5	286	
Urat mata	23.0	258	13.0	5.7	64	6.3	15.3	172	23.5	10.2	115	
Kapur	5.0	56	2.8	2.7	30	3.0	.1	1	.1	2.2	24	
Keruing	8.9	100	5.0	11.9	134	13.4	1.0	12	1.6	8.4	94	
Yellow seraya	37.4	420	21.2	5.6	63	6.3	6.4	72	9.9	8.9	100	
Selangan batu	23.8	268	13.5	14.0	158	15.7	9.6	108	14.8	13.6	153	
Melapi	2.3	26	1.3	2.0	22	2.2	2.1	23	3.2	2.0	23	
Other spp. of Dipterocarpaceae	3.3	37	1.9	3.5	39	3.9	.1	1	.1	2.5	28	
Total	160.4	1 801	90.9	70.7	794	79.2	50.4	566	77.5	73.3	823	
Other commercial spp.												
Belian	1.8	20	1.0	.9	10	1.0	0	0	0	.7	8	
Medang	1.8	20	1.0	3.3	37	3.7	5.4	61	8.3	3.8	42	
Leguminosae	5.7	64	3.2	3.8	43	4.3	.7	8	1.0	3.1	34	
Kedongdong	1.1	13	.7	1.6	18	1.8	.6	7	.9	1.2	14	
Nyatoh	.7	8	.4	1.4	16	1.6	.1	1	.1	.9	10	
Other spp.	4.9	55	2.8	7.6	85	8.4	7.8	87	12.2	7.5	85	
Total	16.0	180	9.1	18.6	209	20.8	14.6	164	22.5	17.2	193	
Total all commercial spp.	176.4	1 981	100	89.3	1 003	100	65.0	730	100	90.5	1 016	

Dipterocarps

It will be noted from Table 20 that the average total volume of commercial species decreases from 176.4 m^3/ha (1 981 Hft^3/ac) in Group 1 to 61.5 m^3/ha (690 Hft^3/ac) in Group 3 with an average of 90.5 m^3/ha (1 016 Hft^3/ac). The Group 1 forest, most of which occurs on hilly or steep land, carries on average a high volume of Dipterocarpaceae, 160.4 m^3/ha (1 801 Hft^3/ac), which is more than 90% of the total commercial volume and more than three times the volume of Dipterocarpaceae in Group 3 forest. The proportion of Dipterocarpaceae in the total commercial volume decreases to 79.2% in Group 2 forest and 77.5% in Group 3 with an average of 81.0%.

In all three groups,red seraya (Rubroshorea group of *Shorea*),which includes *majau* (*Shorea leptoclados*) and *obah suluk* (*S. pauciflora*), is the most abundant timber group and on average accounts for over 28% of the total volume. Other important timber groups are *selangan batu* (Shorea group of *Shorea*), *urat mata* (*Parashorea* spp.), yellow seraya (Richetia group of *Shorea*) and *keruing* (*Dipterocarpus* spp.). It is of interest to note the relative scarcity of *kapur* (*Dryobalanops* spp.) and its almost complete absence in Group 3 forest. Included in the, 'other species of Dipterocarpaceae', are *gagil* and *selangan* (*Hopea* spp.), *pengiran* (*Anisoptera* spp.) and *resak* (*Vatica* and *Cotylelobium* spp.).

Other commercial species

Species other than Dipterocarpaceae, which are considered to be of commercial importance, account for between 9.1% (Group 1 forest) and 22.5% (Group 3 forest) of the total commercial volume, with an average of 19.0%. Compared with the Dipterocarps the actual volume of these species shows much less variation between the groups.

In general the volume of individual species and timber groups is insignificant and on average only two timber groups, namely *medang* (Lauraceae spp. other than *belian*) and *Leguminosae,* account for more than 2% of the total commercial volume. In the forests of the West Coast Residency the volume of *mengaris* (*Koompassia excelsa*) is quite insignificant, and it has not been considered separately.

The group 'other spp.' includes *binuang* (*Octomeles sumatrana*), *karai* (Annonaceae spp.), *kembang* (*Heritiera* spp.), species of Sterculiaceae other than Heritiera, *laran* (*Anthocephalus chinensis*), *kayu malam* (*Diospyros* spp.), *limpaga* (Meliaceae spp.), *jelutong* (*Dyera* spp.) *durian* (*Durio* spp.), *ranggu* (*Koordersiodendron pinnatum*), *pulai* (*Alstonia* spp.), *putat paya* (*Planchonia valida*), *bintangor* (*Calophyllum* spp.), *serungan* (*Cratoxylum arborescens*), *takalis* (*Pentace* spp.), *senkuang* and *layang layang* (Anacardiaceae spp. other than spp. of *Gluta, Melanorrhoea, Swintonia, Mangifera* and *Koordersiodendron pinnatum*).

Although all the other commercial species are considered to have established merchantibility and good potential, many are not at present utilised. The generally low unit area volumes make them unattractive for the export market, and lack of information about their properties and uses, or difficulty in conversion make them unpopular for local use. In some cases, and in particular with *medang*, most of the trees belong to the understorey and many do not reach the minimum girth size for consideration as commercial timber by current standards. If, however, lower basal and top diameter limits were taken then the volume of timber available would be considerably larger.

TIMBER RESOURCES OF THE FOREST RESERVES

It will have been noted from Table 19 that a considerable part of the commercial forest is found in forest reserves which have been classified in Table 18 according to their main functions. The resources of the different classes of forest reserve are now analysed.

Class I Protection forest reserves

There are 14 Class I, Protection forest, reserves varying in size from 121 ha (300 ac) to 69 281 ha (171 196 ac). The distribution of the larger reserves is shown on Text Map 3-12; though the scale of the map makes it impossible to show the smaller reserves. As indicated in Table 18 the total area amounts to 168 977 ha (417 554 ac), some 83% of the area under forest reserve. The main purpose of maintaining forest cover in these areas is the protection of water catchments and the prevention of soil erosion on steepland. As might be expected the greater part of these forests are located on hilly and mountainous terrain. The major reserves together with the main reasons for their establishment are listed below:

1.	Crocker Range	To protect the headwaters and catchment areas of rivers and streams flowing off the Crocker Range and minimise erosion of unstable soils
2.	Trus Madi	To protect the headwaters and catchment areas of the Karamuak, Kegibongan and Bidon rivers and other streams rising in the north eastern part of the Trus Madi Range, and to minimise the erosion of unstable soils
3.	*Ulu Tungud	To protect the headwaters and catchment areas of the Tungud, Kaingaran and Merali rivers and other streams rising in the western sector of the Meliau Range; also to minimise the erosion of unstable soils
4.	Banggi	To minimise the erosion of unstable soils
5.	Mt. Cochrane	To protect the watershed and minimise the erosion of unstable soils

Commercial forests in Class I reserves

Considerable areas of protection forest carry commercial timber stands and these have been classified accordingly (Table 21).

TABLE 21 Distribution of Timber Resource Groups 1, 2 and 3 in Class I, Protection forest reserves

Timber resource group	Undisturbed		Disturbed		Total	
	ha	ac	ha	ac	ha	ac
1	10 857	26 829	0	0	10 857	26 829
2	50 162	123 951	0	0	50 162	123 951
3	37 483	92 621	4	10	37 487	92 631
Total	98 502	243 401	4	10	98 506	243 411

Although some 98 506 ha (243 411 ac) carry commercial stands of timber this forest cannot really be considered as commercial forest since in general logging is not allowed in protection forest; though in some areas restricted and carefully controlled exploitation may be permitted. The average composition of the undisturbed forest in Groups 1, 2 and 3 is given in Table 22.

*Most of this reserve falls within the boundary of the Sandakan Residency, which has been reported on in the previous volume.

TABLE 22 Average composition of undisturbed Group 1, 2 and 3 forest in Class I reserves

Main timber species	Timber resource group									Average		
	1			2			3					
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae												
Red seraya	57.7	648	31.9	28.7	322	32.2	15.9	178	24.5	27.0	304	30.0
Urat mata	25.7	288	14.2	4.8	54	5.4	16.5	185	25.4	11.5	128	12.7
Kapur	2.8	31	1.5	2.0	22	2.2	0	0	0	1.3	15	1.5
Keruing	6.7	75	3.7	7.1	80	8.0	.1	1	.2	4.4	50	4.9
Yellow seraya	41.7	468	23.0	5.6	63	6.3	6.7	76	10.3	10.0	112	11.1
Selangan batu	25.1	282	13.9	13.8	155	15.5	9.2	103	14.1	13.3	149	14.8
Melapi	2.3	26	1.3	1.7	19	1.9	2.1	24	3.2	1.9	22	2.1
Dipterocarpaceae	3.9	44	2.2	4.1	46	4.6	0	0	0	2.5	28	2.8
Total Dipterocarpaceae	165.9	1 862	91.7	67.8	761	76.0	50.5	567	77.7	71.9	808	79.8
Other commercial spp.												
Belian	1.6	18	.9	.6	7	.7	0	0	0	.5	5	.5
Medang	1.8	20	1.0	4.7	53	5.3	5.8	65	8.9	4.8	54	5.3
Leguminosae	5.3	59	2.9	3.5	39	3.9	.4	4	.6	2.5	28	2.8
Kedongdong	1.1	13	.6	2.1	24	2.3	.6	7	.9	1.5	16	1.6
Nyatoh	.5	6	.3	1.5	17	1.7	0	0	0	.8	9	.9
Other spp.	4.8	54	2.6	9.0	101	10.1	7.7	87	11.9	8.1	92	9.1
Total other commercial spp.	15.1	170	8.3	21.4	241	24.0	14.5	163	22.3	18.2	204	20.2
Total all commercial spp.	181.0	2 032	100	89.2	1 002	100	65.0	730	100	90.1	1 012	100

Table 22 shows that the Group 1 forest carries, on average, a very high volume of Dipterocarpaceae 165.9 m^3/ha (1 862 Hft^3/ac) which is more than 91% of the total commercial volume and more than three times the volume of Dipterocarpaceae in Group 3 forest. The proportion of Dipterocarpaceae in the total commercial volume decreases to 76.0% in Group 2 forest and 77.7% in Group 3 with an average of 79.8%.

In Group 1 and 2 forest red seraya is the most abundant timber group while in Group 3 forest it occupies second place, *Urat mata* being slightly more abundant. On average it accounts for 30.0% of the total volume. Other important timber groups are *selangan batu, urat mata* and yellow seraya. These four main timber groups account for 68.5% of the total volume. The volume of *kapur* is on average very low and in Group 3 forest it is too small to be recorded.

The proportion of other commercial species in the total volume varies between 8.3% in Group 1 and 24.0% in Group 2 with an average of 20.2%. However the actual volumes show considerably less variation between groups than the volumes of Dipterocarpaceae.

Medang is the most abundant of the timber groups in the other commercial species accounting for 5.3% of total volume on average while Leguminosae accounts for 2.8%. The volumes of the other species and groups are insignificant.

The very high average total volume of the Group 1 forest in the protection reserves emphasises the fact that lowland dipterocarp forest reaches optimum development on relatively steeply sloping higher land and not on the flat lowlands.

Non-commercial forest in the Class I reserves

Lowland dipterocarp forest with an expected yield of less than 35 m^3/ha (400 Hft^3/ac) covers some 6 698 ha (16 550 ac). Non-commercial montane forest on land between 750 m and 1 500 m (2 500 ft–5 000 ft) covers 33 644 ha (83 134 ac), while non-commercial upper montane forest above 1 500 m (5 000 ft) covers 3 202 ha (7 912 ac). The average volume composition of montane and upper montane forest is given in Tables 23 and 24 respectively. Volume figures are given for the non-commercial species *berangan, mempening* and *obah* which become relatively abundant in montane and upper montane forest, particularly *mempening* in the latter.

If the basal and top diameter limits for the timber groups and species of the montane forests are reduced respectively to 35.8 cm (14.1 in) and 30.5 cm (12 in) then the total volume of all commercial species rises to 51.2 m^3/ha (575 Hft^3/ac) and that of Dipterocarpaceae and other commercial species to respectively 20.5 m^3/ha (230 Hft^3/ac) and 30.7 m^3/ha (345 Hft^3/ac).

Likewise, if the basal and top diameter limits for the upper montane forests are similarly reduced then the total volume of commercial species increases to 21.9 m^3/ha (246 Hft^3/ac) and that of Dipterocarpaceae and other commercial species to respectively 2.0 m^3/ha (23 Hft^3/ac) and 19.9 m^3/ha (223 Hft^3/ac).

TABLE 23 Average composition of montane forest in forest reserves, national parks and stateland

Main timber species	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae			
Red seraya	7.6	85	26.6
Urat mata	1.2	14	4.2
Kapur	.2	2	.7
Keruing	.2	2	.7
Yellow seraya	2.7	30	9.4
Selangan batu	.4	4	1.4
Hopea	.2	2	.7
Resak	1.2	14	4.2
Other spp. of Dipterocarpaceae		0	
Total Dipterocarpaceae	13.7	154	47.9
Other commercial spp.			
Nyatoh	6.7	75	23.4
Medang	2.7	31	9.4
Leguminosae	2.2	24	7.7
Kedongdong	.1	1	.4
Others	3.2	36	11.2
Total other commercial spp.	14.9	167	52.1
Total all commercial spp.	28.6	321	100

Important non-commercial species are as follows:

	m^3/ha	Hft^3/ac
Berangan (*Castanopsis* spp.)	2.0	23
Mempening (*Lithocarpus* and *Quercus* spp.)	1.7	19
Obah (*Eugenia* spp.)	2.3	26

TABLE 24 Average composition of upper montane forest in forest reserves, national parks and stateland

Main timber species	Vol/ha m^3	Vol/ac Hft^3	%
Resak	1.7	19	16.0
Nyatoh	3.0	33	28.3
Medang	2.7	30	25.5
Leguminosae	0	0	0
Kedongdong	1.0	11	9.4
Others	2.2	26	20.8
Total all commercial spp.	10.6	119	100
		m^3/ha	Hft^3/ac
Important non-commercial species: *Berangan*		0.7	8
Mempening		11.7	131
Obah		2.2	25

Non-commercial mangrove forest covers 53 ha (130 ac) while secondary forest following shifting cultivation and other non-forest land covers 26 874 ha (66 615 ac).

Class II Commercial forest reserves

The object of the Class II, Commercial forest, reserves is the supply of timber and other forest produce to meet the general demands of trade and industry. As indicated in Table 18 there are only 12 340 ha (30 493 ac) of this class of reserve in the West Coast and Kudat Residencies and their location is shown on Text Map 3-12. It will be noted from the map that the largest of the four areas of commercial forest is situated on the Kaindangan Peneplain and Bengkoka Lowlands. This is in fact part of the Paitan Forest Reserve, most of which falls in the Sandakan Residency. As such it was included in the northern part of that residency for inventory purposes and falls in a different sampling unit to the forest in the residencies. Of the other areas of commercial forest reserve only a small proportion contains commercial forest and this is in the Ulu Kukut Forest Reserve.

Commercial forests in Class II reserves

The total area of undisturbed forest in Timber Resource Groups 1, 2 and 3 (in the commercial forest reserves) amounts to 8 097 ha (20 008 ac) which is distributed as shown in Table 25. The average composition of undisturbed forest is given in Table 26.

TABLE 25 Distribution of undisturbed forest in Class II, Commercial forest reserves

Timber resource group	Area	
	ha	ac
1	2 948	7 285
2	5 077	12 544
3	72	179
Total	8 097	20 008

26 Average composition of undisturbed commercial forest in Class II, Commercial forest reserves

mber species	Timber resource group											
	1			2			3			Average		
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
ocarpaceae												
seraya	41.9	471	29.3	19.3	217	23.5	15.9	179	24.5	27.6	310	26.4
t mata	10.8	121	7.5	2.9	33	3.5	16.5	186	25.5	5.9	67	5.7
ur	15.8	177	11.0	6.7	75	8.1	0	0	0	9.9	111	9.5
uing	33.4	375	23.4	20.7	232	25.1	0	0	0	25.2	283	24.1
ow seraya	12.9	145	9.0	5.4	61	6.6	6.8	76	10.4	8.2	92	7.8
ngan batu	9.9	111	6.9	8.7	97	10.5	9.1	102	14.1	9.1	102	8.7
api	3.1	35	2.2	1.2	13	1.4	2.1	24	3.2	1.9	21	1.8
er spp. of terocarpaceae	1.9	21	1.3	1.5	17	1.9	0	0	0	1.6	18	1.6
al	129.7	1 456	90.6	66.4	745	80.6	50.5	567	77.7	89.4	1 004	85.6
commercial spp.												
an	.5	6	.4	1.5	17	1.9	0	0	0	1.1	13	1.1
lang	1.4	16	1.0	.7	7	.8	5.8	65	9.0	1.0	11	.9
uminosae	3.0	34	2.1	6.0	68	7.3	.4	4	.6	4.9	55	4.7
longdong	1.3	15	.9	.9	10	1.1	.6	7	1.0	1.0	12	1.0
atoh	.5	6	.4	1.4	16	1.7	0	0	0	1.0	12	1.0
er spp.	6.7	74	4.6	5.5	62	6.6	7.7	87	11.7	6.1	66	5.7
al	13.4	151	9.4	16.0	180	19.4	14.5	163	22.3	15.1	169	14.4
ll commercial	143.1	1 607	100	82.4	925	100	65.0	730	100	104.5	1 173	100

The area of Group 3 forest is so small that more detailed discussion of its composition is not warranted. The absence of *kapur* and *keruing*, however, does indicate a difference in general type between the commercial forest in the Ulu Kukut Forest Reserve which comprises all the Group 3 forest and nothing else and the forest in the Paitan Forest Reserve which includes all the Group 1 forest and the greater part of the Group 2.

It will be seen from Table 26 that the average total commercial volume in Group 1 forest is 143.1 m^3/ha (1 607 Hft^3/ac) and in Group 2 82.4 m^3/ha (925 Hft^3/ac) with an average, including Group 3 forest, of 104.5 m^3/ha (1 173 Hft^3/ac). Dipterocarpaceae account for 90.6% of this total volume in Group 1 forest and 80.6% in Group 2 with an average, including Group 3, of 85.6%.

Red seraya and *keruing* are by far the most important timber groups in both Group 1 and Group 2 forest indicating that the forest is the Rubroshorea/*Dipterocarpus* type (Fox, 1972). Other timber groups of some importance are *kapur, selangan batu* and yellow seraya.

Among the other commercial species the only named timber group which exceeds 2% of the total commercial volume in either Group is the Leguminosae. The volumes of the other named species and timber groups are insignificant.

Non-commercial forests in the Class II reserves

There are 64 ha (157 ac) of lowland dipterocarp forest with an expected yield of less than 35.6 m^3/ha (400 Hft^3/ac) and 301 ha (745 ac) of non-commercial swamp forest. Shifting cultivation and associated regrowth, grassland and other non-forest land cover 3 601 ha (8 899 ac) while plantations cover 262 ha (648 ac).

Class III Domestic forest reserves

The object of domestic forest reserves is to supply timber and other forest produce for local requirements. Eleven domestic forest reserves, varying in size from 6 316 ha (15 607 ac) to 16 ha (40 ac), amount to 16 060 ha (39 686 ac). The distribution of the timber resource groups in these reserves is given in Table 27.

TABLE 27 Distribution of timber resource groups in Class III, Domestic forest reserves, in ha (ac)

Timber resource group							Total
1	2	3	4	5	6	7	
659 (1 629)	5 568 (13 759)	1 444 (3 567)	1 808 (4 467)	3 275 (8 093)	70 (174)	3 236 (7 997)	16 060 (39 686)

Commercial forest in Class III reserves

It may be noted from Table 27 that only 47.8% of the total area carries commercial forest, the average composition of which is given in Table 28. Of this commercial forest, 79.6% occurs in the Bengkoka Forest Reserve and a further 15.8% in the Tagaroh Forest Reserve. Thus most of the domestic forest reserves carry very little commercial forest.

TABLE 28 Average composition of undisturbed commercial forest in Class III, Domestic forest reserves

Main timber species	Timber resource group											
	1			2			3			Average		
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae												
Red seraya	68.0	763	46.0	17.7	199	20.5	14.0	157	21.8	21.3	239	24.4
Urat mata	8.9	100	6.0	6.1	68	7.1	7.2	81	11.2	6.5	73	7.5
Kapur	.4	5	.3	2.7	30	3.1	.7	8	1.1	2.1	24	2.4
Keruing	5.3	60	3.6	18.9	212	22.0	9.3	104	14.5	15.9	179	18.2
Yellow seraya	12.4	139	8.4	5.5	62	6.4	3.9	44	6.1	5.8	65	6.7
Selangan batu	22.1	248	14.9	14.1	158	16.4	13.7	154	21.3	14.7	165	16.9
Melapi	1.8	20	1.2	2.1	24	2.4	1.7	19	2.6	2.0	23	2.3
Other app. of Dipterocarpaceae	2.5	28	1.7	3.1	35	3.6	1.4	16	2.2	2.8	31	3.1
Total	121.4	1 363	82.1	70.2	788	81.5	51.9	583	80.8	71.1	799	81.5
Other commercial spp.												
Belian	7.0	79	4.7	1.2	13	1.4		0		1.5	17	1.7
Medang	2.6	29	1.8	1.9	22	2.2	2.5	28	3.9	2.1	23	2.4
Leguminosae	9.1	102	6.1	4.4	49	5.1	2.6	29	4.1	4.5	50	5.1
Kedongdong	.8	9	.5	1.1	12	1.3	.6	6	.9	1.0	11	1.1
Nyatoh	2.3	26	1.6	1.2	14	1.4	.4	5	.6	1.2	13	1.4
Other spp.	4.7	53	3.2	6.1	69	7.1	6.2	70	9.7	5.8	67	6.8
Total	26.5	298	17.9	15.9	179	18.5	12.3	138	19.2	16.1	181	18.5
Total all commercial spp.	147.9	1 661	100	86.1	967	100	64.2	721	100	87.2	980	100

The total volume of commercial timber varies from 147.9 m^3/ha (1 661 Hft^3/ac) in Timber Resource Group 1 to 64.2 m^3/ha (721 Hft^3/ac) in Group 3, with an average of 87.2 m^3/ha (980 Hft^3/ac). The proportion of Dipterocarpaceae in the total volume is very similar in all three groups, with an average of 81.5%.

In the Group 1 forest, most of which occurs in the Bengkoka Forest Reserve, the red seraya timber group is predominant while *kapur* is almost non-existent. Other important timber groups are *selangan batu*, yellow seraya and *urat mata* while among the other commercial species *belian* is relatively abundant and Leguminosae contributes a significant volume. In the Group 2 forest most of which also occurs in the Bengkoka Forest Reserve the two most important timber groups are red seraya and *keruing* indicating that the forest is the Rubroshorea/*Dipterocarpus* type of Fox (1972). Other important timber groups are *selangan batu, urat mata* and yellow seraya. Among the other commercial species Leguminosae is the only group which accounts for a significant volume. In the Group 3 forest, of which 59% is in the Tagaroh Forest Reserve and 33% in the Bengkoka Forest Reserve, red seraya and *selangan batu* are the two most important timber groups while *keruing, urat mata* and yellow seraya contribute significant volumes but none of the other commercial species do. The volume of *kapur* in this forest is very low and *belian* is not recorded. When the three forest groups are considered together red seraya is the most important timber group followed by *keruing* and *selangan batu.*

Class V Mangrove forest reserves

There are three Class V, Mangrove forest, reserves (see Text Map 3-12) which cover a total area of 5 279 ha (13 044 ac). Of this area 2 824 ha (6 978 ac) is productive mangrove, 1 969 ha (4 866 ac) non-commercial mangrove and 486 ha (1 200 ac) logged-over mangrove. The composition of the productive mangrove forest is given in Table 29.

TABLE 29 Composition of the productive mangrove forest in mangrove forest reserves

Species	Vol/ha m^3	Vol/ac Hft^3	%
Bakau (Rhizophora mucronata)	22.7	255	39.8
Bangkita (Rhizophora conjugata)	18.9	212	33.1
Beus (Bruguiera spp.*)*	1.6	18	2.8
Tengar (Ceriops tagal)	1.1	12	1.9
Api Api (Avicennia spp.*)*	1.0	11	1.7
Prepat (Sonneratia alba)	2.2	25	3.9
Other species*	9.6	108	16.8
Total	57.1	641	100

*These include *buta buta (Excoecaria agallocha)* and *geriting (Lumnitzera* spp.*)*

Volume figures are derived from *Sabah Forest Inventory* data (Forestal International Ltd, 1973). Volumes are calculated on the basis of gross stem volume inside bark of all trees 9 cm (3.5 in) diameter and larger (diameter measured over bark at 70 cm (2.3 ft) above stump height, which is 61 m (2 ft) above ground level or top of stilt roots), to a top diameter of 5 cm (2 in) inside bark. Stem volumes include any merchantable pieces of branchwood of 1.2 m (4 ft) or longer. An allowance of 11.3% has been made for defect.

Bakau and *bangkita* are the most important commercial species as they are preferred for the purpose of chipping for pulp and for most other uses e.g. piling, building poles, firewood and charcoal. *Beus* and *tengar* are also acceptable for chipping and for some other uses. Other mangrove species are of little commercial value at present apart from *geriting*, which is used for salt water piling.

V.J.R. Virgin jungle reserves

Virgin jungle reserves are areas inside other forest reserves, which are set aside to remain permanently undisturbed. Their purpose is to serve as samples of the original jungle, unaffected by Man, and as gene-pools for the future when the rest of the primary forest has been lost. This type of reserve is also used for research work particularly that concerned with the composition, structure and growth of the primary forest. Their total area in the West Coast and Kudat Residencies is only 134 ha (330 ac). Of this, 117 ha (290 ac) falls in Group 2 commercial forest with *keruing*, red seraya and *selangan batu* as the main timber groups, while the balance falls in Group 4 non-commercial lowland dipterocarp forest.

TIMBER RESOURCES OF THE STATELANDS

There are extensive areas of lowland dipterocarp forest, both commercial and non-commercial, in the statelands, and as there has to-date been little logging most of the commercial forest is undisturbed. However, much of the non-commercial forest can be directly attributed to the effects of shifting cultivation, giving rise to large areas of secondary forest where originally there was lowland dipterocarp forest. Other non-commercial forest includes freshwater swamp forest, montane and upper montane forest. There is in addition a substantial area of productive mangrove forest which forms a part of the forest resource. The various types of forest, particularly those of commercial importance, are discussed in the following text.

