Report No. 94

Report on a Reconnaissance Soil Survey
of the

SEBANGAN - SIMUNJAN BATANG KRANG AREA

1 st. Division

By

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HUNTING TECHNICAL SERVICES

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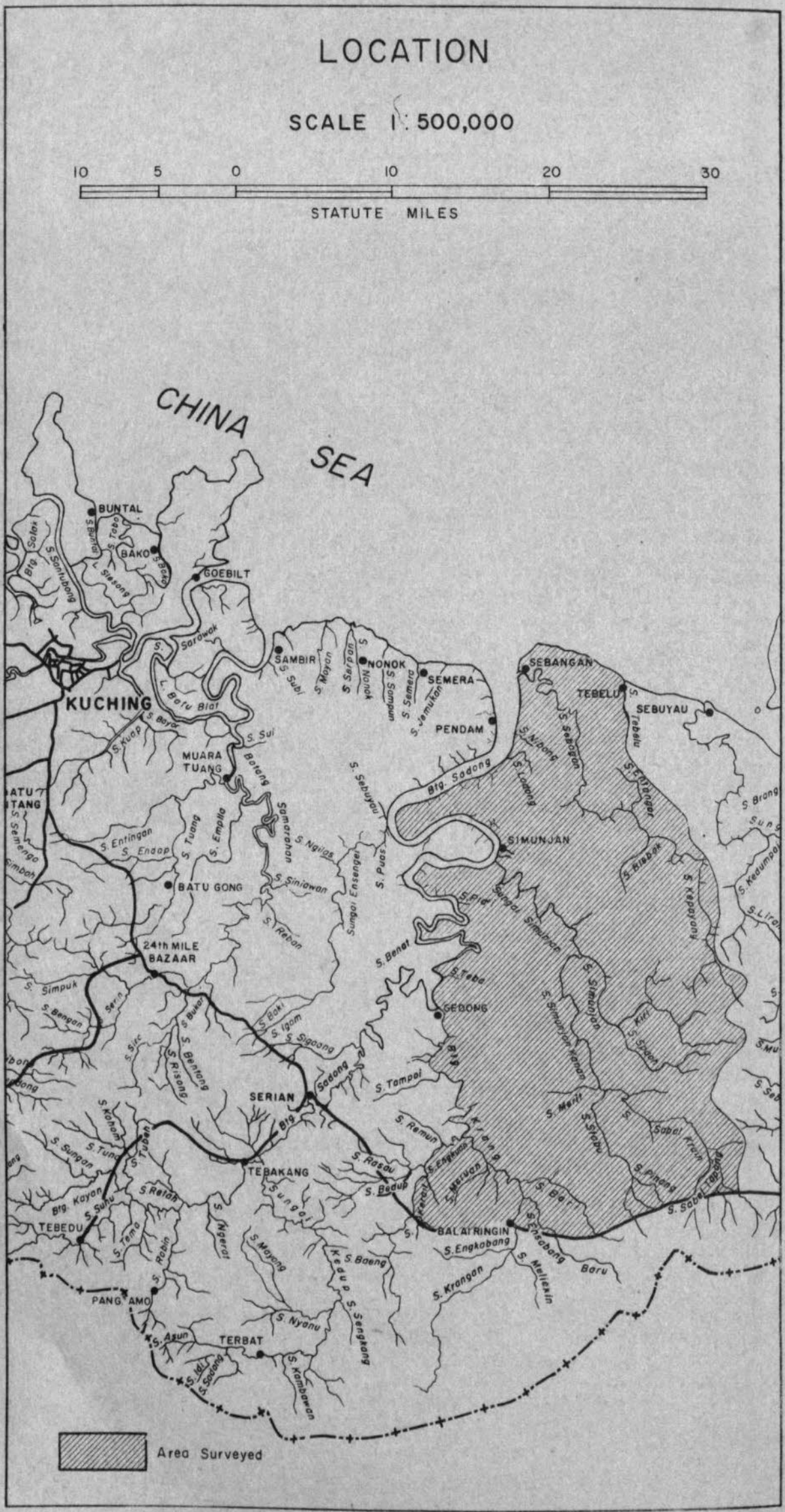
LOCATION
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CHINA SEA
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BATU GONG
24th MILE BAZAAR
SIMUNJAN
GEDONG
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TEBEDU
BALAI RINGIN
PANG AMO
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Area Surveyed

Report on a Reconnaissance Soil Survey of the Sebangan - Simunjan - Batang Krang area, First Division.