Commercial forests in the statelands

As shown in Table 19 the area of commercial forest on stateland amounts to 123 097 ha (304 176 ac). Most of this is undisturbed forest and there is only a relatively small area of disturbed and regenerating forest. The average composition of the undisturbed forest is given in Table 30.

TABLE 30 **Average composition of undisturbed commercial forest on stateland**

Main timber species	Timber resource group											
	1			2			3			Average		
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae												
Red seraya	62.3	700	32.9	23.9	268	26.4	15.8	177	24.3	24.5	275	27.0
Urat mata	26.6	299	14.1	6.6	74	7.3	14.7	165	22.6	10.4	116	11.4
Kapur	2.6	29	1.4	3.0	34	3.3	.2	3	.3	2.2	25	2.4
Keruing	4.5	51	2.4	14.6	164	16.1	1.3	14	2.0	10.1	114	11.1
Yellow seraya	44.4	499	23.4	5.6	62	6.2	6.2	70	9.5	8.7	98	9.6
Selangan batu	25.9	290	13.7	14.7	165	16.2	9.6	107	14.8	14.1	159	15.5
Melapi	2.7	30	1.4	2.2	25	2.4	1.9	22	2.9	2.2	25	2.4
Other spp. of Dipterocarpaceae	3.1	35	1.6	3.2	36	3.6	.2	2	.3	2.4	26	2.6
Total	172.1	1 933	90.9	73.8	828	81.5	49.9	560	76.7	74.6	838	82.0
Other commercial spp.												
Belian	2.2	25	1.2	1.1	13	1.2	0	0	0	.9	10	1.0
Medang	1.9	21	1.0	2.4	27	2.7	5.3	59	8.1	3.2	36	3.5
Leguminosae	6.3	71	3.3	4.0	45	4.4	.9	10	1.4	2.8	31	3.1
Kedongdong	1.2	14	.6	1.2	14	1.3	.6	7	.9	1.0	11	1.1
Nyatoh	.7	8	.4	1.3	15	1.4	.2	2	.3	.9	10	1.0
Other spp.	5.0	55	2.6	6.7	74	7.5	8.2	93	12.6	7.6	86	8.3
Total	17.3	194	9.1	16.7	188	18.5	15.2	171	23.3	16.4	184	18.0
Total all commercial spp.	189.4	2 127	100	90.5	1 016	100	65.1	731	100	91.0	1 022	100

It will be noted that the average total commercial volume decreases from 189.4 m^3/ha (2 127 Hft^3/ac) in Group 1 forest to 65.1 m^3/ha (731 Hft^3/ac) in Group 3, with an average of 910 m^3/ha (1 022 Hft^3/ac). The Group 1 forest of which there are some 9 308 ha (23 000 ac) carries a very high commercial volume over 90% of which is composed of dipterocarps; most of this forest occurs on steepland. The proportion of dipterocarps in Group 2 and 3 forest is respectively 81.5% and 76.7%, with an average for the three groups of 82.0%. In all three forest groups red seraya is the most important timber group while other important timber groups are *selangan batu, urat mata, keruing* and yellow seraya. These forests carry only a low volume of *kapur.*

The volume of other commercial species is similar in all three forest groups varying from 17.3 m^3/ha (194 Hft^3/ac) in Group 1 to 15.2 m^3/ha (171 Hft^3/ac) in Group 3, with an average of 16.4 m^3/ha (184 Hft^3/ac). In general the volume contributed by the individual species and timber groups is not significant. On average *medang* and Leguminosae are the two most abundant timber groups and account for 3.5% and 3.1% respectively of the total commercial volume.

Non-commercial forests in the statelands

In the statelands there are approximately 17 900 ha (44 200 ac) of undisturbed lowland dipterocarp forest with an expected yield of less than 35.6 m^3/ha (400 Hft^3/ac), (Timber Resource Grouo 4). Non-commercial montane and upper montane forest (Group 5) respectively cover some 8 300 ha (20 600 ac) and 680 ha (1 650 ac). The average composition of these two latter types of forest is given in Tables 23 and 24. Non-commercial mangrove forest covers approximately 8 500 ha (20 900 ac), transitional forest 4 150 ha (10 250 ac), beach forest 2 900 ha (7 150 ac) and freshwater swamp forest 1 680 ha (4 160 ac) (Group 6). Secondary forest following shifting cultivation (Group 8) covers some 183 400 ha (453 200 ac).

Mangrove forests in the statelands

Productive mangrove forest (Group 7) covers an area of approximately 36 000 ha (89 000 ac), most of which is found in Marudu Bay and along the shores of the Kudat and Bengkoka Peninsulas. The average composition of this forest is given in Table 31.

TABLE 31 Average compsotion of the productive mangrove forest on stateland

Species	Vol/ha m^3	Vol/ac Hft^3	%
Bakau (Rhizophora mucronata)	25.7	289	36.2
Bangkita (Rhizophora conjugata)	31.1	349	43.8
Beus (Bruguiera spp.*)*	2.2	25	3.1
Tengar (Ceriops tagal)	1.2	13	1.6
Api Api (Avicennia spp.*)*	1.9	22	2.7
Buta Buta (Excoecaria agallocha)	.6	7	.9
Perepat (Sonneratia alba)	.5	5	.6
Other species (including *geriting*)	7.9	88	11.1
Total	71.1	798	100

The mangrove forests of the stateland contain an appreciably greater volume of commercial wood than those of the forest reserves; and this also applies to the two most important species, *bakau* and *bangkita.* This can be seen by comparing Tables 29 and 31.

TIMBER RESOURCES OF THE NATIONAL PARKS

The areas covered by this section are the Kinabalu National Park and its northward extension including what was previously the Mount Templer Forest Reserve, and Tungku Abdul Rahman National Park which was formerly the Pulau Gaya protection forest reserve. The greater part of the national parks carry undisturbed forest, though there is a small amount of secondary forest following shifting cultivation and a little current shifting cultivation. Commercial lowland and montane dipterocarp forest covers 24.7% of the area while non-commercial lowland dipterocarp, montane and upper montane forest covers 59.7%. The distribution of the timber resource groups is given in Table 32 and the main forest types discussed in the following text.

TABLE 32 Distribution of timber resource groups in the national parks in ha (ac)

Timber resource group							Total
1	2	3	4	5	7	8	
1 008 (2 491)	15 362 (37 959)	3 488 (8 620)	939 (2 321)	47 109 (116 407)	16 (40)	12 593 (31 118)	80 515 (198 956)

Commercial forests in the national parks

There are some 19 923 ha (49 230 ac) of commercial forest almost all of which is undisturbed; 63% is lowland dipterocarp forest and the rest montane forest. The average composition of the undisturbed forest is given in Table 33. There are also 16 ha (40 ac) of productive mangrove forest.

TABLE 33 Average composition of undisturbed commercial forest in national parks

Main timber species	Timber resource group											
	1			2			3			Average		
	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%	Vol/ha m^3	Vol/ac Hft^3	%
Dipterocarpaceae												
Red seraya	35.7	401	24.8	26.4	296	30.3	14.6	163	22.6	24.8	278	28.8
Urat mata	12.7	143	8.8	4.6	52	5.3	11.5	130	17.8	6.2	70	7.3
Kapur	6.8	76	4.7	1.9	21	2.2	0	0	0	1.8	21	2.1
Keruing	23.3	262	16.2	9.2	104	10.6	5.9	66	9.1	9.4	105	10.9
Yellow seraya	18.9	213	13.1	5.9	67	6.8	5.4	61	8.4	6.5	73	7.5
Selangan batu	21.4	240	14.8	13.3	149	15.2	12.7	143	19.7	13.6	152	15.8
Melapi	2.3	25	1.6	1.7	18	1.9	2.1	23	3.2	1.7	20	2.0
Other spp. of Dipterocarpaceae	3.6	41	2.5	4.1	46	4.7	.6	7	.9	3.5	39	4.0
Total	124.8	1 401	86.5	67.1	753	77.0	52.8	593	81.7	67.5	758	78.4
Other commercial spp.												
Belian	.5	6	.4	.6	7	.7	0	0	0	.5	6	.6
Medang	1.3	15	.9	4.0	45	4.6	4.1	46	6.3	3.8	43	4.5
Leguminosae	9.1	103	6.3	3.5	40	4.0	1.2	14	1.9	3.4	38	4.0
Kedongdong	1.5	17	1.0	2.0	22	2.3	.5	6	.8	1.7	19	2.0
Nyatoh	1.6	18	1.1	1.4	16	1.6	0	0	0	1.2	13	1.4
Other spp.	5.4	60	3.8	8.6	94	9.8	6.0	67	9.3	8.0	90	9.1
Total	19.4	219	13.5	20.1	226	23.0	11.8	133	18.3	18.6	209	21.6
Total all commercial spp.	144.2	1 620	100	87.2	979	100	64.6	726	100	86.1	967	100

The total commercial volume varies from 144.2 m^3/ha (1 620 Hft^3/ac) in Group 1 to 64.6 m^3/ha (726 Hft^3/ac) in Group 3, with an average of 86.1 m^3/ha (967 Hft^3/ac). The proportion of Dipterocarpaceae varies from 86.5% in Group 1 to 77.0% in Group 2, with an average of 78.4%, which is slightly lower than in commercial forest in forest reserves and stateland. In all three forest groups red seraya is the most important timber group making up, on average, more than 28% of the total commercial volume. Other important timber groups are *selangan batu* and *keruing* while yellow seraya and *urat mata* also contribute significant volumes. The volumes of the species and timber groups in the other commercial species are generally small and insignificant with *medang* and Leguminosae the most abundant, accounting for respectively 4.5% and 4.0% of the total volume.

Non-commercial forests in the national parks

There are 939 ha (2 321 ac) of lowland dipterocarp forest which are classed as non-commercial on account of an expected yield of commercial timber of less than 35.6 m^3/ha (400 Hft^3/ac). There are 26 749 ha (66 097 ac) of non-commercial montane forest and 20 360 ha (50 310 ac) of non-commercial upper montane forest. The average composition of these forests is given in Tables 23 and 24. The remaining area of 12 593 ha (31 118 ac) comprises mainly bare rock and secondary forest following shifting cultivation. There is little current shifting cultivation.

Water resources

The general climate has been discussed, and the rainfall at selected stations is shown on Text Map 3-3, in Part 2 of this report. It will have been noted that the rainfall is invariably high, ranging on the seaboard from about 3 580 mm (141 in) per annum at Bongawan in the south to 2 235 mm (88 in) at Kudat in the north. The rainfall increases with altitude on the western side of the Crocker Range at a rate of approximately 50 mm (2 in) for every 30 m (100 ft) (Bower *et al.*, 1975), giving rise to an average annual rainfall probably of the order of 3 450 mm (136 in) at Ulu Moyog to 4 928 mm (194 in) at Tonggol. The eastern flank of the Crocker Range falls in a rainshadow giving rise to the lower rainfall experienced at Kundasan, 2 032 mm (80 in), and Ranau, 2 286 mm (90 in), during the years of record.

It will also have been noted that the rainfall pattern follows seasonal peaks, during September to November in the south-west part, and during December and January in th north-east. Dry periods, i.e. months with less than 60 mm (2.4 in) (Trewartha, 1954) occur throughout the seaboard areas with the numbers progressively increasing to the north; while in the Crocker Range all times of the year can be considered as being wet (Tewartha, 1954). Rainfall can be intense, a figure as high as 219 mm (8.63 in) being recorded in one day in the Range, and over 100 mm (4 in) in a day at a number of places (Bower *et al.*, 1975).

Loss of water as the result of evaporation is high, but decreases with altitude. This is shown by the figure of 2 018 mm (79 in) * for Kota Kinabalu at 3 m (10 ft), and 1 448 mm (57 in) for Kundasan at 1 290 m (4 300 ft). This it can be seen that in the highlands, where rainfall is the highest and evaporation the lowest, and infiltration rates are not excessive, considerable amounts of water are available as surface runoff, and stream and river flow is continuous. With lower rainfall, higher evaporation and smaller catchments, the streams which drain the lowland areas are generally intermittent; and this is particularly seen in the Kudat and Bengkoka Peninsulas.

*This figure may somewhat exaggerate true evaporation due to the over-exposed site of the recording station (Manaf, 1974).

SURFACE WATER

The following account is based on a report contributed by the Sabah Drainage and Irrigation Department (Manaf, 1974).

The Crocker Range is the main water-catchment and is drained by many short rivers to the west and north. The eastern flank is drained by a number of tributary streams which give rise to the Labuk and Sugut Rivers, which have been described in the companion volume on the Sandakan Residency (Volume 2).

The longest of the rivers is the Bengkoka with a length of about 96 km (60 mi), the majority being no longer than 48 km (30 mi). The catchments are also small, by far the largest being that of the Bengkoka, some 852 km^2 (329 mi^2). The gradients are steep and stream flow rapid, and the information available indicates that the range of annual runoff is of the order of 1 470 mm (58 in) to 2 590 mm (102 in) (Table 34).

TABLE 34 Annual runoff for some rivers in the Crocker Range

River	Station	Run-off		Area of river basin (approx)			
				Above station		Total	
		mm	in	km^2	mi^2	km^2	mi^2
Bandau	Simpangas	1 471	57.90	225	87	275	106
Wariu	Kota Belud	2 386	93.93	236	91	401	155
Kadamaian	Kota Belud	2 587	101.87	357	138	456	176
Tuaran	Kiulu	2 571	101.23	689	266	989	382
Moyog	Penampang	2 228	87.70	186	72	272	105
Papar	Kaiduan	2 466	97.10	381	147	816	315
Papar	Kegapon	2 549	100.37	557	215	816	315

Estimates have been made of the discharge rates of two of these rivers (Snowy Mountains Hydro-electric Authority, 1963). In the middle reaches of the Papar River at Kaiduan, with a catchment area of about 381 km^2 (147 mi^2), the minimum flow is given as 3.1 cumecs (110 cusecs), the average annual flood 340 cumecs (12 000 cusecs), and the long term average flow 31.2 cumecs (1 100 cusecs), while the average flow of the Moyog River (1.6 km (1 mi) north of Madziang is estimated at 11.3 cumecs (400 cusecs).

All these rivers discharge onto alluvial plains before reaching the sea, but flooding is rare and of short duration, except in low-lying areas under tidal influence.

Many of the water catchments in the Kudat and Bengkoka Peninsulas are small and incapable of sustained yields. This is seen in the Kudat area where the town's supplies are obtained from a newly constructed reservoir. The situation is aggravated by much of the forest vegetation of the catchments being removed shifting cultivation.

GROUNDWATER

Generally the country rocks of the two residencies have a low porosity and permeability and prospects of using such groundwater resources as may exist are poor. The sole recorded extensive use of this source of water is that for Kudat town which, until fairly recently, obtained its supplies by pumping from a series of shallow wells in alluvium and coral limestone. These were low-yielding, and varied from sweet to brackish depending on rainfall and seawater pollution from adjoining tidal areas.

Grazing resources

There are quite considerable areas of natural grassland in the West Coast and Kudat Residencies, and in recent years there has been a growing interest in the improvement of this grassland by conversion to pasture for beef production.

PRESENT GRAZING LAND

The buffalo and cattle population of the residencies was estimated in 1970 at approximately 49 500 and 11 500 head respectively (Department of Agriculture, 1971). There is little or no established grazing provided by the owners for most of the buffalo and cattle which graze around the kampongs and in the padi fields after the rice crop is harvested. However some of the cattle are kept in cattle farms where there may be improved grazing. The natural grasslands generally afford only poor grazing. Locally extensive areas of sheet *lalang (Imperata cylindrica)* are regularly burnt to stimulate young regrowth for grazing. This young regrowth is of some nutritional value but it loses this with maturity and becomes almost inedible (Plate 3-5). In some areas centipede grass *(Ischaemium barbatum)*, which is of some value for grazing, does occur naturally.

There are 10 514 ha (26 101 ac) of grazing reserves but much of the area has not been developed for grazing. Table 35 shows the areas of improved pasture and grassland in the grazing reserves and areas of other land use according to land capability classes. It should be noted that much of the Class V land comprises stranded beaches and though they are not considered suitable for agriculture, and are probably not worth improving, they do provide useful rough grazing particularly for buffalo when they cannot be put into the padi fields (Plate 3-6).

TABLE 35 The grazing reserves, their land capability and present use

Land capability class	Improved pasture	Grassland		Other land use		Total	
		ha	ac	ha	ac	ha	ac
II	0	162	403	428	1 181	590	1 584
III	0	204	504	1 165	2 880	1 369	3 384
V	0	2 911	7 192	5 644	13 941	8 555	21 133
Total	0	3 277	7 974	7 237	18 002	10 514	26 101

The distribution of the grasslands and the location of the grazing reserves is shown in Text Map 3-14.

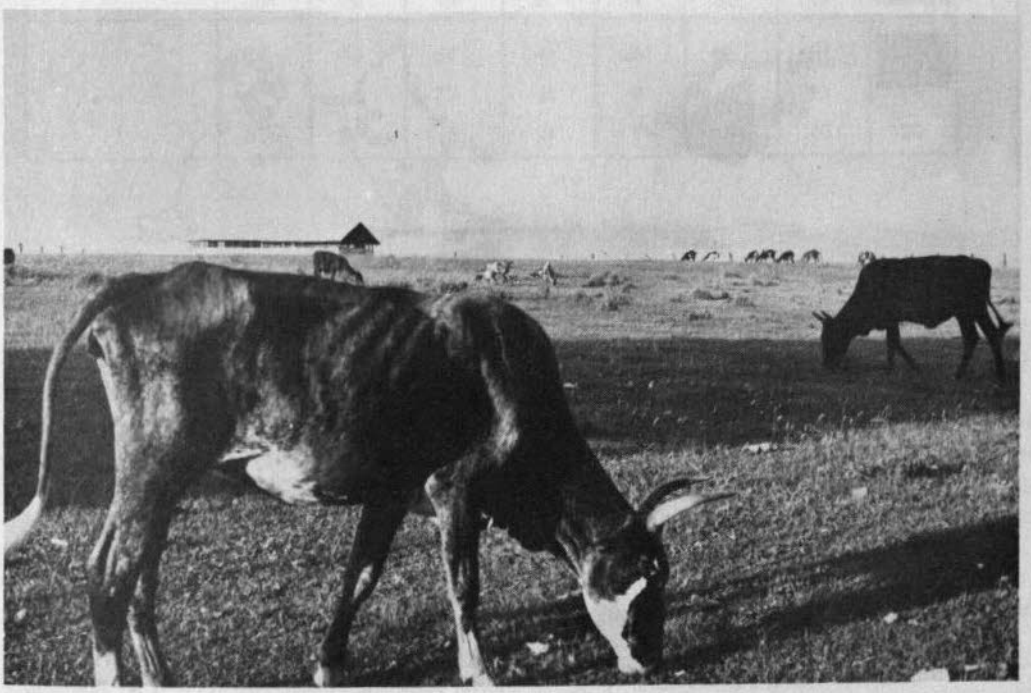
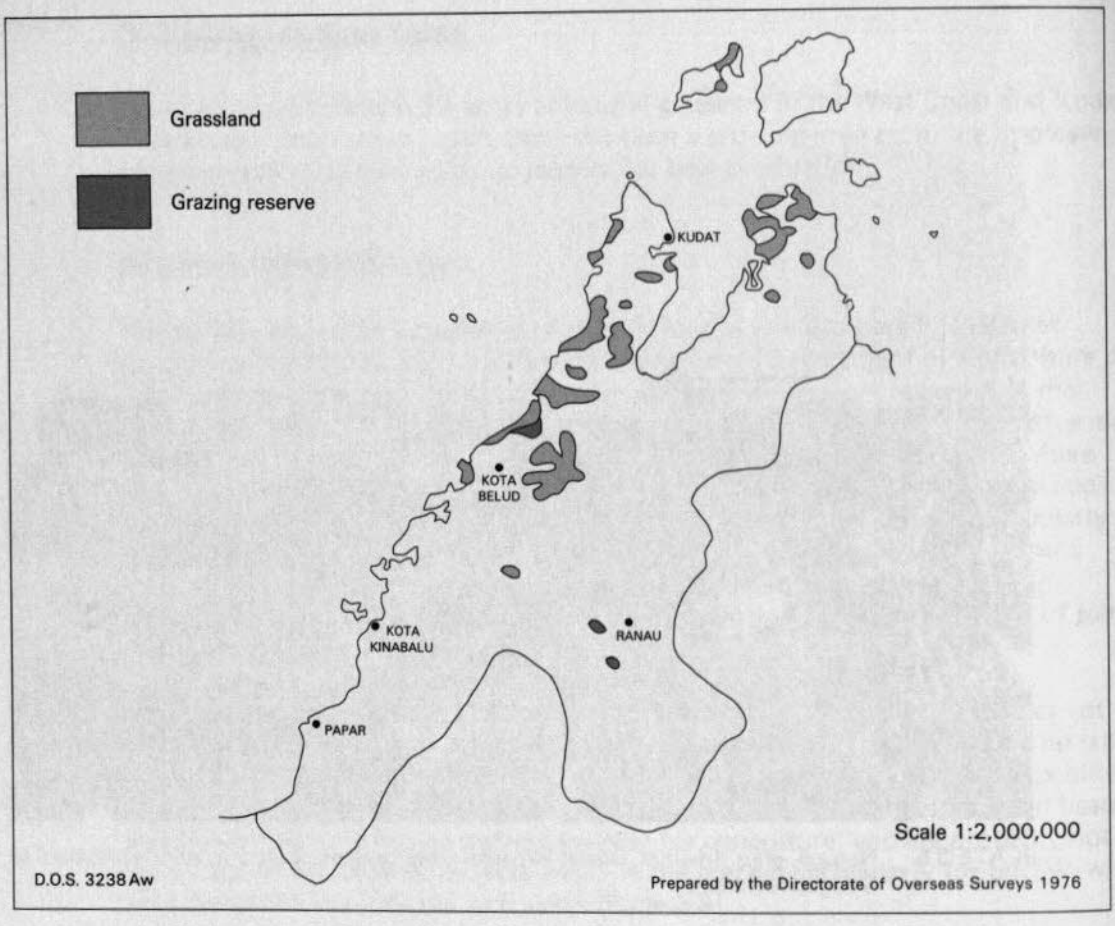


PLATE 3.5 Natural grass (mainly *lalang*) provides poor grazing. Cattle in poor condition in Mangkubou area

PLATE 3.6 Buffalo grazing on stranded beaches near Kota Belud



TEXT MAP 3-14 Distribution of grasslands and grazing reserves

The distribution of improved pasture according to the *Present Land Use Survey* based on information as at 1970 is given in Table 36. However the situation has altered considerably since then with the establishment of more cattle farms. On the major cattle farms in the residencies at Pulau Banggi, Mangkubou, Lok Dangkan, Rosok, and Timbang Mengaris, which support some 3 430 head of cattle (Sabah, Malaysia, Department of Agriculture, 1974), there are estimated to be approximately 1 420 ha (3 500 ac) of pasture which have been improved and a further 1 210 ha (3 000 ac) of fenced *lalang.* The species which have been used for improving pasture include the grasses: Guinea grass, giant Guinea grass and hamil grass *(Panicum maximum* and varieties*)*, Kazungulu *(Setaria sphacelata)*, paspalum *(Paspalum dilatatum* and *P. plicatulum)*, Para grass and signal grass *(Brachiaria mutica* and *B. decumbens)* also *B. brizantha*, coast grass and African star grass *(Cynodon plectostachyus* and *C. dactylon)* and carpet grass *(Axonopus compressus)*; and the leguminous species: stylo *(Styloxanthes gracilis)*, siratro *(Phaseolus atropurpurens)*, centro *(Centrosema pubescens)* and lotonosis *(Lotonosis bainesii)*. Of these grasses and leguminous species stylo has been the most widely used.

TABLE 36 Distribution and land capability of improved pastures

Land capability class	Alienated land		Govt. reserves		Stateland		Total	
	ha	ac	ha	ac	ha	ac	ha	ac
II	16	40	57	141	28	69	101	250
III	0	0	27	68	0	0	27	68
V	36	89	12	31	0	0	48	120

POTENTIAL GRAZING LAND

Natural grassland covers approximately 93 100 (230 000 ac) and its distribution by land categories and suitability for improvement is shown in Table 37. Only some 17% (10 864 ha (26 849 ac)) are inherently suited for grazing i.e. Class II land. Of the 18 067 ha (44 649 ac) of Class III land some will probably be suited for grazing where slopes are not too steep but it is unlikely that any of the Class V land will be suitable. It will be noted from Table 37 that the bulk of the land inherently suited for grazing is either alienated land or stateland and is thus readily available for development for grazing purposes. The dominance of *lalang* would make it necessary to introduce more nutritious grasses and forage crops to improve the pastures. Sheet *lalang* can however be much improved by continuous grazing which seems to reduce its vigour and produce a shorter 'dwarf' variety. The effect of such grazing is clearly demonstrated in the Bengkoka Peninsula where areas of *lalang* have been fenced.

TABLE 37 Alienation and gazettement of the natural grassland and its suitability for pasture improvement in ha (ac)

Suitability for improved pastures*	Alienated land	Forest reserves	Government reserves	Stateland	D.I.D.**	Grazing reserves	Total
Good	3 519 (8 696)	51 (128)	229 (566)	6 895 (17 036)	8 (20)	162 (403)	10 864 (26 849)
Medium	5 172 (12 781)	127 (315)	383 (947)	12 158 (30 046)	23 (56)	204 (504)	18 067 (44 649)
Poor	8 461 (20 909)	1 947 (4 813)	2 240 (5 537)	48 602 (120 103)	0	2 911 (7 192)	64 161 (158 554)

*This is based on a rating for agricultural development

Good = diversified agriculture (Land Capability Class II)
Medium = restricted agriculture (Land Capability Class III)
Poor = not suited for agriculture (Land Capability Class V)

**Drainage and Irrigation Department

It should be noted that approximately 1 880 ha (4 650 ac) of natural grassland, mostly Class V land, fall in the military training area to the east of Kota Belud and are therefore not available for grazing.

In addition to the natural grasslands there is a potential for developing improved pastures on land at present under forest. This would be largely restricted to Class II land and by reference to Table 44 it can be seen that some 27 330 ha (67 540 ac) may be considered for the purpose.

Game resources

There has been no survey of the game resources of the West Coast and Kudat Residencies and very little research on its wild animals. Information available is therefore scanty, and our knowledge of such is based on the various animal collections that have been made from time to time and on miscellaneous personal observations.

Gunong Kinabalu has attracted the attention of many naturalists and zoologists and a number of collecting expeditions and individuals have visited the mountain, but most of the work has been done on the more accessible southern flanks. It is likely that the more remote parts of the Kinabalu National Park carry a rich and varied fauna probably including rare mammals. The animal life on Gunong Kinabalu is not representative of lowland areas as the mammalian fauna above 900 m (3 000 ft) is very different from that of the lowland rain forest (Davis, 1962).

The widespread activities of shifting cultivators have destroyed much of the original high forest resulting in considerable modification of the animal population. Hunting, particularly in and around the main population centres on the Crocker Plains has caused a considerable reduction of the wildlife population. Logging has made very little inroad into the forests which remain but when it does further modification of the animal life will occur. While some species, e.g. pig and deer, may have increased in numbers following the destruction of the high forest, the general picture is probably one of a decreasing wildlife population which is being driven into the undisturbed and more remote areas.

MAMMALS

The asiatic elephant has not been recorded in the residencies, the Labuk Highlands limiting its spread from the east. However almost all the other large mammals known in Sabah have at some time been recorded, many of them on Gunong Kinabalu.

The 1961 Royal Society expedition to Gunong Kinabalu (Corner, 1963) found evidence of both rhinoceros and wild cattle at 2 900–3 000 m (9 500–10 000 ft), and nests of orang-utan were fairly common between 900 and 1 500 m (3 000 and 5 000 ft). Pig and various species of deer, particularly the sambar deer were in abundance in the Mamut Valley and extended up to 3 000 m (10 000 ft). It is apparent that the upper Mamut Valley and the Pinosuk Plateau are important breeding grounds for a great variety of mammals.

Smaller mammals, especially squirrels, tree shrews and rats, were found to be very abundant up to 3 000 m (10 000 ft). Table 38 lists the larger mammals that have been recorded in the residencies and, where indicated (K), on Kinabalu.

Bearded pig and the various species of deer are plentiful throughout the residencies and are certainly the most common of the larger animals. Although their natural habitat is undisturbed high forest they appear to thrive in secondary forest following shifting cultivation and are even found in more open grassland areas, particularly on the Bengkoka Peninsula.

Other smaller mammals which have been recorded include: 23 species of bat of which 10 occur on Gunong Kinabalu, seven species of tree shrew, 19 species of squirrels, nine species of flying squirrels and 26 species of rats and mice. The largest of the bats is the fruit eating flying fox. This is fairly common, and at certain times of the year may be seen at dusk in large numbers as it flies inland from the nipah forest where it roosts during the day.

TABLE 38 The important and more common mammals

Crab eating macaque	*Macaca fascicularis*
Pig tailed macaque (K)	*Macacus nemestrinus nemestrinus*
Grey leaf monkey (K)	*Presbytis aygula hosei*
Maroon leaf monkey (K)	*Presbytis rubincunda rubicunda*
Silvered leaf monkey	*Presbytis cristata ultima*
North Borneo gibbon (K)	*Hylobates moloch funereus*
Orang-utan (K)	*Pongo pygmaeus*
Clawless otter	*Aonyx cinerea cinerea*
Scaly anteater (K)	*Manis javanica*
Malaysian bear	*Helarctos malayanus euryspilus*
Linsang (K)	*Prionodon linsang gracilis*
Masked palm civet (K)	*Paguma larvata ogilbyi*
Palm civet	*Paradoxurus hermaphroditus sabanus*
Hose's civet (K)	*Hemigalus hosei*
Leopard cat (K)	*Felis bengalensis borneoensis*
Large mouse deer	*Tragulus napu borneanus*
Lesser mouse deer	*Tragulus javanicus hosei*
Barking deer (K)	*Muntiacus muntjak pleiharicus*
Sambar deer (K)	*Cervus unicolor brookei*
Flying lemur	*Cynocephalus variegatus*
Sumatran rhinoceros (K)	*Didermoceros sumatrensis*
Wild cattle (K)	*Bos javanicus lowi*
Bearded pig (K)	*Sus barbatus barbatus*
Flying fox	*Pteropus spp*

REPTILES

The green turtle *(Chelonia mydas)* is known to nest on beaches on the Northern Islands, Western Islands and along the western shoreline as far south as Tanjong Aru near Kota Kinabalu. The hawksbill turtle *(Eretmochelys)* is known to nest on beaches in the Kota Belud area, on the Mantanani islands and the Kudat District. The numbers of the two species are not known, but in neither case are they thought to be very numerous (de Silva, 1974). While the turtles are protected under the Fauna Conservation Ordinance (Colony of North Borneo No. II of 1963), their nests are not; and it is likely that many of the eggs laid on the beaches close to habitation are lost to collectors.

The presence of crocodiles (*Crocodilus porosus)* is occasionally reported, particularly in the Tuaran area; however they have been regularly hunted, and it is thought that numbers are small and rapidly decreasing. The monitor lizard *(Varanus salvator)* is commonly found throughout the residencies. A large number and variety of snakes, most of them harmless, are known to occur but are seldom seen and identified. The python *(Python* spp.*)* and King cobra *(Naga hannah)* are occasionally reported as being seen or caught.

BIRDS

There is a very rich and varied avifauna including migrants and winter visitors. Gunong Kinabalu provides a great range of habitats with the result that the bird-life in the Kinabalu National Park is exceptionally rich. To date 259 different species have been seen and identified in the Park and it is expected that another 79 are also present (Jenkins and de Silva, 1974). This includes a large proportion of all species known from Sabah; the main exceptions being sea birds.

In addition to the National Parks, there are two bird sanctuaries in the residencies. One is near Kota Belud and covers part of the Krah Swamp. Its object is to protect migrant and other species of wildfowl. Unfortunately insufficient staff are available to regularly patrol the area and the sanctuary is often violated by hunters. Birds found there include garganey teal, wigeon and tufted duck (de Silva, in Sabah, Malaysia Forest Department, 1966).

The other sanctuary is on the island of Mantanani Besar, where megapodes nest, and a system of controlled harvesting of their eggs is practised by the local inhabitants (de Silva, 1974). The white-breasted swallow shrike is common on the island and frigate birds are found (de Silva, in Sabah, Malaysia, Forest Department, 1966).

TABLE 39 Larger birds, birds of prey and game birds recorded in the West Coast and Kudat Residencies and on Gunong Kinabalu (K)

Honey buzzard (K)	*Pernis ptilorhynchus*
Brahminy kite (K)	*Haliastur indus*
Chinese goshawk (K)	*Accipiter soloensis*
Crested goshawk (K)	*Accipiter trivirgatus*
Asiatic lesser sparrowhawk (K)	*Accipiter virgatus*
Changeable hawk-eagle (K)	*Spizaetus cirrhatus*
Blyth's hawk-eagle (K)	*Spizaetus alboniger*
Rufous bellied hawk-eagle (K)	*Hieraaetus kienerii*
Black eagle (K)	*Ictinaetus malayensis*
White bellied sea eagle	*Haliaeetus leucogaster*
Grey-headed fishing eagle	*Ichthyophaga ichthyaetus*
Crested serpent eagle (K)	*Spilornis cheela*
White fronted falconet (K)	*Microhierax latifrons*
Peregrine falcon (K)	*Falco peregrinus*
Blue breasted button quail (K)	*Coturnix chinensis*
Red breasted tree partridge (K)	*Arborophila hyperythra*
Crested green wood partridge (K)	*Rollulus rouloul*
Crimson headed wood partridge (K)	*Haematortyx sanguiniceps*
Great argus pheasant (K)	*Argusianus argus*
Painted snipe	*Rostratula benghalensis*
Pintail snipe	*Capella stenura*
Swinhoe's snipe	*Capella megala*
Green plover	*Pluvialis squatarola*
American golden plover	*Pluvialis dominica*
Common curlew	*Numereus arguata*
Garganey teal	*Anas querquedula*
Wigeon	*Anas penelope*
Mallard	*Anas platyrhynchos*
Shoveller	*Anas clypeata*
Tufted duck	*Aythya fuligula*
Jambu fruit pigeon (K)	*Ptilinopus jambu*
Green imperial pigeon (K)	*Ducula aenea*
Mountain imperial pigeon (K)	*Ducula badia*
Red cuckoo dove (K)	*Macropygia phasianella*
Little cuckoo dove (K)	*Macropygia ruficeps*
Emerald dove (K)	*Chalcophaps indica*
Bushy crested hornbill (K)	*Anorrhinus galeritus*
Wreathed hornbill (K)	*Aceros undulatus*
Pied hornbill (K)	*Anthracoceros coronatus*
Collared pratincole	*Glareola pratincola*
Rhinoceros hornbill (K)	*Buceros rhinoceros*
Megapode	*Megapodius freycinet*
Christmas Island frigate bird	*Fregata andrewsi*
Lesser frigate bird	*Fregata ariel*
Great frigate bird	*Fregata minor*
Pied harrier	*Circus melanoleucos*
Grey heron	*Aredea cinerea*
Purple heron	*Ardea purpurea*
Large egret	*Egreta alba*
Intermediate egret	*Egreta intermedia*
Little egret	*Egreta garzetta*
Reef egret (white phase)	*Egreta sacra*
Cattle egret	*Bubulcus ibis*
Lesser adjutant stalk	*Leptoptilos javanicus*

(K) Recorded on Gunong Kinabalu

Recreational land resources

Land suited for recreational purposes is,with few exceptions, restricted to the high altitudes of the mountains and parts of the shoreline, and the residencies are well endowed with land in both these categories. There are sports fields in all towns and a golf course and racecourse in Kota Kinabalu.

The value of the mountainous areas for recreational purposes is considerably enhanced where the land is high enough to provide a significantly cooler climate. Such is considered to be the case when the altitude exceeds 1 200 m (4 000 ft) since the maximum day temperature can be expected to be below 23°C (75°F) and the temperature at night lower than 18°C (65°F). There are quite extensive areas of such land with good access in places.

Beaches of varying quality are found along much of the coastline and islands, except for Marudu Bay and the Bengkoka Peninsular where muddy shorelines with mangroves are common. One of the major limitations of many of the beaches is the periodic discoloration of the water arising from the discharge of adjacent rivers. In places the coastline is scenically attractive with wooded hills, rocky headlands and sandy coves.

There are 80 815 ha (198 956 ac) of national parks in the West Coast Residency most of the area being in mountainous and hilly country.

MOUNTAINS AND HILLS

The largest and most important area of land above an altitude of 1 200 m (4 000 ft) lies in and around Gunong Kinabalu, mostly in the Kinabalu National Park. The extent of this area is some 56 900 ha (140 700 ac) with the land rising to a maximum of 4 101 m (13 455 ft) on Gunong Kinabalu and to 2 576 m (8 450 ft) on Gunong Tambuyukon to the north. The scenery, particularly around the summit area of Kinabalu (Plate 3-7), is spectacular, with extensive views and overlooks. The flora and fauna of Kinabalu is of particular interest on account of its wide variety. Its summit is readily accessible; but this is restricted to one route, a footpath, which has the necessary facilities for visitors in the form of a series of huts. The park headquarters at 1 560 m (5 100 ft) provides both chalet and hostel accommodation which is linked to a series of walks (Plate 3-8). However, only a relatively small part of this upland area is accessible, and large parts are remote and largely unexplored. At Poring, about 670 m (2 200 ft) on the east side of the park, there are sulphurous hot springs set in pleasant surroundings with facilities and accommodation for visitors.

In the Crocker Range there are some 13 600 ha (33 700 ac) of land above 1 200 m (4 000 ft), particularly in the vicinity of Gunong Alab (1 965 m (6 447 ft)) and extending south-west along the crest of the Range to Lingan. The scenery in the Crocker Range is spectacular in places with swift clear rivers flowing in deep valleys. The main road from Kota Kinabalu to Tambunan, which crosses the Range close to Gunong Alab, provides access to these highlands. A limitation to the suitability of this area for recreation is the weather. Rainfall is heavy, the highest in the two residencies being recorded at Tonggol, some 8 km (5 mi) from the summit of Gunong Alab (Text Map 3-2). Low cloud and afternoon mists are common.

There is a small area of high land on the eastern boundary of the West Coast Residency around Gunong Mentapok (1 581 m (5 188 ft). This is on the western flank of the Meliau Range, most of which falls in the Sandakan Residency. The area is relatively close to the main east-west highway.

Associated with the high land are a number of attractive river valleys, of which the Tempasuk-Kadamaian system is of particular value, affording, from the Kota Belud to Ranau road, good views of the river and surrounding country; the Tuaran, Moyog and Papar valleys also merit special attention cutting through mountainous terrain with fast flowing streams running through rapids and deep pools.

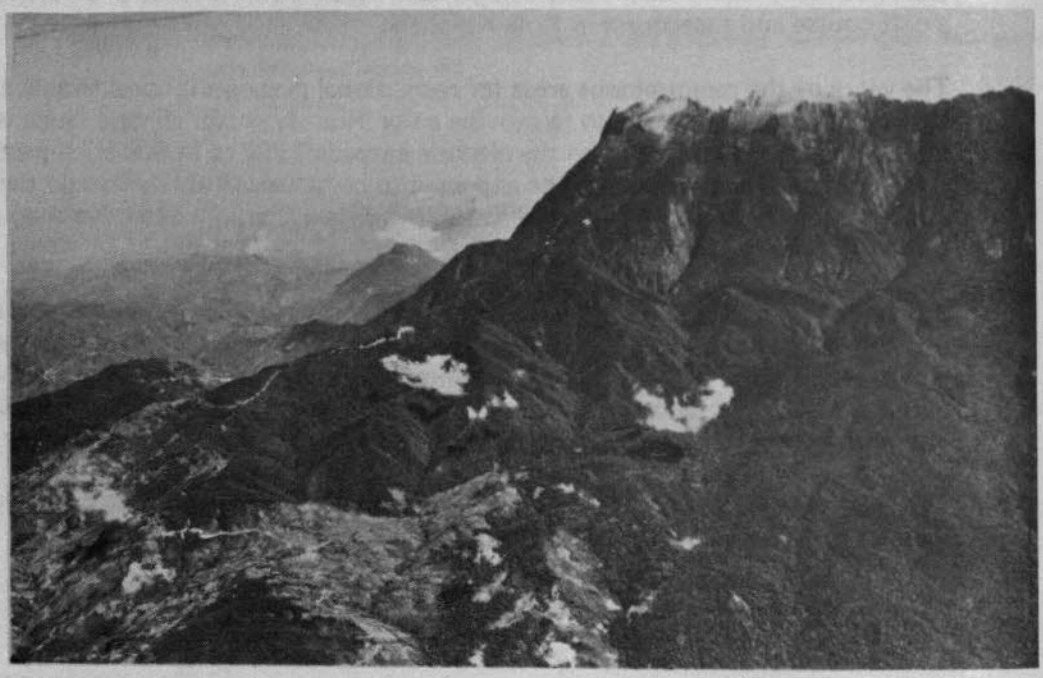


PLATE 3.7 Gunong Kinabalu with shifting agriculture on the Crocker Range

PLATE 3.8 Kinabalu National Park Headquarters, which has accommodation and other tourist facilities

PLATE 3.9 Scenic limestone cliff, Pulau Balambangan

To the east of Kota Belud bordering the Tempasuk Plain is a range of low grass covered hills with clear streams. These provide a pleasant change of scenery and afford views across the Plain to Kota Belud and the sea beyond.

At the south-western end of Balambangan Island a limestone feature gives rise to steep cliffs with caves. Some of the cliffs rise almost shear near an inlet of the sea, marking an area of scenic attraction (Plate 3-9).

COASTS, BEACHES AND ISLANDS

Western coastline

The coastline of Kimanis Bay, from Bongawan in the south-west corner of the West Coast Residency to Tanjong Aru close to Kota Kinabalu, has some attractive good quality beaches with long stretches of sand. However their suitability for recreational purposes is somewhat limited by periodic discoloration of the sea from the numerous rivers which discharge into the Bay. This is particularly the case after periods of heavy rain.

At Tanjong Aru there is a good quality shelving sandy beach with an attractive fringe of Casuarina trees which is readily accessible and extensively used. It is a very valuable asset for Kota Kinabalu both from the point of view of local amenity and recreation and as an attraction to tourists. It is the most intensively used stretch of recreation land in the State but, similar to the rest of Kimanis Bay, the waters are subject to periodic discoloration. When this occurs the beach loses some of its attraction.

Immediately offshore from Tanjong Aru and Kota Kinabalu are the small islands of Manutik, Manukan, Sulug and Singataan (Sapi), together with the larger Pulau Gaya. Singataan and the greater part of Gaya, together with the adjacent coral formations, fall within the Tungku Abdul Rahman National Park. The small islands all have at least one good quality sandy beach, generally steeply shelving into clear waters with associated coral reefs. On Pulau Gaya beaches are mainly restricted to the western side of the island, where there are also picturesque rocky headlands with attractive small sandy coves.

The Ambong Bay area stretching from Tanjong Tembungo to Pulau Usukan generally has a good potential for recreational purposes. There are a number of wooded rocky promontories which are scenically attractive, and these are interspersed by small coves and bays with good quality sandy beaches, shelving steeply into clear seas and with coral reefs offshore. Many of the coves and bays are sheltered and most are within 6½–8 km (4–5 mi) off the main road from Kota Kinabalu to Kota Belud. The beaches along the coastline from Pulau Usukan to Kampong Rampayan are not top quality, and the seas in this area are subject to periodic discoloration.

Along the western coastline of the Kudat Peninsula from Kampong Rampayan to Tanjong Sempang Mangayau there are a number of stretches of good quality sandy beach shelving into clear seas. White Rocks Bay with its rock formations interspersed by sandy shallows is particularly attractive and is readily accessible.

There are some reasonably good sandy beaches on the north-eastern tip of the Kudat Peninsula in particular Bak-Bak, which is regularly used by Kudat residents.

Western islands

Mengalum Island, which lies some 64 km (40 mi) out in the South China Sea from Kota Kinabalu is skirted by good quality sandy beaches which are, however, rather shallow and gently shelving except for one or two deeper narrow inlets on the eastern side. The surrounding seas are clear and there are fringing coral reefs.

The islands of Mantanani Besar and Mantanani Kechil are approximately 35 km (22 m) from Kuala Usukan, which is accessible by road from nearby Kota Belud. Both islands have low limestone hills with cliffs and birds nest caves, which mark their western extremities, and some good quality beaches at the eastern ends. There is clear deep water close inshore with fringing coral reefs further out.

Northern islands

On Pulau Balambangan the only reasonable beaches occur on the east and west facing extremities. The use of these beaches for recreational purposes is limited by their exposure to the prevailing monsoons. Tanjong Priok, at the entrance to Lung Bay in the north of the island is the historical site of the eighteenth century East India Company trading post. Today little remains to be seen of the original settlement. Discoloration of the waters in Lung Bay, as the result of drainage from adjoining peat swamps, and the shallow shelving nature of the beaches seriously limit the value of the area for recreational purposes.

On Pulau Banggi there are some stretches of beach along the northern coast, but the frequent dark colour of the sand, discoloration of the water adjacent to the main estuaries and general shallowness of the beaches limit their attraction for recreational purposes. They are also exposed to the full force of the north-east monsoon. The rest of the coastline is mainly mangrove.

Pulau Tigabu has good sandy beaches along its western shoreline, but most of its length is occupied by a fishing village and is, therefore, subject to pollution. The northern part of the island has clean beaches, but these are generally shallow and skirted by extensive coral reefs and sandy shoals. Similar beaches are to be found on Pulau Mandidarah.

Part 5

Opportunities for resource development

Part 5 is largely devoted to identifying the main resource development opportunities which exist in the West Coast and Kudat Residencies, whilst at the same time providing broad guidelines for further investigations and studies thought necessary for proper implementation planning. It will be seen that the residencies are the most developed in Sabah and much of the land resources have been utilised. There is still, however, considerable scope for further development, but before this is discussed it is enlightening to consider the course of events which has given rise to the present land use pattern.

HISTORY OF LAND DEVELOPMENT

The West Coast appears to have a long tradition of trade and immigration with the outside world. From as early as AD 618 there was probably contact with the Chinese T'ang and later the Sung Empires which established trading posts and encouraged colonial settlements along the coastline as far north as Kota Belud (Whelan, 1970). This contact with the mainland was to be maintained for the next thousand years and is likely to have been supplemented by strong links with India between the ninth and fourteenth centuries through trading ships *en route* to China, and in the sixteenth century by contact with the Portuguese based at Malacca (Whelan, 1970). These external influences must have exerted a strong affect on the course of development. For example, the relatively sophisticated and highly evolved agricultural systems, particularly that concerning wet-rice cultivation, may well be the product of the long and sustained Chinese influence.

In the eighteenth century, however, the coastline became troubled by pirates, with Bandau, Pandasan and Tempasuk their main ports. Their activities severely disrupted external trade and the Chinese settlements disappeared. The East India Company established a trading post on Pulau Balambangan in 1763, but this was abandoned after being sacked by pirates in 1775 (Whelan, 1970).

By the early nineteenth century trade was controlled by Brunei to the south and Sulu to the east. An account by Hunt (in Whelan, 1970) in 1812 describes a great number of small ports along the coastline from Kimanis to Marudu Bay exporting edible birds'-nests, rice, sago, betel-nut, rattan, beeswax, tortoise-shell, camphor-oil, gold (from Tempasuk) and cattle (from Tuaran). These commodities are indicative of communities sustained by both the collection of jungle produce and agriculture. This is confirmed by the reports of Spenser St. John and T S Dobree and L S von Donop, visitors in 1858, 1878 and 1882 respectively. Apart from the rice-growing plains and associated village croplands, most of the agriculture was being carried out on a shifting basis, in much the same fashion as today over many parts of the Crocker Range.

Meanwhile, in 1865 there was an attempt to establish an American settlement at Kimanis. About 36 ha (90 ac) was planted under rice, sugar-cane and tobacco but the enterprise was abandoned in the following year (Tregonning, 1958).

The first concerted attempt at some form of control was to start in 1878 when administrative officers were settled at Papar and Tempasuk near Kota Belud (Governor and officers of the residential staff in Borneo, 1890). The Tempasuk post failed, largely for commercial reasons, and in 1884 was transferred to the eastern point of Pulau Gaya opposite the present-day port of Kota Kinabalu.

During all these years the coastline remained scourged by marauding pirate fleets. Slavery was rampant among the seaboard settlements and trade and development were severely curtailed. Gradually, however, during the late 1870s and early 80s, increasing government control reversed the fortunes of the pirates to such an extent that the capital of the new-founded State was established, in 1882, at Kudat on Marudu Bay, once the centre of piracy.

The protection and stability offered as the result of the government control was conducive to optimism; resulting in increasing exploration, development and trade. Mineral prospectors and agriculturalists made important journeys inland in order to evaluate the resources available.

The first plantation crop to be established was tobacco, which was being grown in the Limbuak Valley on Pulau Banggi in 1886. By 1889 a number of estates had been established on the Bandau Plain, Bengkoka River and Pulau Banggi; and concessions of 31 154 ha (76 983 ac) had been made for the cultivation of the crop (Governor and officers of the residential staff in Borneo, 1890). This was to be shortly followed, as a result of encouragement by the administration, by large-scale plantings of coconut palms. 1893 saw the peak period of tobacco production. The estates were flourishing and the traditional native cultivators in the Crocker Range were being encouraged by government to increase production (Tregonning, 1958). The ensuing two decades were those of decline for the industry, and by 1910 all the tobacco estates had been abandoned or converted to other crops.

The role of tobacco as the major export commodity was to be taken over by rubber. This was first introduced in 1899 (Tregonning, 1958). With the completion of the railway from Beaufort to the new port at Jesselton (Kota Kinabalu) in 1902 much of the southern stretch of the seaboard became accessible and a number of rubber estates were quickly established. By 1917 some 14 095 ha (34 828 ac) were planted in the State (Tregonning, 1958), by far the greater part in the West Coast Residency. Estate development extended northwards to the Tuaran, Langkon and Pitas areas. During the same period rubber as a smallholders' crop became firmly established along the seaboard as far north as Kota Belud, and the coconut holdings were being established along the coastline and over large inland tracts on the Kudat Peninsula.

Although there had been considerable prospecting activity mining was to have very little impact on the development pattern; the only production being limited to the abortive attempt, described in Part 3, to produce manganese near Taritipan between 1903 and 1908.

Similarly, the timber industry has had very little affect on the overall development pattern. Logging has largely been restricted to meet local demands. This has particularly been the case with the mangroves. As early as 1931 large areas between Menggatal and Tuaran had to be closed as the result of over-cutting (State of North Borneo, 1932). An attempt was made in the 1930s to export mangrove bark; some 9 076 m t (8 932 t) was exported in 1936 (State of North Borneo, 1937) but the industry did not survive. The first large-scale dry-land commercial logging operations started in the mid-1960s to the west of Mount Templer and on the Bengkoka Peninsula; only the latter survives.

During the immediate post-war years the main concern was food production. Thus the interest in developing the Bandau Plain for large-scale mechanised rice cultivation, the successful establishment of irrigation facilities over much of the rice-growing areas at Kota Belud, Tuaran and Papar, cattle-ranching at Kota Belud, and the cultivation of temperate vegetables in the Kundasan-Bundu Tuhan area. Meanwhile much of the old rubber and coconut holdings were becoming moribund. Some were replanted, and large new areas of coconut palms were developed with government assistance.

It will, therefore, be seen today that this long history of land use is dominated by the affects of shifting cultivation. This has resulted in the cutting of much of the primordial forest by small, semi-migratory, almost self-sustaining communities, barely involved in the general cash-economy. Much of the commercial timber resource has thereby been destroyed, and this is reflected in the relative unimportance of the logging industry in the residencies. On the riverine plains, however, the level of agriculture is high, based on a permanent form of rice cultivation which involves communal water control and other sophisticated forms of social organisation which such a type of agriculture entails. Further, the advent of commercial tree crops in more recent times has resulted (in common with the rice-growing plains) in extensive areas of the seaboard being alienated for agriculture, in addition to the rice-growing plains.

PRESENT LAND USE AND ALIENATION AND GAZETTEMENT

Wong (1973) during his present land use survey has shown that the residencies are the most developed in the State with over 11% devoted to agriculture. He has also shown, however, that most of the development has been concentrated on the western seaboard and interior plains following the railway and roads. This is illustrated by Text Map 3-15. Most of the hinterland, in which access is poor, remains forested. This is shown in Figure 3-1.