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INTRODUCTION

The survey was carried out at the request of the First Divisional Development Committee and was primarily aimed at investigating the land and soil potential along a proposed feeder road route leading from the Kuching-Simanggang trunk road via Bukit Punda to Simunjan, the district headquarters situated near the mouth of the Sadong river.

The requested survey area has been enlarged so as to include the remaining unsurveyed portion of the eastern section of the First Division.

Also, the area between Batang Krang and the Serian-Simanggang road and the area between Bukit Punda and the Simanggang road which were surveyed in 1960 (see report 33) have been revisited. The soil boundaries mapped in 1960 were partly inaccurate due to inadequate mapping equipment available at that time and the lack of contoured base maps. Resurveying these areas has insured that the accuracy of the map now submitted is of equal standard over the whole area.

To facilitate the use of this map for development planning a small part of survey area 59 reported upon in Soil Survey Report 59, and survey area 47 (Bukit Punda) reported upon in Survey Report 47 have been added to the map so that a complete picture of all the land between the right bank of the Batang Sadong and the Second Division boundary can be shown.

Surveying in the area commenced mid-March 1966 and was completed by mid-May. The Sebangan area and the Batang Krang area were surveyed by Agricultural Assistant Rosli bin Sahari while the remainder was surveyed under direct supervision of the reporter.

It is a pleasure to acknowledge here the cooperation received from the District Officer at Simunjan, Departmental Staff and Tuai Rumah's of various longhouses in the Simunjan District which ensured a smooth proceeding of the survey.
To avoid any delay in development planning, a preliminary report on the area along the proposed Bukit Punda - Simunjan road was released in May. The present report aims to release all information now available on the area and hence supercedes the preliminary report.

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The total area reported upon is 540 square miles of which the greatest portion namely 370 square miles was surveyed this year.

The location of the area is shown on the location map facing page 1.

Map 3 in the backfolder of this report shows the location of rentises and routes along which soil observations were made. Soil boundaries between the observation points were drawn by interpolation using air photograph interpretation as a guide.

Part 1. GENERAL DESCRIPTION

1. General Geography

The survey area embraces that portion of the Simunjan District (Lower Sadong District) which is situated at the eastern side of the Batang Sadong up to the Kuching-Simanggang road.

The area south of the road could not be surveyed because of security reasons.

A small part of the Upper Sadong District (Serian District), n.l. the most eastern part is also included in the survey.

Almost the whole eastern border is formed by the boundary between the First and Second Divisions, in the north the eastern boundary is formed by S. Tebelu where a small portion of the Sebuyau sub-district is included in the survey. The northern boundary is formed by the China Sea and Kuala Sadong, the western boundary by Batang Sadong up to Gedong, the Batang Krang up to Nanga Engkuan, S. Engkuan up to Nanga S. Kerait and S. Kerait up to the Serian-Balai-Ringin road. The southern boundary is formed by the Kuching-Simanggang road.

Simunjan is the only administrative centre in the area. It is also the marketing place for most people living along S. Simunjan Kiri and Simunjan Kanan. People living in the upstream areas of these rivers which previously also frequented Simunjan bazaar now use the Kuching-Simanggang road to come down to Serian. Minor bazaars in the area are Sebangan in the north which serves the people living along S. Sebangan and the coastal area. Gedong which serves the population living along the middle portion of the Sadong river course, and Balai-Ringin which serves the population of the upstream areas of the Batang Krang.

Apart from these bazaars there are a number of small trading centres often consisting of one or two Chinese shop-houses where daily requirements can be obtained often through barter-trade. One of these centres which can boast of a long history is that situated at Bukit Punda.