It will be seen from Table 40 that much of the cultivated land is under permanent crops. Wong (1973) has shown that rubber is the most extensive amounting to about 56 536 ha (139 702 ac) followed by coconut palms 17 792 ha (43 964 ac). Most of the rubber and coconut land belongs to smallholders. Rice is the most important annual crop, some 24 375 ha (60 231 ac) being cultivated on the Crocker and inland plains, on a wetland basis.

TABLE 40 Present land use by districts in ha (ac) (1973)

Major present land use category	District							Total residencies
	Kota Kinabalu	Kota Belud	Kudat	Bandau	Papar	Ranau	Tuaran	
1 Urban and associated land	1 469 (3 630)	135 (335)	173 (429)	80 (199)	176 (435)	433 (1 070)	184 (455)	2 652 (6 553)
2 Horticulture	1 815 (4 486)	3 795 (9 377)	1 012 (2 501)	1 601 (3 956)	1 614 (3 988)	2 148 (5 307)	2 506 (6 192)	14 491 (35 807)
3 Tree, palm and permanent crops	18 954 (46 835)	3 193 (7 890)	17 575 (43 429)	5 257 (12 991)	14 584 (36 038)	1 025 (2 534)	17 831 (44 061)	78 420 (193 778)
4 Annual or rotational crops (shifting cultivation)	4 524 (11 178)	9 297 (22 974)	12 604 (31 146)	4 286 (10 592)	5 139 (12 700)	9 008 (22 260)	7 556 (18 672)	52 416 (129 522)
5 Improved permanent crops	0	323 (799)	72 (179)	12 (31)	0	0	0	408 (1 009)
6 Grassland	3 191 (7 884)	27 488 (67 925)	31 480 (77 789)	9 141 (22 588)	4 276 (10 567)	6 562 (16 215)	10 964 (27 092)	93 102 (230 060)
7F Forest	38 306 (94 656)	44 276 (109 409)	101 692 (251 286)	108 397 (267 853)	78 262 (193 390)	240 360 (593 940)	23 199 (57 325)	634 493 1 567 859)
7S Scrub forest	9 461 (23 379)	41 763 (103 199)	76 405 (188 801)	38 773 (95 811)	7 783 (19 233)	33 793 (83 503)	44 727 (110 522)	252 706 (624 448)
8 Swamp, marshland and wetland forest	2 716 (6 712)	7 026 (17 362)	41 641 (102 897)	7 241 (17 892)	11 548 (28 535)	1 (2)	8 292 (20 491)	78 465 (193 891)
9 Unused and cleared land	734 (1 815)	2 160 (5 337)	1 501 (3 710)	728 (1 799)	386 (954)	1 155 (2 854)	152 (376)	6 817 (16 845)
Total	81 170 (200 575)	139 458 (344 607)	284 158 (702 167)	175 518 (433 712)	123 770 (305 840)	294 485 (727 685)	115 411 (285 186)	1 213 971 (2 999 772)

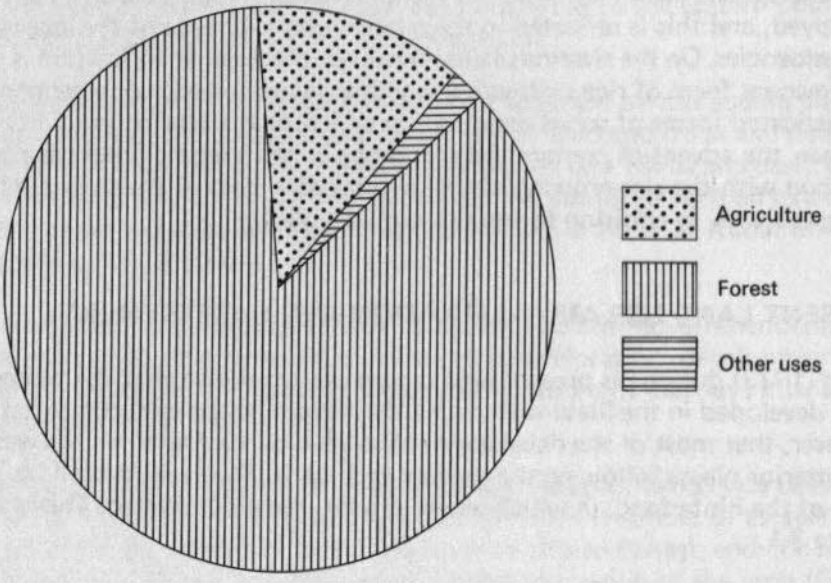
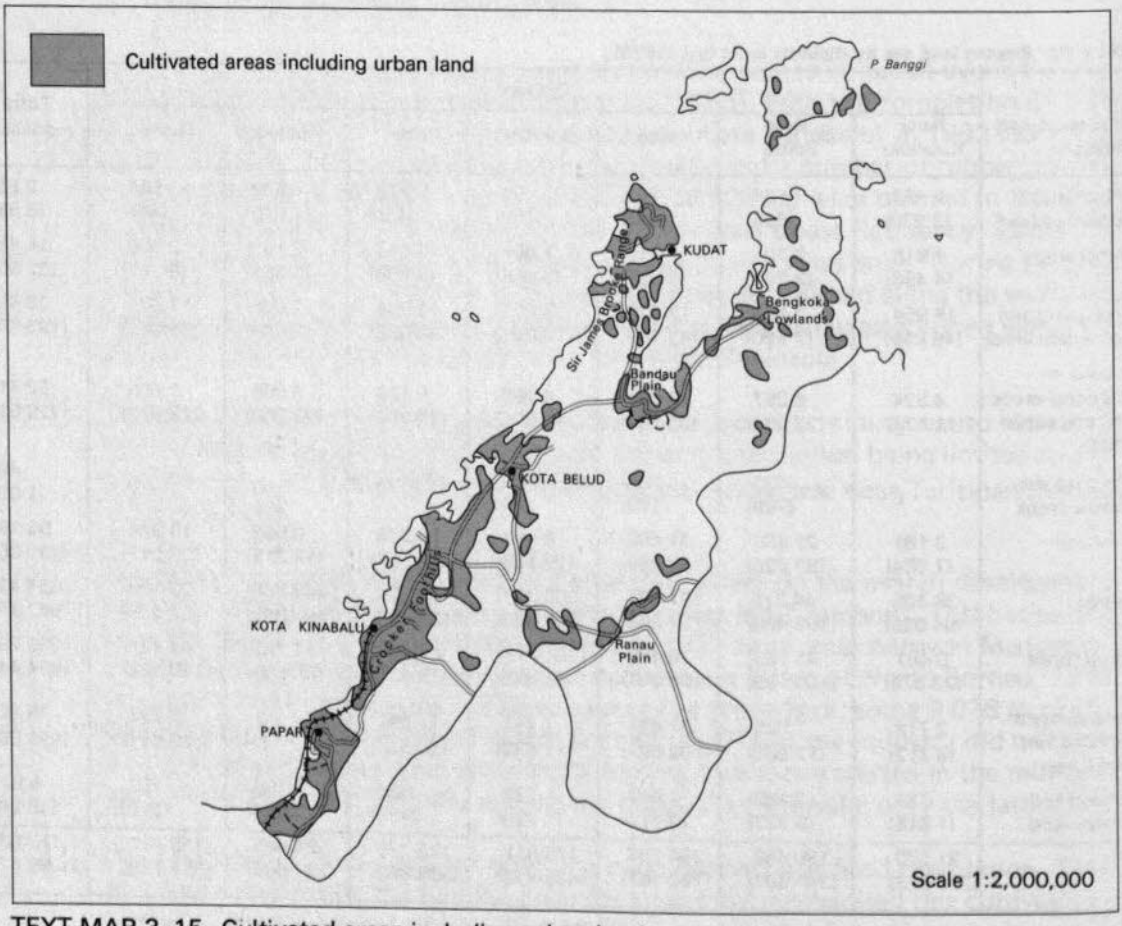


FIGURE 3-1 Present land use



TEXT MAP 3-15 Cultivated areas including urban land

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Prepared by the Directorate of Overseas Surveys 1976

Shifting cultivation, of which the most common crops are upland rice, tapioca, maize, yams, sweet potatoes and tobacco, is carried out on a loosely defined rotational basis (see Plate 3-10). The total extent of standing crops estimated by Wong (1973) was 24 375 ha (60 231 ac), which represents about 17% of all the cultivated land. The extent of the over-all effect of this system of agriculture, however, is shown in Table 40 by the figures for scrub-forest and grassland; essentially fallow stages representing inter-cropping periods. These represent some 345 808 ha (854 508 ac).

The alienation and gazettement pattern follows that of present land use, with the alienated land concentrated on the western seaboard, together with the grazing reserves, government reserves and land coming under the control of the Drainage and Irrigation Department; forest reserves occur in the more remote uplands, and a broad belt of stateland between these and the coast largely marks the traditional shifting cultivation areas. This is illustrated by Text Map 3-16.

Figure 3-2 shows that by far the greatest proportion (60.3%) remains uncommitted as stateland, although some 44 693 ha (110 438 ac) are shown on Table 41 as being cultivated. This represents over 31% of the total area under agriculture, and is comprised largely of the areas under shifting cultivation. Only 21.3% has been gazetted as forest reserves, which in no mean part reflects the relatively unimportant role which forestry has served in the past.

TABLE 41 Present land use within the land categories in ha (ac)

Present land use category	Land category					
	Alienated land	Forest reserve	Government reserve	Grazing reserve	Stateland	Drainage and Irrigation areas
1 Urban and associated land	1 293 (3 194)	10 (25)	631 (1 560)	33 (81)	685 (1 693)	0
2 Horticulture	9 293 (22 963)	51 (126)	216 (534)	216 (533)	4 554 (11 253)	161 (398)
3 Tree, palm and permanent crops	66 280 (163 782)	301 (743)	393 (972)	243 (600)	11 065 (27 343)	137 (338)
4 Shifting cultivation	21 535 (53 214)	559 (1 382)	144 (355)	280 (693)	29 046 (71 773)	852 (2 105)
5 Improved permanent pasture	52 (129)	231 (571)	97 (240)	0	28 (69)	0
6 Grassland	17 155 (42 390)	2 127 (5 256)	2 853 (7 050)	3 277 (8 099)	67 659 (167 189)	31 (76)
7F Forest	30 873 (76 289)	229 524 (567 163)	8 544 (21 114)	2 114 (5 225)	363 437 (898 068)	0
7S Scrub forest	35 706 (88 230)	16 465 (40 686)	4 193 (10 362)	1 038 (2 565)	195 280 (482 545)	24 (60)
8 Swamp, marshland and wetland forest	10 182 (25 159)	7 216 (17 832)	221 (546)	3 252 (8 036)	57 155 (141 232)	439 (1 086)
9 Unused and cleared land	1 255 (3 102)	2 031 (5 020)	45 (111)	58 (144)	3 427 (8 468)	0
Total	193 624 (478 452)	258 515 (638 804)	17 337 (42 844)	10 511 (25 976	732 336 (1 809 633)	1 644 (4 063)

About 16% of the area of the residencies has been alienated for agriculture, although only 50.2% of this is actually being cultivated (Table 41). Areas reserved for specific government purposes, i.e. grazing reserves, government reserves and drainage and irrigation areas occupy a relatively small area. The distribution of the various land categories is shown on Text Map 3-16.

MINING DEVELOPMENT OPPORTUNITIES

A section of Part 4 has been devoted to the mineral resources, and it will have been noted that even though mineralisation is thought possible over some 140 875 ha (348 092 ac), only 2 768 ha (6 841 ac) of these are considered, with the information at present available, to be suited for mining. It will have also been noted that extensive

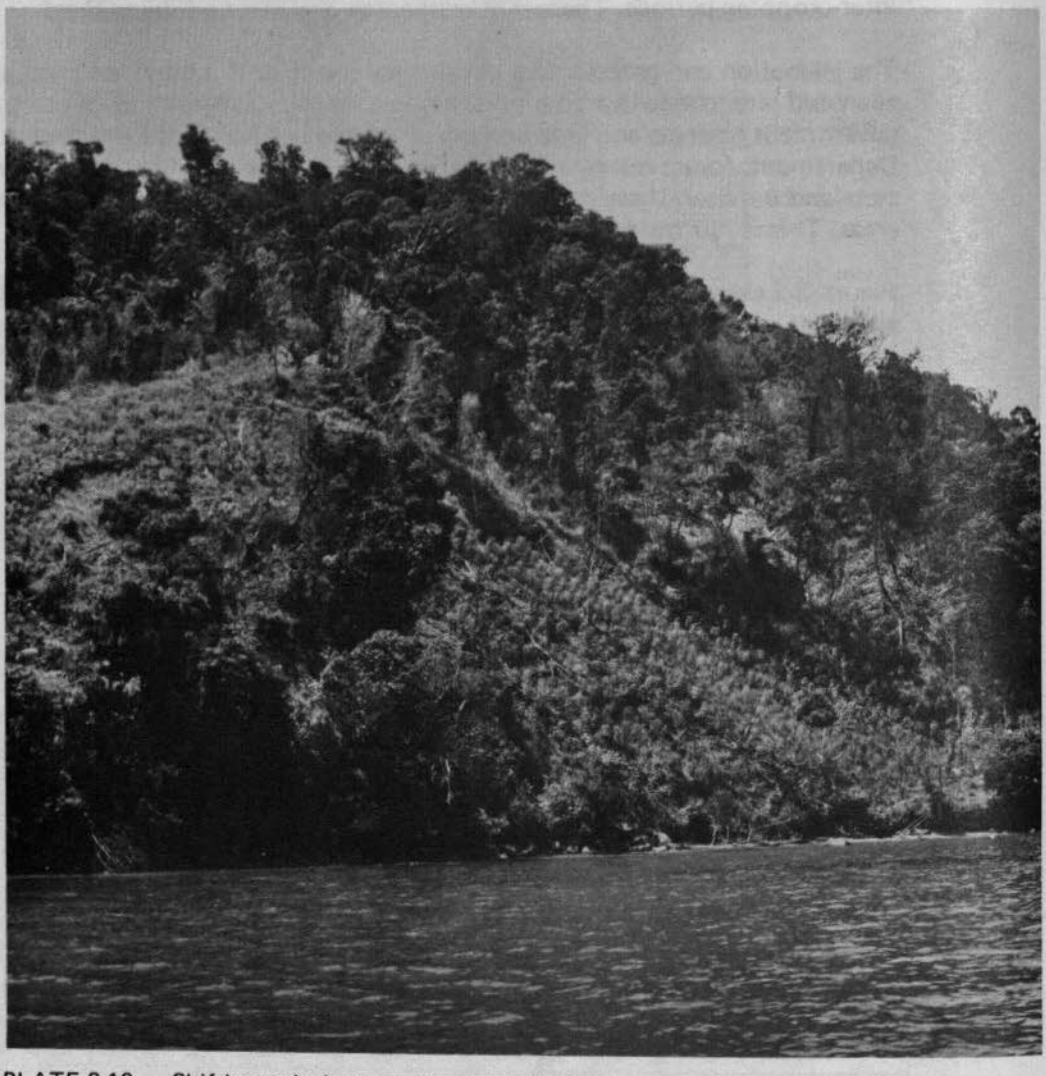


PLATE 3.10 Shifting agriculture on steepland, Putatan area

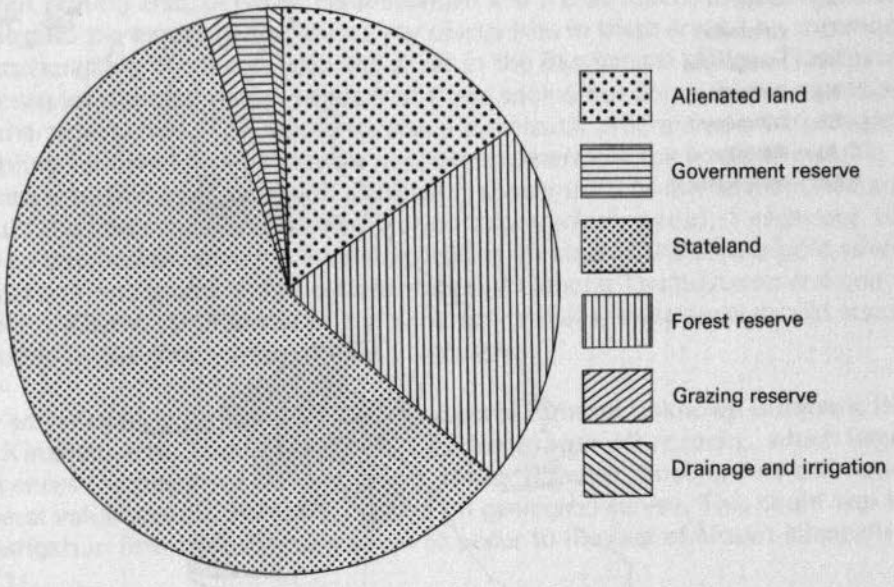
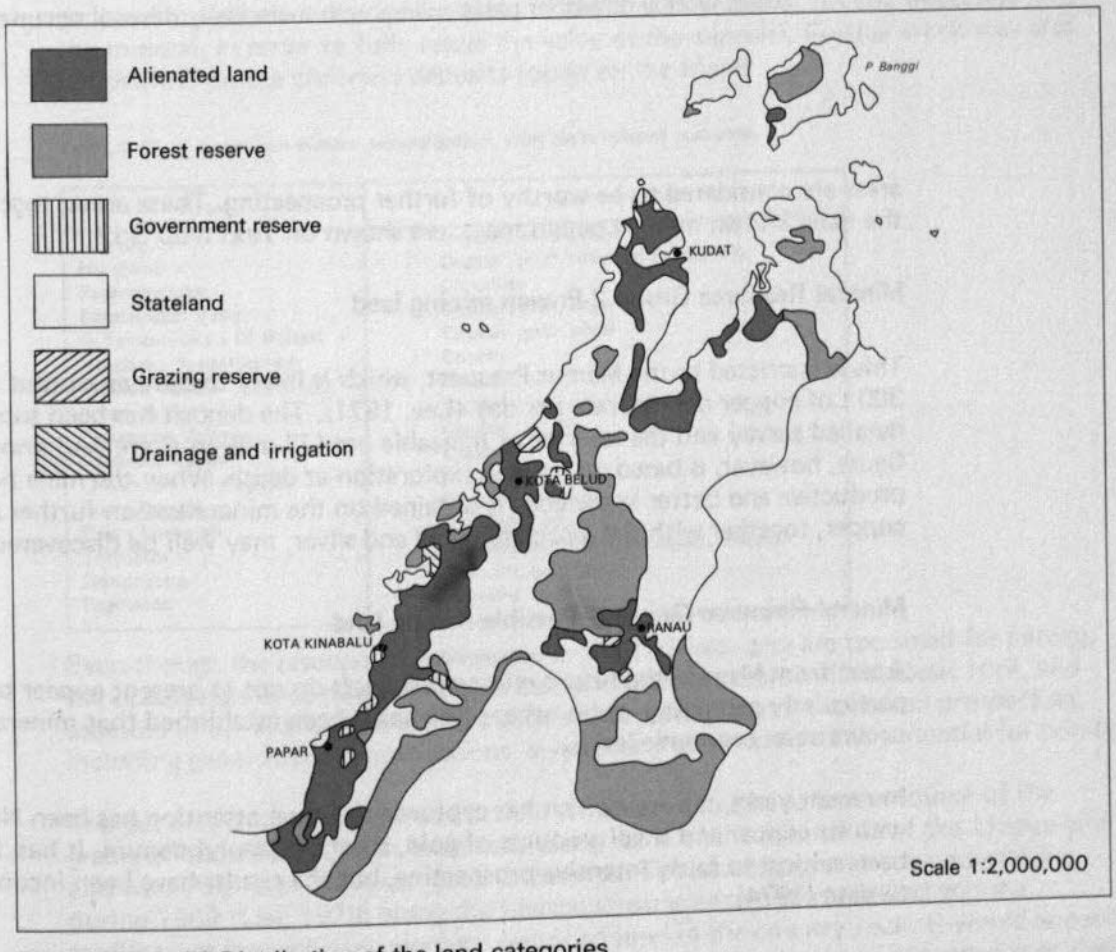


FIGURE 3-2 Alienation and gazettement



TEXT MAP 3-16 Distribution of the land categories

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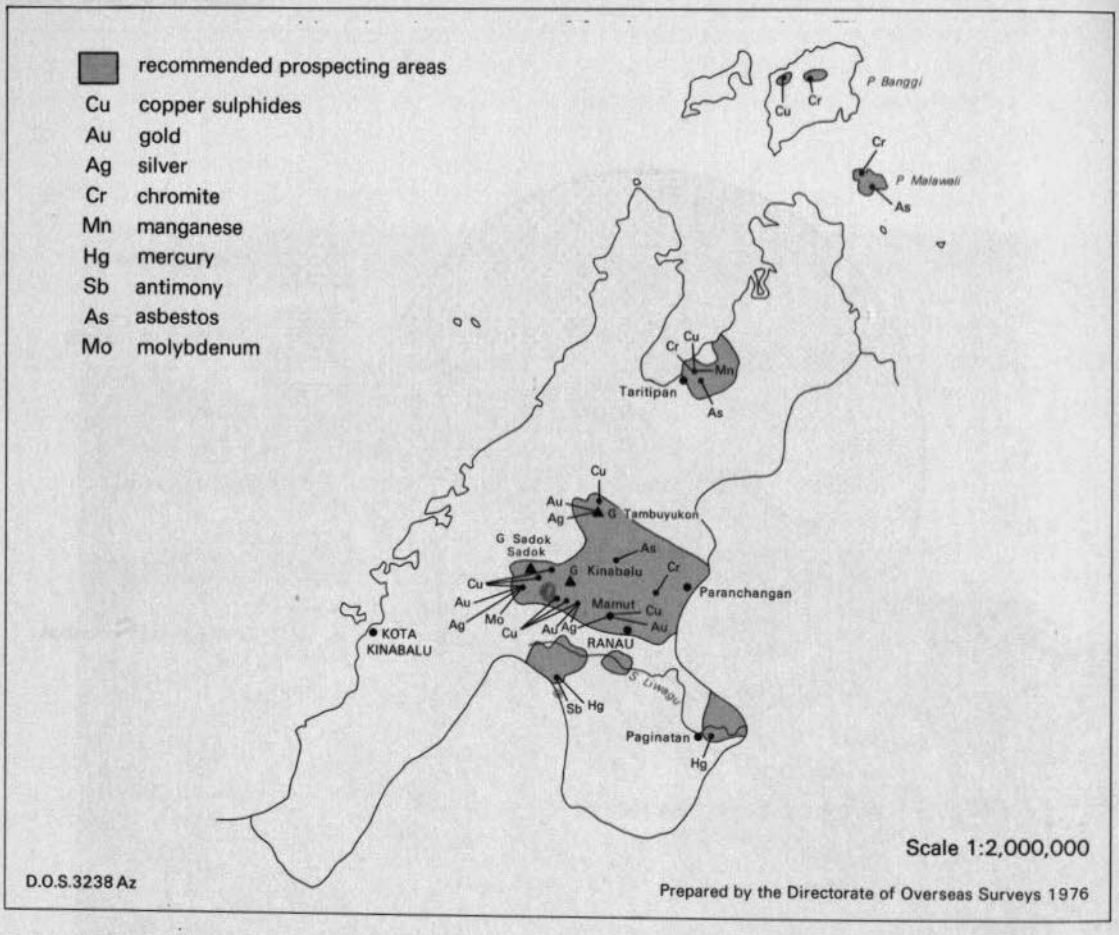


TEXT MAP 3-17 Areas worthy of further prospecting, with main likely mineral occurrencies

areas are considered to be worthy of further prospecting. These areas, together with the main known mineral occurrences, are shown on Text Map 3-17.

Mineral Resource Group 2 Proven mining land

This is restricted to the Mamut Prospect, which is likely to have an output of about 360 t of copper concentrate per day (Lee, 1971). The deposit has been subject to detailed survey and the reserves of mineable ore (77 million t) are well known. This figure, however, is based on limited exploration at depth. When the mine becomes productive and better knowledge is obtained on the mineralisation further reserves of copper, together with the associated gold and silver, may well be discovered.

Mineral Resource Group 3 Possible mining land

Apart from Mamut, the future mining prospects do not at present appear to be particularly promising; at no other place has it been established that mineralisation occurs at an economic level.

In recent years, the area which has captured the most attention has been Nungkok with its copper and small amounts of gold, silver and molybdenum. It has, however, been subject to fairly intensive prospecting, but the results have been inconclusive to-date (1974).

Apart from the Mamut Mine and the Nungkok Prospect the Kinabalu area in general, compared to the other known mineralised zones, probably holds the greatest possibility for further mineral discoveries. The 1970 aeromagnetic survey (Hunting Geology and Geophysics Ltd., 1970) identified a number of magnetic anomalies, to the west of the Mamut mining area, between Paranchangan and Ranau and in the Merali Valley. This confirmed the earlier geological survey discoveries in these areas, i.e., chromium at Paranchangan and copper, gold and silver in the Bambangan Valley. The report on the aeromagnetic survey recommends that these anomalous zones should be subject to a geochemical survey. This would involve a systematic programme of stream-sediment sampling followed by soil analysis in order to determine the levels of metallic minerals. In this way areas with significant concentrations can be identified and these should then be subject to detailed ground survey which would, if necessary, ultimately lead to detailed prospecting involving drilling. In view of the copper-gold-silver concentrations found on the eastern slopes of Gunong Tambuyukon and copper in the Mesilau, Kilambuan, Panataran and Kinarom Valleys, these areas should also be included in the geochemical survey programme.

The aeromagnetic survey also discovered some hitherto unknown ultrabasic bodies in the Kinabalu area. Their nature and relationship with other rocks, which largely influences the degree of mineralisation, is not, however, known. Any estimate of their mineral value would, therefore, depend on geological survey. This could also include an investigation into the asbestos known to occur to the east of Mount Kinabalu (Lee, 1971).

The sulphide and chromite mineralisation which occurs in the north-western part of Pulau Banggi is such that, in the opinion of Collenette (1964), more detailed investigations, including geochemical prospecting, would be justified in this area.

Similarly the asbestos deposits on Pulau Malawali would warrant further work. More prospecting is recommended by Wilson (1961) in the hope of finding thicker veins of the mineral, in order to fully assess the value of the deposits. Further work may also be justified on the chromite deposits found on the island.

TABLE 42 Areas with proven mineralisation, with main mineral resources

Area	Main minerals
Mamut	Copper, gold, silver
Nungkok	Copper, gold, silver, molybdenum
Paranchangan	Chromite
Bambangan Valley	Copper, gold, silver
G Tambuyukon (E slopes)	Copper, gold, silver
Kinabalu Power Station	Copper
Mesilau Valley	Copper
Kilambuan Valley	Copper
Panataran Valley	Copper
Kinarom Valley	Copper
G Kinabalu (E slopes)	Asbestos
Pulau Banggi	Copper, chromite
Pulau Malawali	Chromite, asbestos
Taritipan	Manganese, chromite, copper, asbestos
Rendagong	Mercury, antimony
Paginatan	Mercury

Even though the reserves of manganese in the Taritipan area are too small for mining, the occurrence of chromite in beach sands, copper in basalt and ultrabasic rock, and asbestos in ultrabasic rock would indicate that a programme of detailed prospecting, including geochemical investigations, is necessary to ascertain their potential for mining.

The pockets of mercury mineralisation, which are thought to be the source of the grains of cinnabar found in the alluvia along some of the tributaries of the Liwagu and also near Paginatan, have not been discovered. The panning operations undertaken during 1969 (Lee, 1970) along the Liwagu streams were not completed and the results were inconclusive; mercury was not found in the country rock. It would appear that further investigations would be justifiable, and these should be extended over the Paginatan area. Although the antimony deposit at Rendagong is too small for mining, the search for mercury should be undertaken with the view of discovering further stibnite occurrences.

AGRICULTURAL DEVELOPMENT OPPORTUNITIES

The residencies, compared to those of the east coast which have been described i Volumes 1 and 2, have a relatively small agricultural development potential. Tabl shows that only some 229 671 ha (567 522 ac), or 18.9%, are considered suited various forms of agriculture. This is illustrated by Figure 3-3. By far the greatest proportion (73.8%), of such land is classified as Soil Suitability Group 3, with or 60 194 ha (148 740 ac) of Groups 1 and 2 i.e., suited for diversified forms of agriculture.

Table 43 shows that over half (52.6%) of the land suited for agriculture remains legally uncommitted as stateland, with 40.3% having been alienated. The forest reserves, in contrast to the situation in the east coast residencies, hold a relatively small agricultural soil resource, only some 4.6% of all the land suited for agricult

TABLE 43 Suitability of the land categories for agriculture in ha (ac)

Agricultural suitability	Soil suitability	Land capability	Land category					
			Alienated land	Forest reserve	Government reserve	Grazing reserve	Stateland	Drainage a irrigatio areas
Diversified agriculture	Group 2	Class II	26 201 (64 744)	1 731 (4 278)	891 (2 201)	229 (567)	30 564 (75 525)	216 (533)
Restricted agriculture	Group 3	Class III	66 337 (163 921)	8 844 (21 853)	1 324 (3 273)	1 730 (4 276)	90 173 (222 821)	1 428 (3 530)
Not suited for agriculture	Groups 4 and 5	Classes IV,V and I	101 086 (249 787)	247 941 (612 673)	37 370 (15 123)	8 552 (21 133)	611 599 (1 511 287)	0

The relationships between land capability classes, soil suitability groups and agricultural suitability are also shown. The full relationships between the land capability classes, land exploitation units and all the resource suitability groups are shown in Table 7 on p. 26.

Figure 3-3 also illustrates the relationship between soil suitability and agricultura development. More than half of the land suited for agriculture is not being cultiv This is shown on Text Map 3-18. A significant proportion of the land considered unsuitable for agriculture is being cultivated. This is largely due to the practice o shifting cultivation (Plate 3- 10) common to much of the mountain areas, and to rubber holdings, frequently dating back to the early part of this century, on stee Data showing the relationships between present land use and suitability for agric are given in Table 44.

TABLE 44 Present land use and agricultural suitability

Present land use category	Agricultural suitability					
	Diversified agriculture		Restricted agriculture		Not suited fo agriculture	
	ha	ac	ha	ac	ha	
1 Urban and associated land	186	460	728	1 800	1 737	
2 Horticulture	3 933	9 720	5 704	14 096	4 853	1
3 Tree, palm and permanent crops	10 016	24 749	24 963	61 685	43 441	10
4 Annual or rotational crops	5 357	13 238	22 338	55 198	24 721	6
5 Improved permanent pasture	101	250	27	68	279	
6 Grassland	10 865	26 849	18 069	44 649	64 168	15
7F Forest	8 656	21 389	45 713	112 959	580 124	1 43
7S Scrub forest	18 676	46 150	44 221	109 271	189 809	46
8 Swamp, marshland and wetland forest	2 105	5 202	6 781	16 756	69 579	17
9 Unused/cleared land	297	733	931	2 300	5 589	1

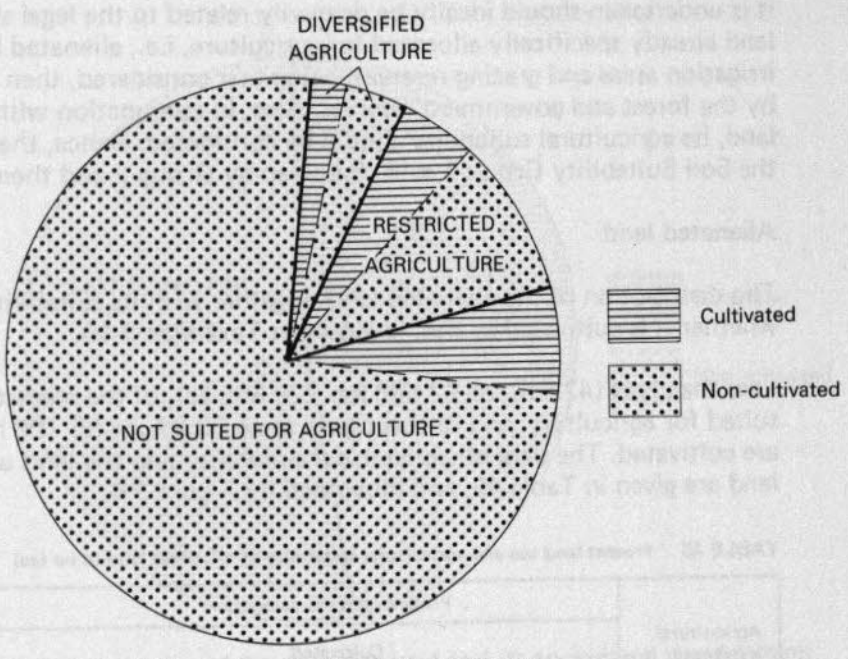
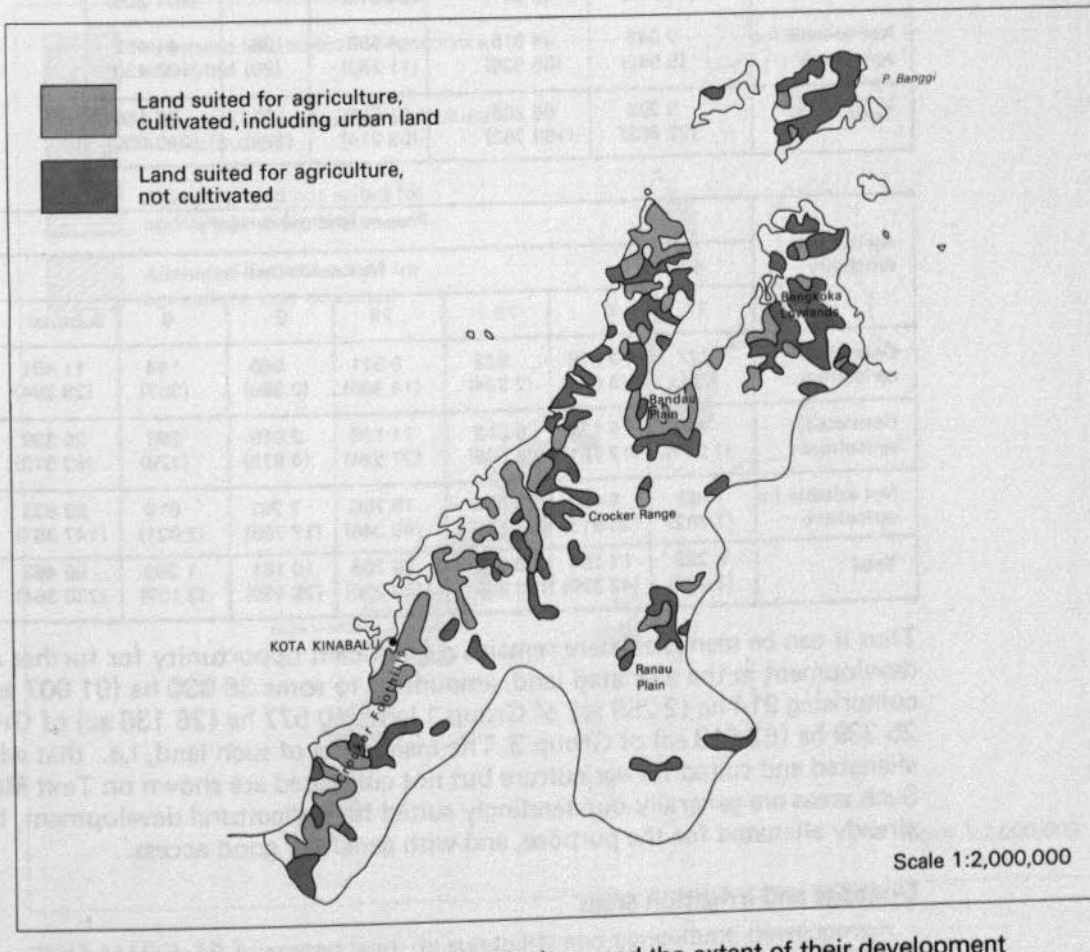


FIGURE 3-3 Land suitability and agricultural development



TEXT MAP 3-18 Areas suitable for agriculture and the extent of their development

Prepared by the Directorate of Overseas S

The course of developing these agricultural soil resources will be dependant on a number of factors such as ease of access and communications, but the order in which it is undertaken should ideally be primarily related to the legal status of the land, with land already specifically allocated for agriculture, i.e., alienated land, drainage and irrigation areas and grazing reserves, being first considered, then stateland, followed by the forest and government reserves. Also, in conjunction with the legal status of the land, its agricultural suitability should be considered. Hence, the first choice would be the Soil Suitability Group 1 soils, followed by Group 2 and then Group 3.

Alienated land

The distribution of the alienated land, together with its suitability for agriculture and whether it is cultivated or not, is shown in Text Map 3-19.

Less than half (47.8%), or 92 538 ha (228 665 ac), of the alienated land, however, is suited for agriculture; and of this figure some 60.2%, or 55 708 ha (137 657 ac), only are cultivated. The data on agricultural suitability and the land use of the alienated land are given in Table 45, and illustrated by Figure 3-4.

TABLE 45 Present land use and agricultural suitability of alienated land in ha (ac)

Agricultural suitability	Present land use category				
	Cultivated				
	2	3	4	5	Subtotal
Diversified agriculture	2 753 (6 802)	8 852 (21 875)	3 089 (7 633)	16 (40)	14 710 (36 350)
Restricted agriculture	4 297 (10 619)	22 821 (56 391)	13 888 (34 318)	0	40 998 (101 308)
Not suitable for agriculture	2 243 (5 542)	34 615 (85 536)	4 558 (11 263)	36 (89)	41 452 (102 430)
Total	9 293 (22 963)	66 288 (163 782)	21 535 (53 214)	52 (129)	97 160 (240 088)

Agricultural suitability	Present land use category							Total
	Non-cultivated							
	1	6	7F	7S	8	9	Subtotal	
Diversified agriculture	122 (301)	3 519 (8 696)	928 (2 294)	5 811 (14 360)	965 (2 386)	144 (357)	11 491 (28 394)	26 201 (64 744)
Restricted agriculture	409 (1 011)	5 172 (12 781)	6 312 (15 595)	11 138 (27 524)	2 015 (4 978)	293 (724)	25 339 (62 613)	66 337 (163 921)
Not suitable for agriculture	762 (1 882)	8 463 (20 913)	23 633 (58 400)	18 756 (46 346)	7 201 (17 795)	818 (2 021)	59 633 (147 357)	101 085 (249 787)
Total	1 293 (3 194)	17 154 (42 390)	30 873 (76 289)	35 705 (88 230)	10 181 (25 159)	1 255 (3 102)	96 463 (238 364)	193 623 (478 452)

Thus it can be seen that there remains a significant opportunity for further agricultural development in the alienated land, amounting to some 36 830 ha (91 007 ac), comprising 914 ha (2 259 ac) of Group 1 land, 10 577 ha (26 136 ac) of Group 2 and 25 339 ha (62 613 ac) of Group 3. The main areas of such land, i.e. that which is alienated and suited for agriculture but not cultivated are shown on Text Map 3-19. Such areas are generally outstandingly suited for agricultural development, being already alienated for the purpose, and with generally good access.

Drainage and irrigation areas

It will have been noted during the description of the alienation and gazettement that the area served by the Drainage and Irrigation Department comprises only 1 644 ha (4 063 ac) and has been mapped in the Tuaran area only.

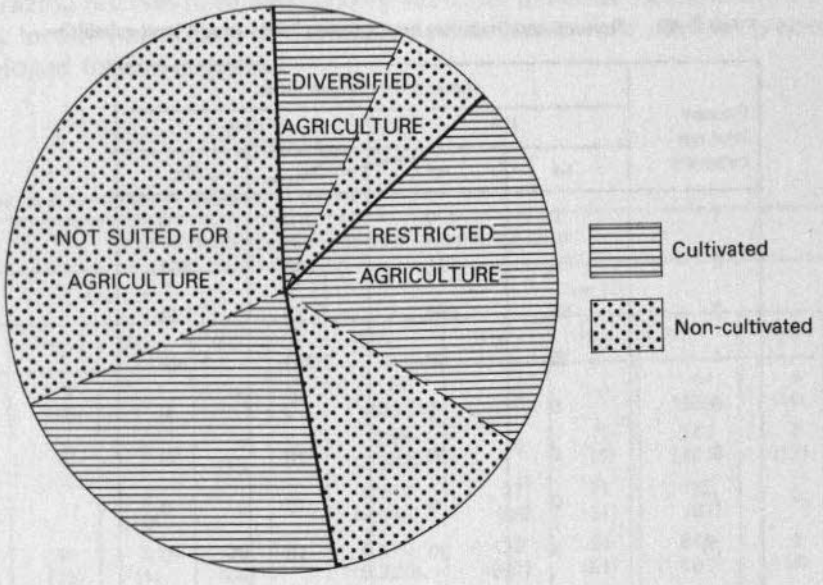
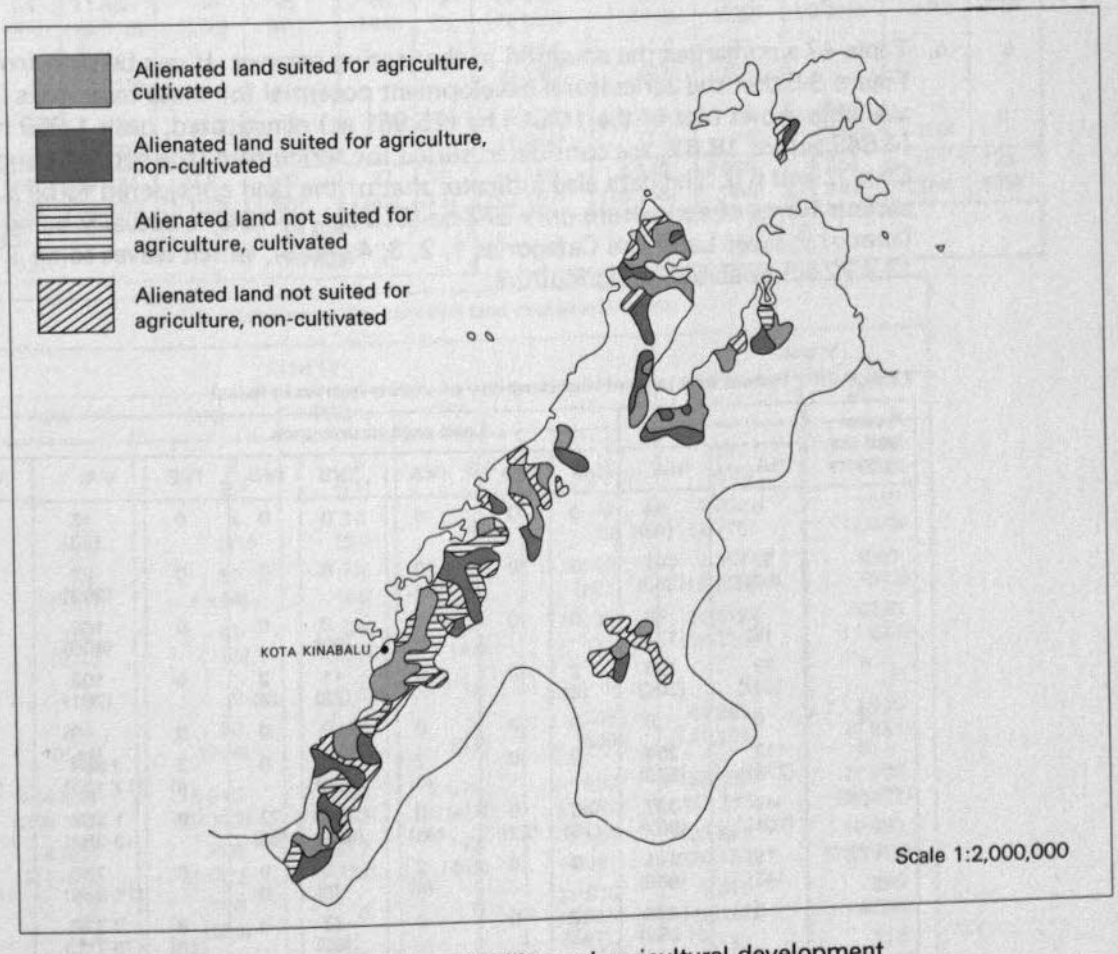


FIGURE 3-4 Soil suitability of the alienated land and its agricultural development



TEXT MAP 3-19 Alienated land, its suitability and agricultural development

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Table 46 gives an account of the land capability and present land use. It can be seen that all the land is suited for agriculture and 70% is being cultivated. Some 494 ha (1 221 ac) only remains available for development.

TABLE 46 Drainage and irrigation area, present land use and land capability

Present land use category	Land exploitation units			
	IIA		IIIA	
	ha	ac	ha	ac
1	0	0	0	0
2	53	131	108	267
3	64	159	72	179
4	23	56	829	2 049
5	0	0	0	0
6	8	20	23	56
7F	0	0	0	0
7S	8	20	16	40
8	59	147	380	939
9	0	0	0	0
Unit total	216	533	1 429	3 530

Grazing reserves

Table 47 summarises the situation in the grazing reserves. It can be seen from this and Figure 3-5 that the agricultural development potential for these reserves is low. The data available shows that of the 10 514 ha (25 981 ac) constituted, only 1 959 ha (4 843 ac), or 18.6%, are considered suited for agriculture (the sum of Land Capability Class II and III). The data also indicates that of the land considered to be suited for various forms of agriculture only 372 ha (919 ac), or 19%, is actually being cultivated (sum of Present Land Use Categories 1, 2, 3, 4 and 5), which leaves some 1 587 ha (3 9 22 ac) available for agriculture.

TABLE 47 Present land use and land capability of grazing reserves in ha(ac)

Present land use category	Land exploitation units									
	IIA	IIIA	IIIB	IIID	IVA	IVB	IVD	IVE	VA	VB
1	0	19 (48)	0	0	0	0	0	0	13 (33)	0
2	22 (52)	101 (250)	0	0	10 (24)	0	0	0	82 (203)	2 (4)
3	3 (8)	69 (172)	0	0	0	8 (20)	0	0	162 (400)	0
4	33 (83)	123 (305)	2 (6)	0	0	11 (28)	2 (4)	0	105 (261)	2 (6)
5	0	0	0	0	0	0	0	0	0	0
6	112 (278)	254 (629)	0	0	2 (5)	10 (24)	0	2 (4)	2 889 (17 139)	8 (20)
7F	41 (101)	367 (907)	30 (75)	9 (22)	38 (95)	188 (466)	22 (55)	0	1 369 (3 384)	49 (122)
7S	18 (45)	244 (606)	0	0	2 (4)	2 (5)	0 0	0	755 (11 866)	18 (39)
8	0	426 (1 052)	50 (143)	0	0	32 (60)	0	8 (16)	2 730 (6 745)	0
9	0	25 (61)	0	0	0	0	0	0	33 (83)	0
Unit total	229 (567)	1 629 (4 030)	90 (224)	9 (22)	52 (126)	252 (623)	24 (59)	10 (20)	8 138 (20 114)	77 (191)
Class total	229 ha (567 ac)	1 730 ha (4 276 ac)			338 ha (828 ac)				8 215 ha (20 305 ac)	

It should be noted that 3 277 ha (8 098 ac), or 31.2%, only is covered by grassland. This is comprised largely of lalang which affords very poor grazing. There are no improved pastures in the grazing reserves. All the evidence, therefore, points to the fact that the grazing reserves have been poorly sited, are under-utilised and the little, but frequently locally important, land which could be successfully used for grazing has not been developed for the purpose.

Stateland

TABLE 48 Present land use and land capability in stateland in ha (ac)

Present land use category	Land capability class and land exploitation units											
	Class I	Class II					Class III					
	IA	IIA	IIB	IIC	IID	IIE	IIIA	IIIB	IIIC	IIID	IIIE	IIIF
1	0	12 (30)	9 (23)	0	0	0	137 (338)	0	0	44 (109)	4 (10)	0
2	0	1 016 (2 512)	0	0	6 (16)	0	948 (2 343)	0	2 (6)	143 (353)	5 (12)	0
3	0	855 (2 112)	0	4 (10)	0	0	1 754 (4 335)	27 (66)	21 (51)	25 (61)	0	0
4	4 (10)	2 044 (5 051)	30 (75)	0 (1)	26 (65)	0	6 570 (16 236)	132 (327)	21 (51)	645 (1 593)	3 (8)	0
5	0	28 (69)	0	0	0	0	0	0	0	0	0	0
6	2 (4)	6 687 (17 017)	3 (7)	5 (12)	0	0	11 672 (28 842)	31 (78)	22 (55)	433 (1 071)	0	0
7F	441 (1 091)	5 977 (14 770)	369 (912)	68 (168)	7 (18)	28 (69)	23 335 (57 661)	3 649 (9 016)	2 579 (6 373)	2 205 (5 449)	87 (214)	95 (235)
7S	59 (147)	11 969 (29 576)	47 (116)	25 (61)	58 (144)	3 (7)	29 525 (72 957)	228 (713)	210 (520)	1 098 (2 713)	8 (20)	28 (70)
8	0	937 (2 315)	0	0	0	0	3 798 (9 385)	17 (43)	12 (30)	0	0	0
9	0	149 (368)	0	0 (1)	0	0	426 (1 054)	5 (12)	2 (4)	160 (397)	4 (10)	0
Unit total	506 (1 252)	29 874 (73 820)	458 (1 133)	102 (253)	97 (243)	31 (76)	78 165 (193 151)	4 149 (10 255)	2 869 (7 090)	4 753 (11 746)	111 (274)	123 (305)
Class total	507 (1 252)	30 563 (75 525)					90 170 (222 821)					

Present land use category	Land capability class and land exploitation units						
	Class IV					Class V	
	IVA	IVB	IVC	IVD	IVE	VA	VB
1	0	2 (5)	8 (21)	0	7 (17)	397 (415)	99 (158)
2	38 (94)	4 (11)	13 (33)	0	29 (73)	1 932 (4 775)	415 (1 025)
3	73 (181)	30 (74)	5 (14)	0	162 (401)	7 902 (19 526)	207 (512)
4	328 (810)	91 (225)	94 (232)	18 (45)	29 (71)	15 919 (39 336)	3 090 (17 637)
5	0	0	0	0	0	0	0
6	261 (644)	90 (224)	28 (70)	9 (24)	258 (639)	44 981 (111 151)	2 975 (7 351)
7F	104 536 (258 313)	15 916 (39 329)	13 720 (33 902)	3 621 (8 947)	599 (1 481)	158 738 (392 249)	27 466 (67 871)
7S	4 638 (11 460)	609 (1 506)	517 (1 278)	182 (451)	2 007 (4 961)	133 613 (330 164)	10 392 (125 681)
8	13 (33)	156 (386)	0	0	31 676 (78 273)	9 875 (49 113)	699 (1 654)
9	33 (83)	42 (10)	46 (113)	9 (22)	117 (289)	2 151 (5 316)	319 (789)
Unit total	109 920 (271 618)	16 940 (41 770)	14 431 (35 663)	3 839 (9 489)	34 884 (86 205)	385 598 (952 612)	45 662 (112 678)
Class total	180 014 (444 745)					431 170 (1 065 290)	

The stateland holds the greatest potential for agricultural development; it contains 52.6% of the agricultural soil resource. Table 43 shows that this amounts to a total of 120 737 ha (298 346 ac) consisting of 30 564 ha (75 525 ac) of land suited for a diversified form of agriculture and 90 173 ha (222 821 ac) for a more restricted range. It can be seen, therefore that only 16.5% of the stateland is suited for agriculture. This is illustrated by Figure 3-6.

Table 48 gives the data on present land use and land capability. It shows that a surprisingly high proportion, 12%, amounting to 14 483 ha (35 788 ac) is being used for agriculture; this includes 48 ha (119 ac) covered by urban development. This extensive use of the stateland can be attributed largely to two factors: that the issue of land titles is not keeping abreast of settlement and development, and that shifting cultivation is almost exclusively practised on such uncommitted land. Even so, significant agricultural development opportunities remain: 26 562 ha (65 636 ac) of Class II and 79 692 ha (196 922 ac) of Class III land, a total of 106 254 ha (262 558 ac). Most of this land is to be found in the Kudat District. Elsewhere it is restricted to relatively small, scattered tracts which normally occur along the middle and sometimes upper reaches of the main valleys. The location of the main areas of stateland with a potential for further agricultural development is shown in Text Map 3-20.

Soil Suitability Group 1 in stateland

It is not surprising that most of the Group 1 soils have been alienated and are being farmed. Only small scattered areas remain as stateland, with an aggregate total of 1 046 ha (2 584 ac). Almost all, 1 000 ha (2 460 ac), occur on the alluvial soils of the Bandau Plain where again it would appear that the rate of development has outstripped the granting of land titles, with just over (50.2%) of Group 1 non-alienated land being cultivated. The potential remaining for development on the Plain is restricted to 520 ha (1 290 ac).

Soil Suitability Group 2 in stateland

These comprise some 29 517 ha (72 938 ac), and the main areas are given in Table 49.

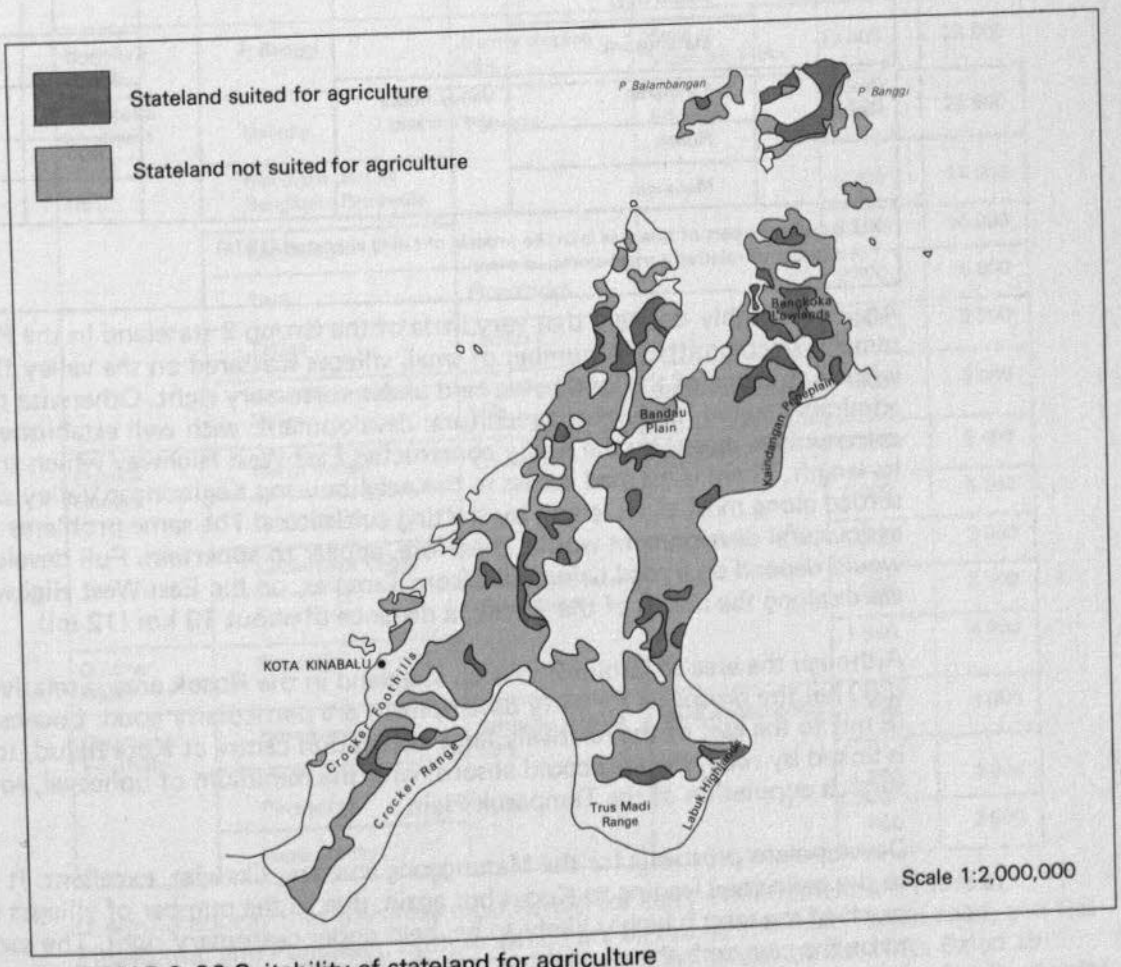
The greatest potential for development exists in the Bengkoka Lowlands. At present, however, this is severely limited by poor communications; largely dependant on sea transport with Kudat and internally on footpaths and a few logging tracks. This situation will improve considerably with the construction of the road from Kota Marudu thereby connecting the main part of the Bengkoka Peninsula with the west coast road system, and in the long-term with the construction of a road linking with the east coast roads via the Sandakan Peninsula. Internally, agricultural development will depend on a main road being built running northwards from the Pitas area to the tip of the Peninsula, a distance of about 35 km (22 mi).

The immediate development prospects of the Group 2 soils in the Lohan and Merali Valleys are particularly favourable. Served by a system of recently constructed roads both are easily accessible to the more densely populated Ranau Town area. Settlement is taking place at a fairly rapid pace; probably outstripping alienation, and it is highly likely that much of this stateland has in fact been settled and held by natives under customary rights. The same applies to the Merungin area which can be considered as an eastern extension of the Merali Valley and which is also connected to the Ranau road system. The Panataran area is more remote but will shortly be served by a road which is being constructed from Paranchangan to the south. Otherwise development prospects appear to be similar.

A similar situation probably occurs with the Group 2 soils still remaining as stateland on the Bandau Plain. It is highly unlikely that any extensive areas remain unbespoken-for in such a highly populated and accessible area. A similar constraint is likely to be found in the adjacent Bandau Valley and the more remote Marak-Parak area. Further development in both areas will be dependant on a road being built southwards from Kota Marudu (Bandau) for some 22 km (14 mi).

FIGURE 3-5 Suitability of grazing reserves for agriculture

FIGURE 3-6 Suitability of stateland for agriculture



TEXT MAP 3-20 Suitability of stateland for agriculture

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TABLE 49 Main areas of Group 2 soils occurring in the stateland

Region	Area	Soils		Extent	
		Landform	Parent material	ha	ac
Bengkoka Lowlands	+Mengkubou	Terraces	Alluvium	3 000	7 400
	Pitas	Meander belts		2 100	5 200
	*Bengkoka Peninsula			2 000	5 000
	Kanibongan			1 100	2 500
Ranau Plain	Lohan - Merali Valleys	Valley floors and terraces		2 650	5 400
Bandau Plain	Bandau Plain	Meander belts		1 600	4 000
	Marak-Parak	Valley floors and terraces		1 400	3 500
	*Bandau Valley	Meander belts		950	2 300
Labuk Highlands	Paginatan	Valley floors and terraces		1 600	3 900
	Kegibongan			850	2 200
Northern Islands	P Banggi			1 150	2 800
	P Balambangan	Gently sloping hills	Mudstone/clay	1 000	2 500
Crocker Foothills	*Marimbau (White Rocks Bay)	Meander belts	Alluvium	1 150	2 800
	Matunggong			800	2 000
Crocker Range	Panataran	Valley floors and terraces		850	2 100
	Rosok			800	2 000
	Merungin			750	1 800

+ A substantial part of this area is in the process of being alienated (1974)
* A number of relatively small scattered areas

Again it is highly unlikely that very little of the Group 2 stateland in the Paginatan area remains uncommitted. A number of small villages scattered on the valley floor bear witness to much of the land being held under customary right. Otherwise the area is admirably suited for further agricultural development: with well established farming communities served by the newly constructed East-West Highway which transgresses its length. There is no road access to the neighbouring Kegibongan Valley which is again settled along most of its length by shifting cultivators. The same problems related to agricultural development would, therefore, appear to appertain. Full development would depend on a road being built from Tampias, on the East-West Highway, westwards along the length of the valley, a distance of about 19 km (12 mi).

Although the area of Group 2 soils on stateland in the Rosok area is relatively small (800 ha) the prospects for early development are particularly good. Located only 13 km (8 mi) to the east of the relatively large population centre at Kota Belud, to which it is linked by road, the area could absorb, with the minimum of upheaval, some of the surplus population of the Tempasuk Plain.

Development prospects for the Matunggong area are, likewise, excellent. It lies close to the main road leading to Kudat but again, due to the number of villages in the area, much of the land is highly likely to be held under customary right. The same is likely to be the case with the alluvial tracts in the Marimbau area, and development is further limited by poor access.

Agricultural development on Pulau Balambangan will not be extensive, due largely to its limited soil resource. Other constraints include remoteness, lying some 40 km (25 mi) from the port at Kudat, and also the presence of shifting cultivators on much of the land suited for development. The main scope for development lies in establishing a permanent form of agriculture on such land.

The prospects for Pulau Banggi are very much better. It will be seen from the following text that the island, in addition to the Group 2 soils of the stateland which have already been discussed, holds in all a very considerable agricultural soil resource, and since development can be undertaken on a large scale, the constraint imposed by its insularity diminishes accordingly. At present there are very few roads, but there should be no undue difficulty in constructing a proper road system to facilitate agricultural expansion. The establishment of appropriate shipping facilities will be necessary. The sheltered waters lying to the south-west should serve the purpose, possibly by improving and expanding the facilities at the government post at Karakit.

Soil Suitability Group 3 in stateland

The Group 3 soils in the stateland occupy 90 172 ha (222 821 ac) (Table 48). The main areas are given in Table 50 and on the land capability classification map. In all but Pulau Banggi development is likely to be influenced by the native customary rights to land.

TABLE 50 Main areas of Group 3 soils occurring in the stateland

Region	Area	Soils		Extent	
		Landform	Parent material	ha	ac
Northern Islands	P. Banggi	Gently sloping hills	Basic to ultrabasic rocks	13 300	32 900
Bengkoka Lowlands	Datong	Terraces	Alluvium	9 300	22 900
	Northern part of Bengkoka Peninsula			5 700	14 000
	Kanibongan			5 700	14 000
	Pitas	Floodplains		2 000	5 000
	Telaga	Terraces		900	2 200
	Middle Bengkoka Valley	Strongly sloping hills	Sandstones/shales	900	2 000
Crocker Range	Wariu Valley	Terraces	Alluvium	2 200	5 400
	Papar Valley			2 000	5 100
	Kadamaian Valley			1 300	3 200
	Gana Plain	Floodplains		1 400	3 500
Crocker Plains	Pandasan			1 950	4 800
Crocker Foothills	Bongawan	Strongly sloping hills	Sandstones/shales	1 450	3 600
	Pinawantai			1 200	3 000
	Papar Valley			800	2 000

It would appear that the areas most suited for early development are those at Pinawantai and Pandasan, both of which are served by the main Kudat road, and the Kadamaian Valley, the middle reaches of which are served by the Kota Belud to Ranau road and the upper reaches by spur roads from the Ranau road. Smaller feeder roads will be required to facilitate development in both areas.

The Bengkoka Lowlands offer the greatest overall opportunity for agricultural development especially considering the areas of Group 2 soils which exist in the stateland. As for the Group 2 soils the development of the soil resources of the Bengkoka Peninsula will depend on an effective road system being constructed.

The development prospects for Pulau Banggi are very considerable, but are unlikely to be appreciated in the near future. This is because of the island's remoteness and the extensive areas of similar land which are of very much easier access on the mainland of the East Coast. The soil resources of the island will undoubtedly be developed eventually and the recommendations concerning transport and communications, given for the development of its Group 2 soils, similarly apply.

The Gana Plain lies some 19 km (12 mi) south-east of the Bandau Plain; there are communications by foot-path only. The development of its agricultural resources will largely depend on an inter-connecting road being built, also, much of the land because of its swampy nature, will require drainage. The construction of a road and drainage system is of doubtful value and requires further study.

The remaining main areas of Group 3 soils in the statelands, i.e., in the Wariu and Papar Valleys are inhabited but sparsely cultivated. There are opportunities for extending and improving the agriculture in both. The construction of access roads will be an essential pre-requisite.

Forest reserves

The forest reserves hold a relatively small agricultural soil resource. This is illustrated by Figure 3-7. The total area is estimated as 10 575 ha (26 131 ac) only. This represents 4.10% of all land gazetted as forest reserves and from Tables 43 and 51 it can be seen that most of this land 8 844 ha (21 853 ac) is suited for a restricted range of agricultural crops.

The distribution of the main areas suited for agriculture within the forest reserve boundaries is shown on Text Map 3-21. It can be seen that they are restricted to the Banggi, Paitan and Bengkoka Forest Reserves.

Soil Suitability Group 2

These are restricted to a number of small, scattered valley floors in the Banggi Forest Reserve. The soils are formed on terraces and valley floors and they are derived from alluvial deposits. They are of very restricted extent covering in total some 890 ha (2 200 ac) only, the largest single occurrence being not more than 50 ha (600 ac). Any agricultural development along these riverine tracts will be closely related to the opening-up of the adjoining statelands for agriculture.

Soil Suitability Group 3

Some 3 800 ha (9 000 ac) of Group 3 soils occur in the Paitan Forest Reserve in the Kanibongan area. The soils are developed on alluvial terraces. The prospects for the exision of these soils from the Forest Reserve would, at present, seem remote; especially considering the availability of similar soils in the nearby stateland and the present-day constraints to development imposed by poor communications.

A considerable area of Pulau Banggi contains Group 3 soils in the stateland which are found on gently sloping hills and derived from ultrabasic to basic rocks. These soils also extend into the Banggi Forest Reserve over an area of 2 900 ha (7 000 ac). Again the development of such land for agriculture will be inter-linked with the utilisation of the adjoining statelands.

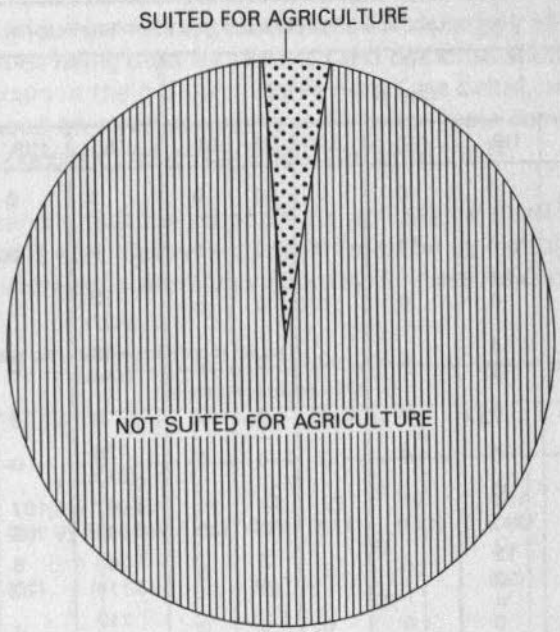
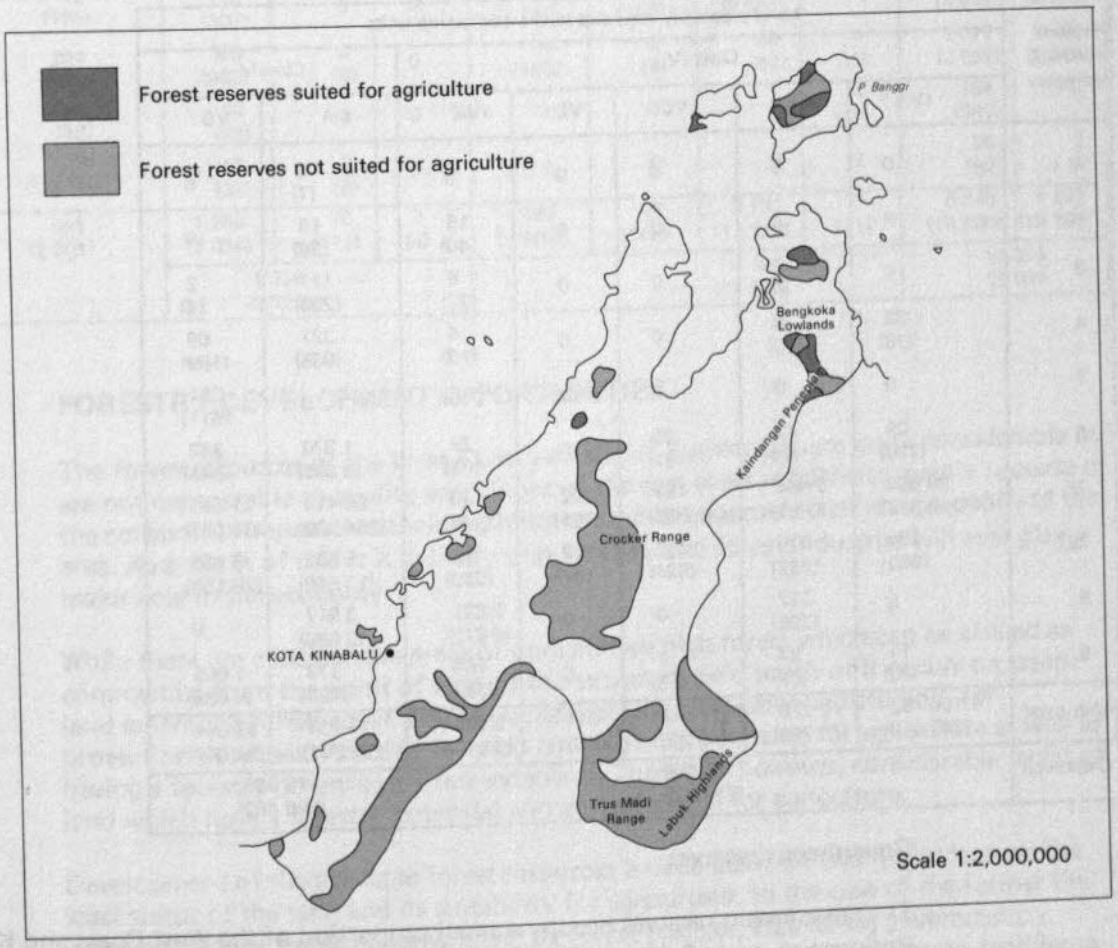


FIGURE 3-7 Suitability of forest reserves for agriculture



TEXT MAP 3-21 Suitability of forest reserves for agriculture

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TABLE 51 Forest reserves present land use and land capability in ha (ac)

Present land use category	Land capability class and land exploitation units												
	Class I	Class II						Class III					
	IA	IIA	IIB	IIC	IID	IIE	IIF	IIIA	IIIB	IIIC	IIID	IIIE	IIIF
1	0	7 (18)	0	0	0	0	0	0	0	0	0	0	0
2	0	19 (48)	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	173 (427)	0	0	0	0	0
4	0	54 (133)	4 (9)	0	0	0	0	58 (144)	0	4 (11)	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	51 (127)	0	0	0	0	0	126 (313)	0	1 (2)	0	0	0
7F	263 (652)	798 (1 973)	158 (390)	51 (127)	29 (72)	24 (60)	14 (35)	4 067 (10 049)	2 107 (5 206)	525 (1 297)	82 (202)	227 (560)	35 (87)
7S	0	463 (1 145)	13 (32)	0	0	2 (4)	0	1 260 (3 114)	8 (20)	57 (141)	0	0	0
8	0	42 (104)	0	0	0	0	0	113 (280)	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit total	263 (652)	1 436 (3 548)	175 (432)	51 (127)	29 (72)	26 (64)	14 (35)	5 798 (14 327)	2 115 (5 226)	587 (1 451)	82 (202)	227 (560)	35 (87)
Class total	263 (652)	1 731 (4 228)						8 844 (21 853)					

Present land use category	Land capability class and land exploitation units						
	Class IV					Class V	
	IVA	IVB	IVC	IVD	IVE	VA	VB
1	0	0	0	0	0	3 (7)	0
2	0	0	0	0	16 (40)	15 (38)	0
3	0	0	0	0	9 (22)	117 (290)	2 (4)
4	32 (78)	8 (20)	0	0	4 (10)	327 (808)	69 (169)
5	0	0	0	0	0	0	231 (571)
6	89 (220)	42 (103)	35 (87)	0	29 (73)	1 370 (3 385)	382 (945)
7F	99 680 (246 313)	9 664 (23 881)	17 404 (43 006)	292 (721)	140 (346)	66 413 (164 109)	27 549 (68 077)
7S	365 (902)	215 (532)	212 (524)	19 (47)	93 (230)	5 602 (13 849)	8 156 (20 153)
8	0	322 (796)	0	0	2 821 (6 972)	3 917 (9 680)	0
9	15 (30)	27 (67)	7 (18)	0	154 (382)	173 (428)	1 655 (4 089)
Unit total	1 100 182 (247 549)	10 279 (25 399)	17 658 (43 035)	311 (768)	3 266 (8 075)	77 937 (192 587)	38 044 (94 008)
Class total	131 696 (234 826)					115 981 (286 602)	

Government reserves

The government reserves occupy a small proportion of the West Coast and Kudat Residencies, some 3.3% or 39 586 ha (97 819 ac). Table 43 shows that 2 216 ha (5 574 ac) only, or 5.6%, of the reserves are considered suited for agriculture, 891 ha (2 201 ac) for diversified agriculture (Land Capability Class II) and 1 325 ha (3 273 ac) for a more restricted form (Class III).

Table 52 summarises the present land use and land capability of the government reserves. From this it can be deduced that 758 ha (1 873 ac), or 34.2%, of the land suited therein for agriculture is being cultivated. This is largely attributed to a number of agricultural stations being used for research and demonstration purposes. Most of the unused land occurs in the military reserve near Kota Belud, and consists mainly of alluvial soils developed on terraces and meander belts. These comprise both Group 2 and 3 soils but they occur in relatively small, scattered tracts.

It can be seen, therefore, that the potential for agricultural development in the government reserves is very limited and, apart from the agricultural stations, will play very little part in future agricultural development in these residencies.

TABLE 52 Government reserve present land use and land capability in ha (ac)

Present land use category	Land exploitation units									
	IIA	IIIA	IIID	IIIE	IVA	IVB	IVC	IVE	VA	VB
1	36 (88)	86 (212)	27 (68)	2 (4)	0	0	0	2 (4)	497 (1 184)	0
2	57 (142)	96 (238)	11 (25)	0	0	0	0	0	39 (97)	13 (32)
3	197 (486)	49 (122)	0	0	8 (20)	0	0	0	139 (344)	0
4	42 (104)	45 (112)	27 (66)	0	0	0	0	0	29 (73)	0
5	57 (141)	27 (68)	0	0	0	0	0	0	12 (31)	0
6	229 (566)	383 (947)	0	0	0	0	0	0	2 073 (5 123)	167 (414)
7F	42 (104)	124 (307)	0	0	1 530 (3 781)	42 (105)	3 096 (7 651)	0	2 003 (4 949)	1 706 (4 217)
7S	204 (505)	388 (960)	3 (8)	0	44 (108)	2 (4)	35 (87)	1 (3)	1 077 (2 661)	2 439 (6 026)
8	23 (58)	40 (98)	0	0	0	0	0	4 (10)	154 (380)	0
9	3 (7)	13 (32)	2 (6)	0	0	0	0	0	25 (62)	2 (4)
Unit total	891 (2 201)	1 253 (3 096)	70 (173)	2 (4)	1 582 (3 909)	44 (109)	3 131 (11 773)	7 (11)	6 048 (14 904)	4 327 (10 393)
Class total		1 325 (3 273)			4 764 (11 773)				10 375 25 597	

FORESTRY DEVELOPMENT OPPORTUNITIES

The forest resources of the West Coast and Kudat Residencies are quite considerable but are not comparable in quality with those of the east coast residencies mainly because of the constraints imposed on their exploitation and development by the topography of the area. As a result of this it is unlikely that forestry and forest industries will ever play a major role in the economy.

While there are considerable areas of undisturbed high forest which can be classed as commercial from the point of view of the expected yield much of it occurs on steep-land where the forest cover should be maintained, preferably undisturbed, for protection purposes. Areas of forested land which are suitable for agriculture as well as having a forestry potential are not extensive. There are, however, considerable areas of land which have a forestry potential and are not suited for agriculture.

Development of the available forest resources is dependent on two major factors; the legal status of the land and its suitability for agriculture. In the case of the former the order of priority for development will be forest reserves, statelands, government reserves and alienated land. In the case of the latter priority will be given to land more suited for forestry than the various forms of agriculture i.e., Class IV land first followed by III and then II. Class V land with no potential for either agriculture or forestry is not considered for development. The timber resources of the national parks

cannot be exploited; to do so would contravene the basic objectives of such parks. As has been noted in Part 4 much of the accessible commercial forest on stateland and in forest reserves has been licenced and it is expected that most will be logged within the foreseeable future. None of the forest is at present being managed on a sustained yield basis.

In this section of the report, Timber Resource Groups 1, 2 and 3 are grouped together and treated as one category, Commercial forest, while Group 7, Productive mangrove forest, is treated separately. The reason for this is that areas of Groups 1, 2 and 3 forest are often found intermingled and in most cases it would be impractical to consider separate exploitation and development. On the separate land capability classification map these groups are not shown separately but as one category, Land Class IV which also includes mangrove forest. As Groups 4, 5, 6 and 8 are not considered to have any commercial potential in the foreseeable future, areas classified as such are not considered as having any development opportunities and, accordingly, are not discussed further.

Data have been derived from two sources; Forest Department mapping prior to 1970 and the Forest Inventory afterwards. Both were based on aerial photographic interpretation and form the basis for the land capability classification mapping and data contained in Table 53. Table 19, however, is based on the published stock tables of the forest inventory (Forestal, 1973), which were arrived at by ground survey supplementing the photographic interpretation. It should therefore be noted that the data in Tables 19 and 53 differ accordingly.

Forest reserves

Forest resource development areas in forest reserves and national parks are shown on Text Map 3-22 and summarised in Table 53.

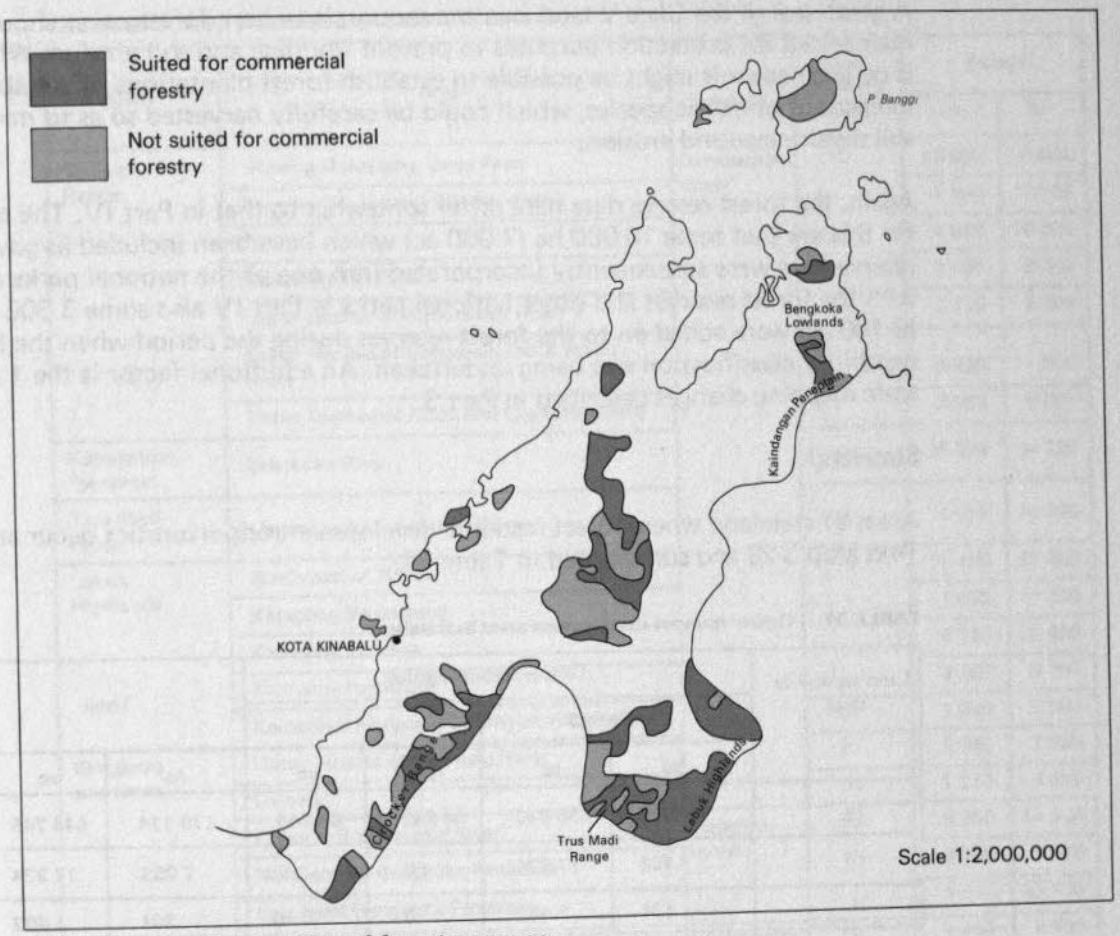
Much of the Class IV land carrying commercial forest is in protection forest reserves and the need to maintain adequate forest cover on such areas is a severe constraint on development. Any exploitation of this forest should be carefully and strictly controlled. As can be seen from Table 53 there is a development opportunity in mangrove forest (Group 7), albeit the area is relatively small.

TABLE 53 Timber resource development areas in forest reserves

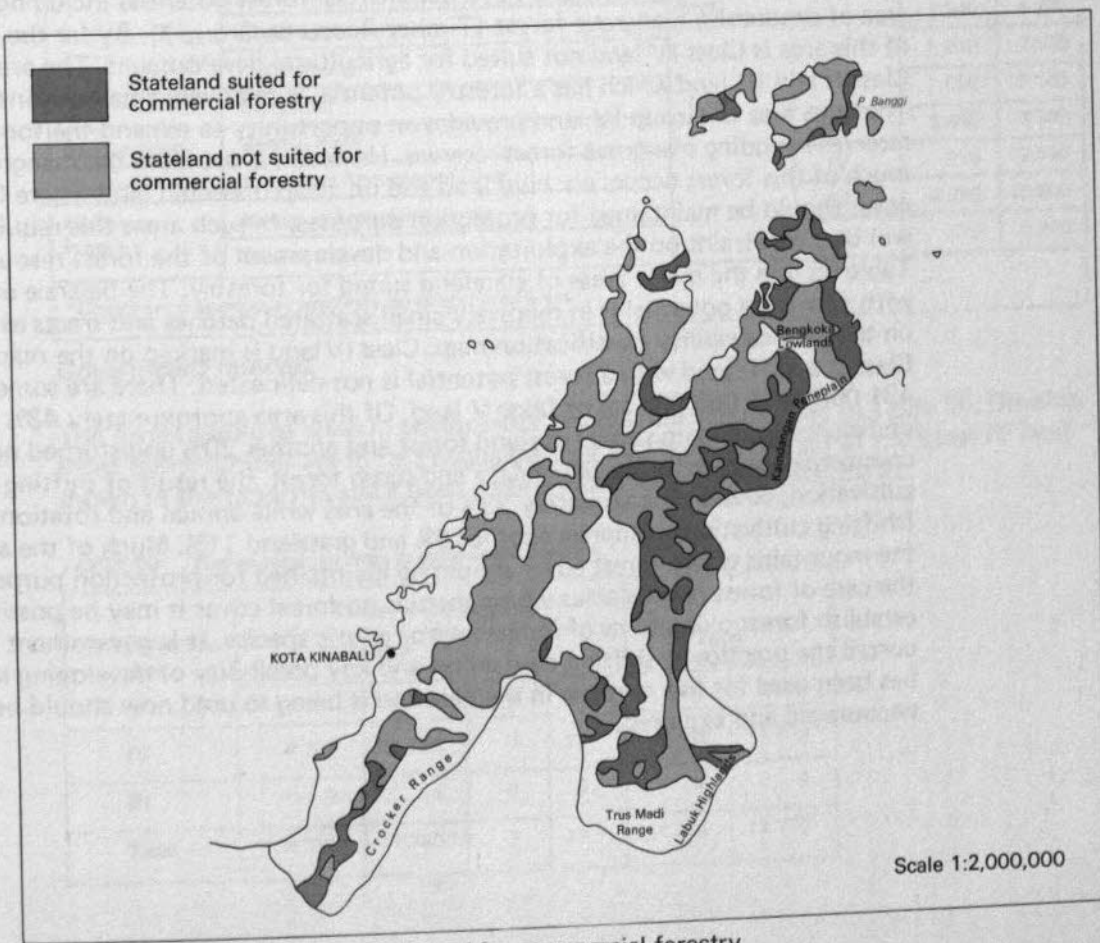
Land capability class	Timber resource group				Total	
	1, 2 and 3		7			
	ha	ac	ha	ac	ha	ac
IV	*131 023	323 758	3 380	8 351	134 403	332 109
III	2 964	7 324	0	0	2 964	7 324
II	266	658	0	0	266	658
Total	134 253	331 740	3 380	8 351	137 633	340 091

* Includes 19 862 ha (49 080 ac) in national parks

The area of Class II, III and IV land in the forest reserves with a timber potential amounts to only some 57% of the total, the balance being Class II and III land with no timber potential (3%) and Class V land (40%). Of the land with no potential approximately 44% is covered with undisturbed non-commercial dryland forest much of which it montane while a further 4% carries undisturbed non-commercial swamp forest. The balance comprises mainly secondary forest, being regrowth following shifting cultivation, non-forest land i.e. current shifting cultivation, grassland and permanent cultivation, and non-productive land, most of which is bare rock around the summit area of Gunong Kinabalu.



TEXT MAP 3-22 Suitability of forest reserves and national parks for commercial forestry



TEXT MAP 3-23 Suitability of stateland for commercial forestry

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A great deal of the Class V land is in the mountains where forest cover should be maintained for protection purposes to prevent flooding and soil erosion. Where there is no such cover it might be possible to establish forest plantations of suitable indigenous or exotic species, which could be carefully harvested so as to minimise soil disturbance and erosion.

Again, the forest reserve data here differ somewhat to that in Part IV. The main reasons for this are that some 10 900 ha (7 000 ac) which have been included as government reserve here were subsequently incorporated into one of the national parks and included with the forest reserves and other national parks in Part IV also some 3 300 ha (8 100 ac) were added on to the forest reserves during the period when the basic land capability classification was being undertaken. An additional factor is the 1:50 000 scale mapping changes described in Part 3.

Stateland

Areas of stateland where forest resource development opportunities occur are shown on Text Map 3-23 and summarised in Table 54.

TABLE 54 Timber resource development areas in stateland

Land capability class	Timber resource group				Total	
	1, 2 and 3		7			
	ha	ac	ha	ac	ha	ac
IV	144 288	358 540	34 886	86 205	179 174	444 745
III	7 253	17 924	0	0	7 253	17 924
II	591	1 462	0	0	591	1 462
Total	152 132	377 926	34 886	86 205	187 018	464 131

A considerable area of stateland has a commercial forest potential including a fairly large area of productive mangrove forest (Timber Resource Group 7). By far the greater part of this area is Class IV land not suited for agricultural development. The area of Class II and III land which has a forestry potential is relatively small and insignificant. The large area of Group IV land provides an opportunity to expand the forest reserves including mangrove forest reserves. However, apart from the mangrove areas, much of this forest occurs on hilly land and on steep dissected land where forest cover should be maintained for protection purposes. In such areas this requirement will be a constraint on the exploitation and development of the forest resource. Table 55 lists the major areas of stateland suited for forestry. The balance of the land with a forestry potential is in relatively small scattered patches and tracts as shown on the land capability classification map. Class IV land is marked on the map but Class II and III land with a forest potential is not delineated. There are some 431 000 ha (1 065 000 ac) of Class V land. Of this area approximately 43% carries undisturbed non-commercial dryland forest and another 20% undisturbed non-commercial swamp forest. Secondary and scrub forest, the result of shifting cultivation, covers approximately 33% of the area while annual and rotational crops (shifting cultivation) comprise another 4% and grassland 11%. Much of the area is in the mountains where forest cover should be maintained for protection purposes. As in the case of forest reserve areas where there is no forest cover it may be possible to establish forest plantations of indigenous or exotic species. It is government policy to curtail the practice of shifting cultivation and any possibility of developing land which has been used for this purpose in the past and is being so used now should be encouraged and explored.

TABLE 55 Major areas suited for forestry in stateland

Region	Area	Forest potential	Land capability class	Extent	
				ha	ac
Crocker Range	Gunong Mensalong, Gana Plain	Commercial forest	IV	39 660	98 000
	Bongan, Tuaran and Bandau rivers			7 080	17 500
	*Poring			4 040	10 000
	*Kampong Tamboa			2 430	6 000
	Upper reaches of Kapunakan River			2 710	6 700
	Upper reaches of Bongawan and Kimanis rivers			4 450	11 000
	Upper reaches of Papar and Gramatol rivers			3 960	9 800
Kaindangan Peneplain	Bengkoka River		IV	21 970	54 300
Trus Madi Range	*Upper reaches of Melaut River		IV	5 950	14 700
Labuk Highlands	South east of Ranau		IV	11 130	27 500
	Kampong Barambang			7 000	17 300
	Kampong Tampias			6 230	15 400
	Kampong Paginatan			2 300	5 700
	*Kampongs Kimangis, Lidong and Maringkan		III	1 250	3 100
Bengkoka Lowlands	*Upper reaches of Biliajong River		IV	3 160	7 800
	*Datong		III	1 210	3 000
	Estuary of Bengkoka River	Mangrove forest	IV	5 750	14 200
	Northern tip Bengkoka Peninsula			3 200	7 900
	East coast Bengkoka Peninsula			9 510	23 500
Crocker Foothills	Upper reaches of Puas and Gamager rivers	Commercial forest	III	1 050	2 600
	Upper reaches of Nadutan River			445	1 100
	Agal Bay	Mangrove forest	IV	1 010	2 500
	Kudat Harbour			1 700	4 200
	Mengkabong			1 010	2 500
	Menggatal			850	2 100
Bandau Plain	Bandau Plain		IV	3 440	8 500
Crocker Plains	Estuary of Matunggong River		IV	970	2 400
Northern Islands	Banggi and adjacent islands		IV	4 290	10 600
	Balambangan		IV	570	1 400

*Comprises a number of relatively small scattered areas

Government reserves

The forest resource areas in government reserves are summarised in Table 56. Development opportunities are in fact negligible as 4 742 ha (11 716 ac) of the Class IV land shown in the table has since been incorporated into the national parks.

TABLE 56 Timber resource areas in government reserves

Land capability class	Timber resource group				Total	
	1, 2 and 3		7			
	ha	ac	ha	ac	ha	ac
IV	4 757	11 756	7	17	4 764	11 773
III	2	4	0	0	2	4
Total	4 759	11 760	7	17	4 766	11 777

Drainage and irrigation areas

There are no forest resource development opportunities in areas under the control of the Drainage and Irrigation Department.

Grazing reserves

Forest resource areas in grazing reserves amount to only some 428 ha (1 052 ac). Of this total 338 ha (828 ac) are Class IV land and the balance is Class III. There are two main areas with forest potential, at Ranau where there are some 182 ha (450 ac) on Class IV land and at Kampong Gadong (near Kimanis) where there are some 61 ha (150 ac) also on Class IV land. The remainder is in small scattered patches.

Alienated land

Timber resource areas in non-cultivated alienated land are not extensive and are summarised in Table 57. Such areas having no committment to permanent forestry, are likely to be logged in the near future and the greater part cleared for agricultural development.

TABLE 57 Timber resource areas in alienated land

Land capability class	Timber resource group				Total	
	1, 2 and 3		7			
	ha	ac	ha	ac	ha	ac
IV	8 042	19 888	329	814	8 371	20 702
III	863	2 042	0	0	863	2 042
II	5	12	0	0	5	12
Total	8 910	21 942	329	814	9 239	22 756

The major areas of alienated land suited for forestry are listed in Table 58. The balance of the land with a forest potential is in small scattered patches and tracts.

TABLE 58 Major areas suited for forestry in alienated land

Region	Area	Forest potential	Land capability class	Approximate extent	
				ha	ac
Crocker Range	Ulu Sg. Kimanis	Commercial forest	IV	1 580	3 900
	Tenompok			1 520	3 750
	Kg Kayau			570	1 400
Crocker Plains	Kimanis			690	1 700

WATER RESOURCES DEVELOPMENT OPPORTUNITIES

Although a certain amount of hydrological data is available, no comprehensive water resource survey has been carried out and records are far from complete and adequate. There is thus a need for such a survey in order that the water resources may be properly developed and utilised. It will have been noticed in Part 4, when the water resources were discussed, that surface water is the main source of supply for all purposes, groundwater being generally negligible.

The southern part of the West Coast Residency, with the generally high rainfall on the west facing slopes of the Crocker Range feeding the rivers flowing down to the coast, has in most areas adequate supplies of surface water to meet current and expected future requirements. However the situation is rather different in the Kudat Residency

particularly in the Kudat and Bengkoka Peninsulas. Here the rainfall is generally considerably lower and surface water supplies are hardly adequate to meet current demand let alone expected future requirements. In the Ranau area where rainfall is also relatively low, water supplies, while in general adequate for domestic purposes, may not be sufficient for large scale irrigation. More hydrological data are required to properly assess the situation.

Potable water

The development of water resources will be necessary to ensure adequate supplies of potable water to meet the needs of the expanding urban and rural population. This is particularly so in the Kudat and Bengkoka Peninsulas, especially the latter where there is potential for considerable agricultural development. To safeguard water supplies and ensure maximum utilisation of precipitation it is essential that catchment areas should be properly protected. Ideally the natural forest cover should be maintained and neither the vegetation nor soil disturbed. This is particularly important in areas like the Bengkoka Peninsula where surface water supplies are meagre. Unfortunately logging of the only forest reserve area in the Peninsula has already started and it is likely that these operations will have an adverse effect on water supplies. Where exploitation of catchment areas cannot be avoided then logging should be carefully controlled so as to reduce disturbance of the soil and vegetation cover to a minimum. In this context it is important that sources of potable water supplies should be identified without delay and steps taken to protect the catchment areas concerned both by conserving the vegetation and also limiting human settlement to avoid pollution (see Plates 3-11 and 3-12).

Because the reserves of groundwater are likely to be inadequate the construction of dams to impound water may be necessary. This has in recent years been done to provide water supplies for domestic purposes to the town of Kudat. The reservoir holds up to 2 271 250 000 1 (500 million gal) and at present the average daily draw off is only 1 635 300 1 (360 000 gal). The supply is thus adequate for the present and foreseeable future and demonstrates the feasibility of this method.

Despite the rapidly increasing population of Kota Kinabalu and its immediate surroundings raw water supplies, which are drawn from the Moyog River upstream from Penampang, are considered quite adequate for the foreseeable future. A similar situation applies to the other communities on the coastal and Ranau plains.

Irrigation water

Large supplies of water are required for irrigation purposes mainly in connection with rice cultivation and in particular where double cropping is carried out. With the expected expansion of the area of irrigated crops and the wider use of double cropping the demand for water for this purpose is likely to increase considerably. Even in the southern part of the residencies' rainfall is not by itself sufficient and must be supplemented, and this is much more so in the northern part and the Ranau area where rainfall is lower. Information on the availability of water for irrigation is at present scanty and in general inadequate. Again, more hydrological data are required in order to plan and develop the necessary supplies.

Water control

Flooding is not in general a serious problem and floods which do occur are usually of short duration except in low-lying areas under tidal influence. However this situation could change drastically if there is widespread and uncontrolled exploitation of the forests in the catchment areas in the Crocker Range. Protection of the main river catchment areas is essential if serious flooding and soil erosion are to be prevented. The importance of maintaining the Crocker Range Forest Reserve for its prime protective function is particularly relevant in this context; logging operations should be completely prohibited. As mentioned earlier the conservation of catchment areas is also essential to regulate and conserve water supplies. Shifting cultivation is an important factor and wherever possible should be restricted especially in catchment areas.

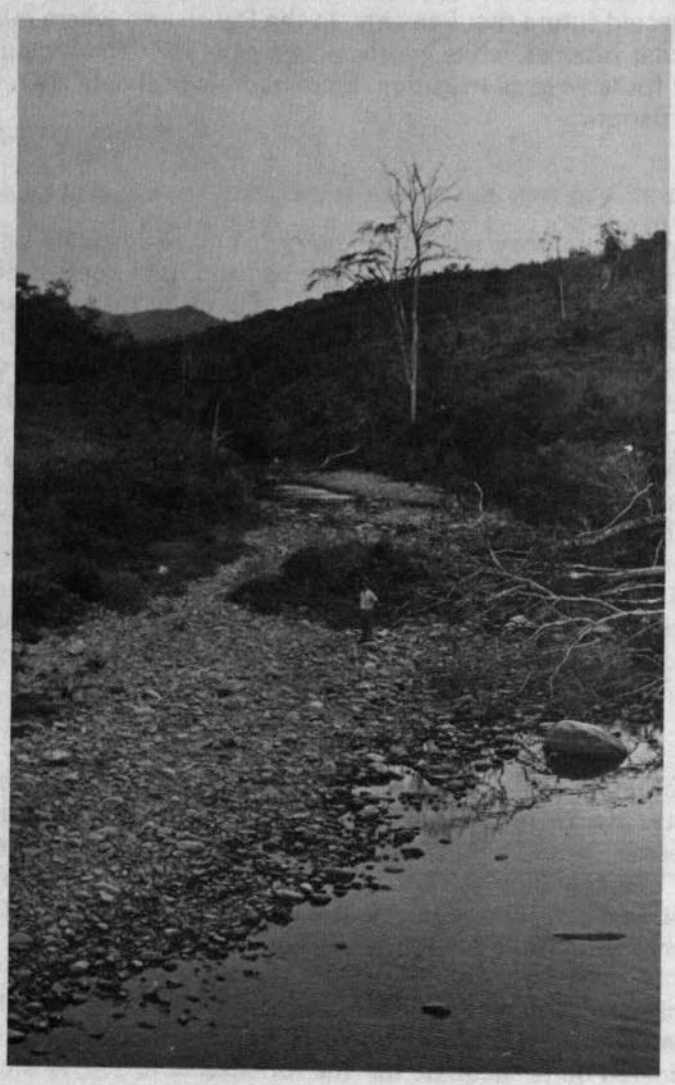


PLATE 3.11

Dry river bed, Langkon area. The forests in the catchment have been largely lost

PLATE 3.12 Recently cut primary forest and encroaching grasslands on Bengkoka Peninsula

Some areas are being drained. The work has been largely undertaken, with limited success, on Soil Suitability Group 4 soils in tidal swamps and, as stated when the soil resources were discussed earlier in Part 5, agricultural development on such land is not recommended. Further drainage works should therefore be limited to the Group 3 soils occurring in the limited areas of freshwater swamps described on page 42.

The investigations undertaken between 1961 and 1963 of the hydroelectric potential (Part 3) were inconclusive. The sole prospect identified for large-scale production was located at Kaiduan on the middle reaches of the Papar River. This involved a tunnelled diversion to the Labak near Kinarut. The project was shelved, however, because the draw-off would be such as to decrease the water supplies to the Papar Plain downstream. There has been no appreciable change in the general situation since these studies were undertaken, and the possibility of harnessing water to produce large-scale electricity supplies would, therefore, appear to be remote.

GRAZING RESOURCE DEVELOPMENT OPPORTUNITIES

With the present interest in beef production there are opportunities for developing the grazing resources, both in the gazetted grazing reserves and in the other natural grasslands, also in other lands. In general because of the need for land to be relatively flat for grazing, only Land Capability Class II is considered to be suitable for development for this purpose. However, where the topography of Class III land is flat or rolling it also may be suitable for development.

Grazing reserves

Table 35 shows that within the grazing reserves there are only 590 ha (1 584 ac) Class II land of which 162 ha (403 ac) are grassland and the balance under other land use, mainly forest. There are also 1 369 ha (3 384 ac) of Class III land some of which may be suitable for grazing and justify development. Over 80% of the land in grazing reserves is Class V and it is not considered suitable for development. Some of the grassland, mainly on stranded beaches, may be improved for rough grazing by fencing and slashing.

Natural grasslands

There are considerable areas of natural grassland outside the grazing reserves and it is here that the greatest opportunity for the development of grazing resources lies.

There are a total of 10 702 ha (26 446 ac) of Class II land, 33% of which is alienated and 64% of which is stateland. Table 59 indicates the main areas of stateland; the balance is in small scattered patches.

TABLE 59 Main areas suited for grazing in the stateland grasslands

Region	Area	Land capability class	Extent	
			ha	ac
Bengkoka Lowlands	Northern tip of Bengkoka Peninsula	II	1 380	3 400
	South of Bengkoka Forest Reserve		140	350
	Upper reaches of the Pitas River		190	470
Crocker Foothills	Limau Limauan		440	1 100
	Kampong Tigaman Darat		320	800
	Kampong Tigaman		280	700
	White Rocks Bay		570	1 400
	Kampong Taburan		100	250
Crocker Plains	Kota Belud		530	1 300

There are also 17 863 ha (44 145 ac) of Class III land most of which is again either stateland or alienated land and some of this may be suitable for grazing and justify development. The balance of the natural grassland area is Class V and is not suited for development.

Forested land

27 156 ha (67 104 ac) of forested Class II land would be suitable for grazing. It should be kept in mind that such land is also suited for other forms of cultivation, and any consideration concerning grazing thereon may involve the possible conflict with other forms of agricultural development.

CONSERVATION DEVELOPMENT OPPORTUNITIES

In this section the development opportunities for game resources and for recreational resources are combined. There has been no detailed survey of the game resources of the West Coast and Kudat Residencies but the indications are that the Kinabalu National Park has a rich and varied fauna including some of the rarer mammals. In the forested and undeveloped areas outside the national parks game is probably still relatively abundant but with increasing development and the possibility of fairly extensive timber exploitation, with its concomitant destruction of habitat, the game resources are likely to suffer. The national parks provide a substantial area where fauna is protected and, providing protection is enforced and maintained, these areas should ensure satisfactory preservation and survival of a wide range of wildlife.

It is likely that a considerable variety of wildlife will also survive in the hilly forested areas forming water catchments. The importance of maintaining these forests for water-conservation has already been stressed. In order to preserve a suitable habitat for waterfowl including birds of passage and winter visitors it is important that the bird sanctuary at Kota Belud should be maintained and given adequate protection.

In addition to the fauna it is of vital interest and importance for botanical, ecological and other purposes, particularly the maintenance of gene-pools, to preserve adequate samples of the varied flora found in the residencies. The national parks will serve this purpose well as one of the objects of their management is to maintain the vegetation in its natural state as far as possible. It is to be hoped that other areas outside the national parks which carry different types of vegetation may also be preserved undisturbed and it is suggested that steps should now be taken to delineate and gazette such areas as virgin jungle reserves. At present the total area of virgin jungle reserves is very small.

The importance of leaving the natural vegetation undisturbed in catchment areas on steep terrain is emphasised and providing this is done such areas will serve the purpose of conserving the natural flora.

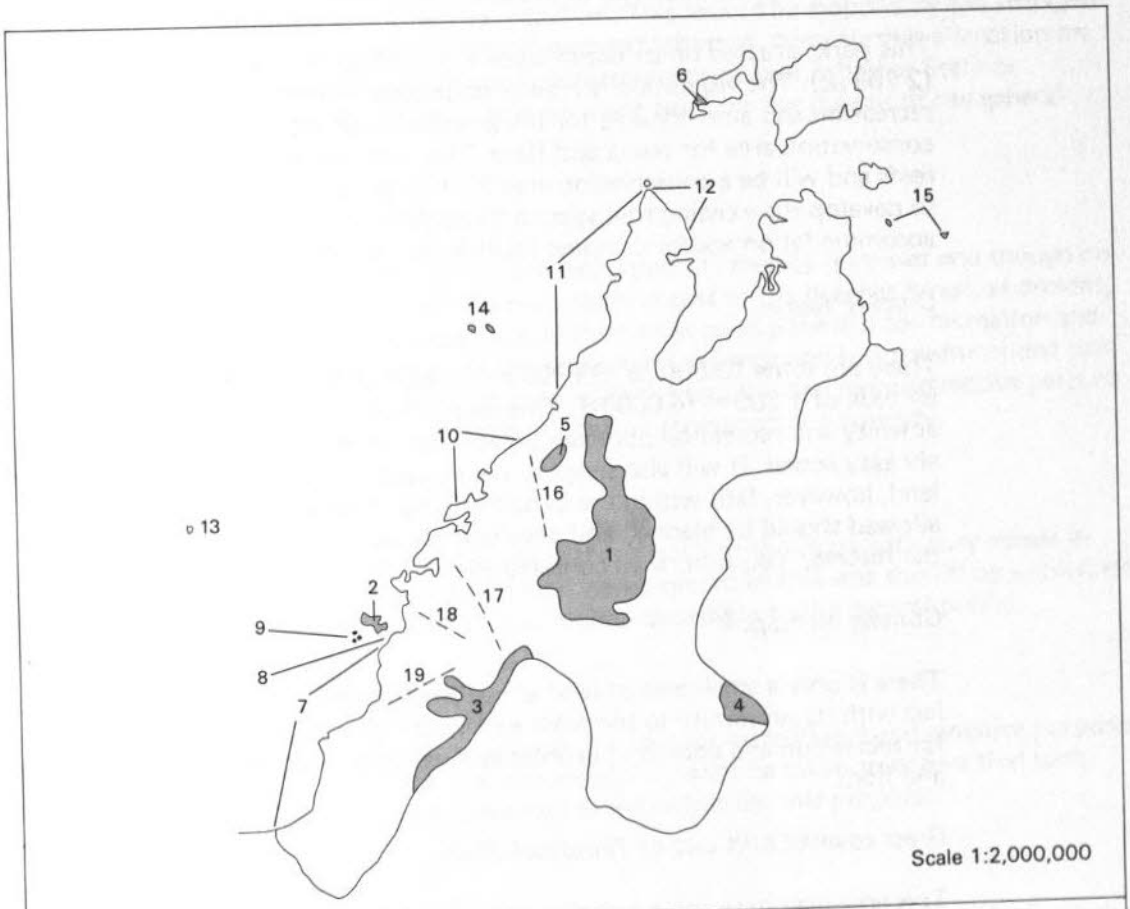
It has been shown in Part 4 that the two residencies are relatively rich in areas suitable for amenity and recreation and with development and an increasing population, particularly in urban areas, there will be an increasing demand for land for these purposes. It is important that such areas should be identified and designated for conservation as soon as possible. Areas mentioned in Part 4 of this report are shown in Text Map 3-24 and the main features of each area are discussed in the following text.

Conservation areas

The approximate location of suggested conservation areas is shown on Text Map 3-24.

Kinabalu National Park

This park covers an area of 79 395 ha (196 188 ac) and includes Gunong Kinabalu. Altitudes range from less than 300 m (1 000 ft) to over 4 000 m (13 000 ft) with the accompanying variation in flora and fauna. The greater part of the vegetation is



	Area	Main purpose of conservation
1	Kinabalu National Park	All aspects of conservation
2	Tungku Abdul Rahman National Park	All aspects of conservation
3	Crocker Range, land above an altitude of 1200m(4000ft)	Recreation, amenity, fauna and flora
4	Gunong Metapok	Recreation, amenity, fauna and flora
5	Grass covered hills east of Tempasuk Plain	Amenity
6	Pulau Balambangan limestone cliffs	Amenity and flora
7	Beaches along Kimanis Bay	Amenity and recreation
8	Tanjong Aru beach	Amenity and recreation
9	Manutik, Manukan and Sulug Islands	Amenity and recreation
10	Ambong Bay	Amenity and recreation
11	Western coastline, Kudat Peninsula	Amenity and recreation
12	North-east tip, Kudat Peninsula	Amenity and recreation
13	Pulau Mengalum	Amenity, recreation and fauna
14	Mantanani Islands	Amenity and recreation
15	Pulau Tigabu and Mandidarah	Amenity
16	Tempasuk/Kadamaian Valley	Amenity
17	Tuaran Valley	Amenity
18	Moyog Valley	Amenity
19	Papar Valley	

TEXT MAP 3-24 Suggested conservation areas

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undisturbed and the park will continue to serve as a major conservation area for fauna and flora. It is also an important recreation and amenity area for the people of Sabah, particularly in view of the markedly cooler climate prevailing over much of the area, and is one of the main attractions in the State for foreign tourists. The development of the park, since its inception, has been rapid, and the demands for facilities there are likely to increase considerably. There is, therefore, great scope for further development.

Tungku Abdul Rahman National Park

This park, situated on an island close to the State capital, covers an area of 1 120 ha (2 768 ac). The vegetation is mainly undisturbed forest. It will be an important recreation and amenity area for the population of Kota Kinabalu and will serve as a conservation area for fauna and flora. The park includes some of the surrounding coral reefs and will be a conservation area for marine fauna and flora. There is ample scope to develop the existing trail system through the forest together with providing accommodation and/or camping facilities on the shore.

Crocker Range

There are some 13 600 ha (33 700 ac) of land in the Crocker Range above an altitude of 1 200 m (4 000 ft). This area is likely to be developed in the future for amenity and recreation purposes on account of its markedly cooler climate and relatively easy access. It will also serve as a conservation area for flora and fauna. All of this land, however, falls within the Crocker Range Forest Reserve and any settlement allowed should be planned and developed so as to conform with the basic function of the reserve, i.e., watershed conservation.

Gunong Mentapok

There is only a small area of land above an altitude of 1 200 m (4 000 ft) but nevertheless with its proximity to the main east-west highway it may at sometime be developed for recreation and amenity purposes and will also serve as a conservation area for fauna and flora.

Grass covered hills east of Tempasuk Plain

This area may have some amenity value for the people of the Kota Belud District as the open grass covered hills with extensive views provide a pleasant change from the usual forested land.

Pulau Balambangan

The small area in the south of the island with its limestone cliffs (Plate 3.9) is scenically attractive and will have value as an amenity area, in the longterm, for the people of Kudat. It will also serve as a conservation area for the unique flora found on limestone.

Beaches along Kimanis Bay

Despite the occasional discoloration of the water these beaches will provide important recreational and amenity areas for the growing population on the Crocker Plains, south of Kota Kinabalu. When planning development of the shoreline areas care should be taken to ensure that the amenity value of the beaches is maintained and that there is easy public access.

Tanjong Aru Beach

This is a very important recreational and amenity area for the population of Kota Kinabalu and could be a major tourist attraction if retained in a natural unspoiled state. It is considered vitally important that development should not destroy the recreational and amenity value of this beach and that the public should have free access to it.

Manutik, Manukan and Sulug Islands

These small islands just offshore from Tanjong Aru, Kota Kinabalu provide recreational and amenity areas of great attraction for those who have water transport. They have fine sandy beaches with coral offshore. These are prime areas for bathing, boating and other water-based pastimes and, lying close to the rapidly expanding urban community of Kota Kinabalu, offer a significant opportunity for development as recreational areas. The beaches are, however, rapidly deteriorating due to the practice of transporting sand for construction work on the mainland. This should be stopped by the stringent application of the laws which prohibit such exploitation. Also, further alienation on these islands should be stopped; and it is recommended that, whether State or privately owned, all foreshores should be made available for the use of the general public.

Ambong Bay

This area is at present little utilised for recreation or amenity purposes and though no part of it is very far from the main road ready access to the beaches is not, at present, available in most places. It is considered that it has good potential for recreation and amenity purposes in the future as the population expands and it is recommended that development should be planned so as to keep the beaches and more attractive parts of the coastline available and accessible for public recreation and amenity.

Western coastline, Kudat Peninsula

There are some attractive beaches along this stretch of the coast with easy access in some cases. It is recommended that land development in this area should be so planned as to keep these beaches available and readily accessible to the general public.

North-east tip, Kudat Peninsula

There are beaches in this area which can be used for recreational and amenity purposes by the people of Kudat. It is recommended that steps be taken to ensure that such beaches remain available and accessible to the public for this purpose.

Pulau Mengalum

This island has some attraction for recreation and amenity purposes though its relative inaccessibility makes it unlikely that this aspect will be developed in the immediate future. However it is suggested that any development of the island should take into account the future potential for these purposes.

Mantanani Islands

These islands are constituted as bird sanctuaries to give protection, in particular, to the megapode (*Megapodius freycinet*) which nests there. They also have some potential for recreation and amenity which might be developed at some time in the future. However any development of this aspect must take account of the fact that the islands are bird sanctuaries and the interests of the birds must be safeguarded.

Pulau Tigabu and Mandidarah

These two islands have some potential for recreation and amenity though any development of this aspect is unlikely to take place in the near future, because of their inaccessibility and distance from any major centre of population. Nevertheless it is recommended that this potential should be borne in mind and the islands designated as conservation areas.

The valleys of the Tempasuk/Kadamaian, Tuaran, Moyog and Papar Rivers

Sections of these river valleys are scenically attractive and have potential as amenity areas. It is suggested that such areas should be designated and conserved for this

purpose and access to them by the general public safeguarded. Development of nearby areas should be planned so as not to reduce or destroy the amenity value.

GENERAL OPPORTUNITIES

Any piece of land may have one or more resources worthy of use and, up to this stage of the report, attention has been focused on individual resources. No account has been made of the situation where two or more resource development opportunities occur together. In such cases a choice has ultimately to be made as to the permanent form of land use. Sometimes this is a simple task: for example; land may be ideally suited and situated for agriculture, but it contains rich timber stands. The obvious development plan would be to log first and then cultivate.

Frequently, however, the options are not so clear-cut, and any decision on the permanent form of land use should be made with a clear understanding of the conflicting resource development potentials weighed with land tenure status, i.e., the ownership aspects. This would then lend itself to an appraisal of the future development pattern which will evolve in each of the physiographic regions. It will be seen, therefore, that the remaining sections of the report are of particular relevance to planning, especially that involving the public sector.

Conflicting resource development potentials

Table 60 gives an overall picture of the extent of the problem between mining, agriculture and forestry. In practical terms the main conflict occurs between agricultural and forestry interests (land exploitation units IIB, C, E, F, IIIB, C, E and F). A possible conflict between mining and agriculture is also indicated (land exploitation units IID, E, F, IIID, E and F), and forestry (land exploitation units IVC, D and E), and all these combined (land exploitation units IIE, F, IIIE and F). It should be noted, however, that such land categorised as mining land is Mineral Resource Group 3, i.e., where geological evidence of a cursory nature indicates that mineralisation of economic importance *might* occur. Until proven, mineral interests should, for planning purposes, be subordinate to those of agriculture and forestry.

Table 61 gives an account of the nature of various resource issues in conflict relative to the legal status of the land. With mining interests likely ultimately to involve relatively insignificant areas of land it can be seen that the main controversy occurs between agricultural and forestry interests. Some 12 528 ha (30 957 ac) are involved which, compared to the 1 003 273 ha (2 479 127 ac) and 496 250 ha (1 226 216 ac) of similar land which occurs in the Sandakan and Tawau Residencies respectively, is a very low figure.

The relatively small areas involved in the conflict between agricultural and forestry interests, and their main distribution are shown in Text Map 3-25.

Table 61 shows that the greatest proportion occurs as stateland where some 7 844 ha (19 383 ac) are involved. The main areas are shown on Text Map 3-25. All are close to populated areas and it would appear that the prospects of maintaining such land under commercial forest are likely to be short-lived with the increasing population, better communications and spread of agricultural holdings.

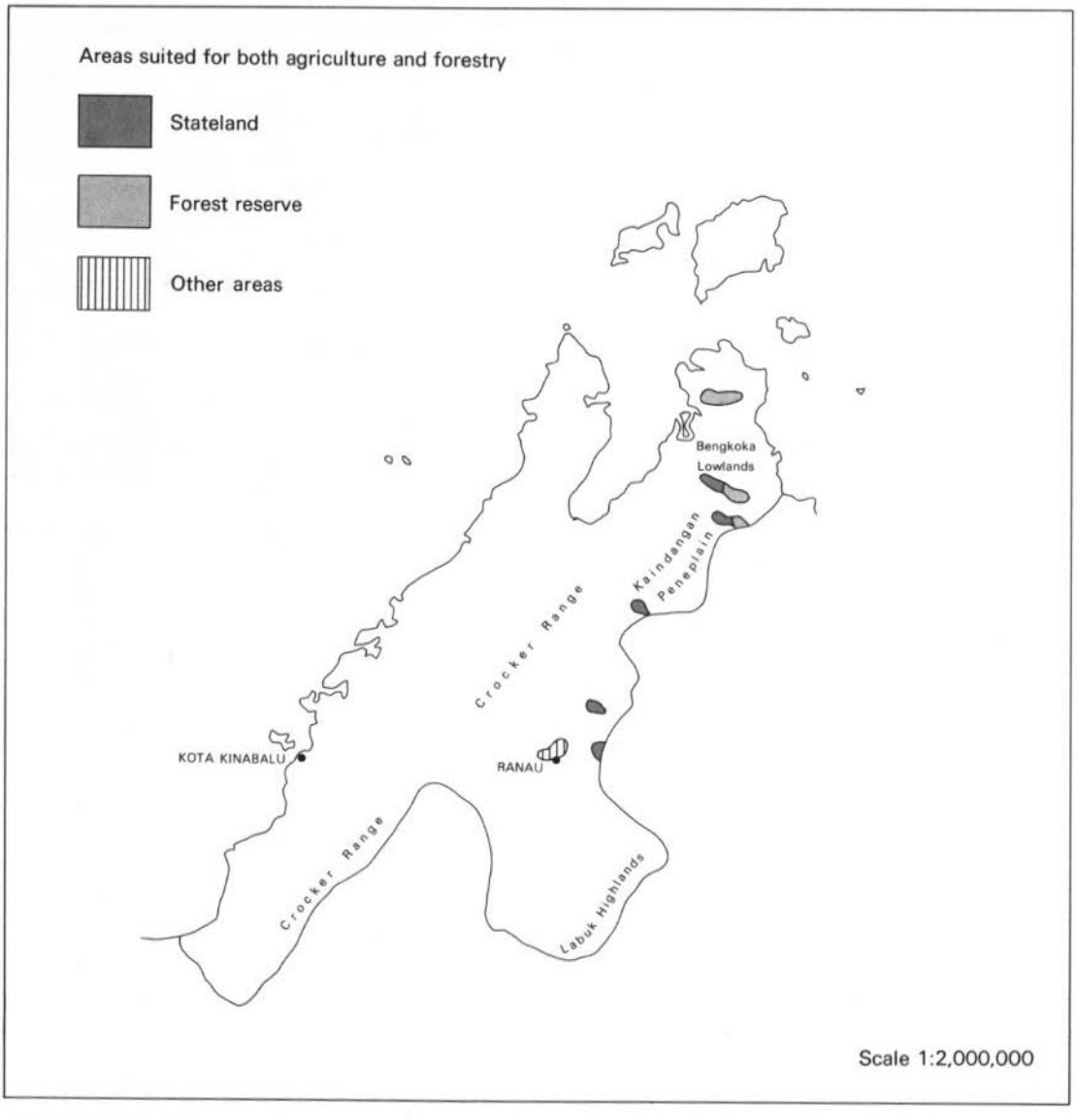
Table 61 also shows that the forest reserves contain a significant area of land suited for agriculture and forestry (3 230 ha,7 981 ac). The main areas are shown on Text Map 3-25. These are located in the Bengkoka and Paitan forest reserves. In the latter such land occurs along a number of narrow valleys and de-reservation of such tracts would not, in the foreseeable future, appear warrantable. In the Bengkoka Forest Reserve, however, it forms a contiguous northern block which, if agricultural development keeps abreast of road construction, is likely to be under pressure for farming purposes.

TABLE 60 Present land use and land capability in ha (ac)

Present land use category *	Land capability class and land exploitation units												
	Class I	Class II						Class III					
	IA	IIA	IIB	IIC	IID	IIE	IIF	IIIA	IIIB	IIIC	IIID	IIIE	IIIF
1	13 (32)	176 (437)	9 (23)	0	0	0	0	639 (1 579)	0	0	84 (207)	6 (14)	0
2	0	3 899 (96 315)	21 (52)	0	6 (16)	0	0	5 266 (13 012)	0	2 (6)	437 (1 080)	6 (15)	0
3	0	9 968 (24 632)	3 (8)	4 (10)	0	0	0	24 849 (61 404)	44 (109)	49 (121)	61 (150)	0	0
4	38 (93)	5 219 (12 897)	67 (167)	0 (1)	26 (65)	0	33 (80)	20 769 (51 322)	139 (343)	26 (64)	1 408 (3 479)	7 (18)	0
5	0	101 (250)	0	0	0	0	0	27 (68)	0	0	0	0	0
6	3 (8)	10 694 (26 426)	116 (286)	5 (12)	0	0	0	17 597 (43 485)	35 (86)	25 (62)	462 (1 141)	0	0
7F	2 532 (16 258)	7 746 (19 141)	568 (1 403)	119 (295)	36 (90)	52 (129)	14 (35)	33 332 (82 364)	5 785 (14 297)	3 884 (9 598)	2 388 (5 900)	313 (774)	130 (322)
7S	153 (378)	18 453 (45 598)	81 (201)	25 (61)	58 (144)	4 (11)	0	42 342 (104 628)	328 (810)	298 (736)	1 271 (3 142)	8 (20)	28 (70)
8	0	2 026 (5 006)	0	2 (4)	0	0	0	6 761 (16 705)	75 (186)	23 (57)	0	0	0
9	29 (72)	296 (732)	0	0 (1)	0	0	0	732 (1 808)	8 (20)	4 (11)	182 (451)	4 (10)	0
Unit total	2 768 (6 841)	58 578 (231 434)	866 (2 140)	155 (1 384)	127 (315)	57 (140)	46 (115)	152 315 (376 375)	6 415 (15 851)	4 311 (10 655)	6 293 (15 550)	344 (851)	158 (392)
Class total	2 768 (6 841)	60 188 (235 420)						169 473 (418 782)					

Present land use category	Land capability class and land exploitation units						
	Class IV					Class V	
	IVA	IVB	IVC	IVD	IVE	VA	VB
1	0	2 (5)	14 (34)	0	8 (21)	1 616 (3 993)	84 (208)
2	84 (209)	8 (20)	19 (47)	0	46 (113)	4 142 (10 236)	553 (1 366)
3	139 (343)	82 (202)	6 (14)	0	230 (569)	42 528 (105 087)	457 (1 129)
4	409 (1 012)	141 (348)	129 (319)	20 (49)	33 (81)	20 466 (50 572)	3 485 (8 612)
5	0	0	0	0	0	48 (120)	231 (571)
6	387 (957)	187 (463)	77 (191)	10 (24)	309 (763)	59 493 (147 009)	3 701 (19 147)
7F	210 240 (519 509)	27 445 (67 817)	35 086 (86 699)	3 969 (9 807)	762 (1 882)	242 295 (598 717)	57 799 (142 822)
7S	5 144 (12 711)	894 (2 209)	819 (2 023)	205 (508)	2 156 (5 328)	158 804 (392 481)	21 635 (53 461)
8	13 (33)	1 226 (3 029)	0	0	34 733 (85 827)	32 938 (81 390)	669 (1 654)
9	61 (150)	33 (82)	69 (170)	9 (22)	280 (693)	3 072 (7 592)	2 036 (5 031)
Unit total	216 478 (392)	30 018 (534 924)	36 218 (89 497)	4 213 (10 410)	38 557 (95 277)	565 402 (1 397 197)	90 651 (224 001)
Class total	325 484 (804 283)					656 053 (1 621 198)	

* 1 Urban land; 2 Horticulture; 3 Tree, palm and permanent crops; 4 Shifting cultivation; 5 Improved pasture; 6 Grassland; 7F Forest; 7S Scrub forest; 8 Swamp, marshland and wetland forest; 9 Unused and cleared land.



TEXT MAP 3-25 Areas of conflicting potential use between agriculture and forestry

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TABLE 61 Nature and extent of the conflict between the resource development opportunities

Land category	Nature of conflict							
	Agriculture and forestry		Mining and agriculture		Mining and forestry		Mining and agriculture and forestry	
	ha	ac	ha	ac	ha	ac	ha	ac
Alienated land	955	2 360	1 416	3 499	1 422	3 514	37	91
Grazing reserve	497	1 228	370	914	34	84	361	892
Stateland	7 844	19 383	5 116	12 642	53 158	131 375	265	655
Forest reserve	3 230	7 981	413	1 021	21 235	52 473	302	746
Government reserve	2	5	72	178	3 138	7 754	2	5

All evidence seems to point to the fact that very little or no conflict is likely to arise between conservation and recreation interests with the other development opportunities.

REGIONAL DEVELOPMENT OPPORTUNITIES

The land resource information contained in the preceding pages of this report is of fundamental use for planning the development of the West Coast and Kudat Residencies. The data and maps are presented so as to be of use for planning at a number of levels of abstraction, generally of fair detail. Broad-scale planning may best be undertaken on a regional basis, and the following pages give a general account of the main development opportunities which exist in the physiographic regions defined in Part 2. It is important that this account is read in conjunction with the land capability classification map which gives in more detail the recommended long-term use of the land resources.

Crocker Range

The overall prime function of the Crocker Range is that of water supply, and it is of paramount importance that as much as possible of the mountain chain is conserved so as to afford the maximum protection to these supplies. Already much of the land has been designated for this purpose in the form of the Crocker Range Forest Reserve. This is virtually all forested and it is of the utmost importance that the tree cover remains intact and logging is strictly prohibited.

The problem of shifting cultivation over large areas and its harmful affect on the water regime must also be acknowledged. Ideally, the best course of action would be to slowly wean the people involved in the practice to sedentary forms of agriculture in the lowlands. Whether this is feasible in practical terms can be questioned, and a *status quo* is likely for the foreseeable future. At all events further extension of the areas under shifting cultivation should be strictly prohibited.

The Range is also likely to become, in time, an important recreation zone. In addition to those associated with the Kinabalu National Park, settlements are likely to be established at a number of places where the combination of cool temperatures and scenery would hold considerable attraction for both settler and recreation seeker alike, particularly in the long-term when the lowlands have become fully developed and densely populated.

The Mamut Copper Mine, when in full production, will be the most important industry. Its impact on the economy and road communications related to the Ranau area is already significant. Further mineral finds, if they occur, are likely in the Gunong Kinabalu area and any mining operation should be undertaken so as to have the minimum effect on the natural ecology of the area.

The prospects for agriculture are limited; largely restricted to a more intensive use of a number of narrow valleys, most of which are inhabited and, at present, mostly subject to shifting cultivation.

Trus Madi Range

This is also an important watershed: providing catchments for a number of large tributaries of the Labuk, Kinabatangan and Padas Rivers. It has little or no commercial timber, soil or mineral resources. Its function then will be conservation which, even though its recreation value is not high, might in the long-term be combined for the use of seekers of wilderness conditions.

Labuk Highlands

Similar to the main part of the Labuk Highlands which falls in the Sandakan Residency and which has been discussed in Volume 2, forestry is likely to play an important role in the economy of this region. The main constraints to commercial forestry however, are the general ruggedness of the terrain and the Region's remoteness to shipping-points. It will be necessary for logging to be operated in such a way so as to minimise flooding by the Labuk River, and the road communications will have to be up-graded considerably in order to haul logs to the east coast. Agricultural development will be restricted to the Paginatan and Kegibangan areas in the form of a more intensive use of these riverine tracts.

Crocker Foothills

These are already important agricultural areas, sustaining most of the dry-land crops. Large areas, however, occur under sheet lalang, the result of soil degradation due to an earlier history of intense shifting cultivation. Such land will ultimately be put to permanent use: the possible choices appearing to be either plantation forestry or grazing.

Bengkoka Lowlands

Future development here will, when access and internal road communications have been fully established, be based on agriculture. The Bengkoka Peninsula holds the greatest opportunity for agricultural development in the two residencies. The extensive areas of lalang covered downs would appear to be suited for development for grazing purposes; and the region might well become the most important beef producing area in the State. Forestry will be limited to a protective function, conserving the important forested catchments in the Sungei Paitan and Bengkoka Forest Reserves.

Kaindangan Peneplain

Forestry will be this region's main industry with agriculture being limited to some narrow valleys which are already sparsely settled and cultivated. The utilisation of the forests should be undertaken in such a way so as to conserve the catchments of the Kanibongan River,and eastern tributaries of the Bengkoka River,all of which will become particularly important when the region is fully developed. In addition to its protective role, there will be ample scope for commercial forestry.

Crocker, Bandau and Ranau Plains

These are amongst the most intensively used regions in the State. Almost all parts are settled and alienated. They will continue to be the main areas of agricultural settlement for a great number of years and considerable scope remains for intensifying the agricultural use of the land.

Pinosuk Plateau

Ecologically, this is a unique part of the State together with being an integral part of the Kinabalu National Park. Its use for recreation should override all other functions, and there is ample scope for improving its facilities for this purpose.

Northern islands

At present agriculture appears to be the sole development prospect as far as the land resources are concerned and, apart from relatively small areas on Pulau Balambangan, this will largely be restricted to Pulau Banggi. Much of the island will be settled and farmed, becoming an important agricultural area. The mountainous zone in the north is the main water catchment and should be used for protection forestry, and the prospect of mining being established there should also be kept in mind. The prospects for the other islands are poor. Malawali's depends on mining being proven as a practical proposition, and the smaller islands to the east such as Tigabu and Mandidarah would largely rest on recreational use.

Western islands

Here development of the land resources will be almost exculsively based on recreation and, to a lesser extent, conservation interests. It has already started on Pulau Gaya with the establishment of the Tungku Abdul Rahman National Park. The prospects of establishing facilities on the more remote Mengalum and Mantanani islands, in the foreseeable future, are not good. In the meantime it is important that the bird-interests on Mantanani should be conserved.

RECOMMENDATIONS FOR FURTHER STUDIES

This report provides a general basis for development planning. It should not be construed to be the final instrument. There remain considerable gaps in our knowledge of the resources; much of the work now requires updating; no account has been made of socio-economic and demographic aspects. For land planning and development to be fully effective the following general recommendations are made; they are not in any particular order of importance:

1. Intensifying mineral prospecting over the areas selected.

2. Carrying out more detailed soil surveys over the areas recommended for agricultural development. These should be made in conjunction with agronomic studies into the relationships between crops and the soils, together with fertilizer and other management requirements.

3. Updating the forest inventory, obtaining more detailed information on the forest resource and the formulation of a forest management plan compatible with overall planning and development.

4. Undertaking a systematic hydrological survey of the residencies with a view to conserving and controlling the water resources in a way consistent with the use of the other resources.

5. Making a complete appraisal of the areas identified as having a capability for recreation. The Kinabalu National Park merits special attention together with a comprehensive study of the general ecosystem including the animal life, of this unique area.

6. Undertaking specific studies on population and manpower, particularly in relation to migration, in order to satisfy the demands of agricultural development in the State as a whole.

7. Undertaking a full study on the practice of shifting cultivation with the view to curtailing its spread and ultimately resettling the people involved to a sedentary form of agriculture.

8. Undertaking detailed studies on the establishment of feeder roads necessary for the servicing of the agricultural development areas.

9. And, largly in conjunction with the foregoing studies, formulating an overall development plan compatible with the interests of the State and Nation, and based on the projected requirements of mining, agriculture, forestry, conservation and recreation, with the view to the phased development of the land resources.

Part 6

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