Balai Ringin is the only bazaar which has at present a road communication to Serian and beyond. All other bazaars can only be reached by water transport which involves difficult and long hours travelling and which is the reason why in the dry season communications with upstream areas such as Ulu Simunjan, Ulu Sebangan and Ulu Kepayang are very restricted due to low water.

Apart from the Kuching-Simanggang road in the south the only motorable roads in the area are a three mile long jeep track from Simunjan to the foothills of Bukit Simunjan where the secondary school is situated (Nanas road) and a small private track leading from the Simanggang road to the Anglican Mission Farmers Training Centre at Kampong Pinang. Communications in the whole area therefore leave much to be desired.

2. Population

Although the population is mixed in the whole area, the several racial groups tend to live concentrated each in their own specific areas. Malay centres of population are to be found at Gedong, along the lower reaches of Sungei Simunjan and at Simunjan. Bugis and Malay in the Sedilu peninsula and at Kuala Sadong.

Sebuyau Sea Dayaks live around Bukit Simunjan at Sebangan and along S. Sebangang, in the upstream areas of S. Kepayang, S. Simunjan Kiri and some along the Batang Sadong upstream of Simunjan.

Balau Sea Dayaks live in the upstream areas of S. Simunjan Kanan, S. Sebenkoi and S. Pinang and along the Simanggang road up to Balai Ringin.

Melikin Dayaks are found in that part of the Serian District situated between S. Kerait and Balai Ringin. Apart from a settlement of Chinese farmers in the coastal area near Sebangan, and a small settlement near the old coal mines at Simunjan, there are no large Chinese settlements in the areas. They live, however, scattered throughout the area and are mainly engaged in local trading and pepper cultivation.

The population is very scattered but is found mainly concentrated along the rivers, the main communication channels. Most densely populated areas are the foothills of Bukit Simunjan where people formerly employed by the now-closed coal mines have permanently settled, the upstream areas of Sungei Simunjan Kiri and Simunjan Kanan and the coastal area near Sebangan.

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The density of population over the whole area is one of the lowest in the First Division, three quarters of the area being undrained deep peat.

Farming is the main activity in the area. Timber is extracted in the large peat swamps enclosed by S. Kepayan, S. Sebangan, S. Simunjan and the Batang Sadong.

Peat swamp exploitation is further carried out along the Batang Krang near Gedong.

Recent timber extraction is taking place at S. Sebenkoi (near Bukit Punda).

3. Physiography

The largest portion of the area consists of a large expanse of swamp covered by deep peat deposits.

The remainder being hilly terrain, is conveniently subdivided into:-

A. the isolated hills in the peat swamp;

B. the transition zone between peat swamp and high lying mainland which consist mainly of low lying gently undulating terrain of an altitude ranging from 50 to 350 feet high;

C. the mainland above 350 feet.

The swamp land extends from the coastline to almost the Simanggang road in the south. The absence of beach deposits and marine clays along the coast suggests that this peat swamp probably extended farther into the sea in former times but that through coastal erosion the peat has been largely removed. A thin strip of marine clays overlying the peat at the coast line and at the Sadong estuary may suggest rebuilding of a coastal flat although erosion and accretion is taking place simultaneously along this part of the coast.

It is suggested that the peat swamp was once a large inland basin filled with sea water in which a number of islands existed which now form conspicuous hills (A) in the midst of the peat swamps. Possibly the Sadong river and the Batang Lupar are responsible for cutting off this basin from the sea by their deposits along their courses and at their estuaries.

The amount of deposited material is, however, surprisingly small when judging the size of the river channels and probably most of the silt was and is deposited near the coast in the sea. When peat started to develop in the lowlying basin stream channels were possibly spared out but the present drainage pattern suggests that these stream channels have changed their courses during the peat development since no-or very little stream deposits are found along these channels. Examples of such channels are the S. Kepayang, S. Simunjan Kanan and

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Simunjan Kiri. Only near the confluences with the Batang Sadong riverine deposits are found along the present stream beds, in many cases, however, overlying deep buried peat deposits. These stream deposits were probably formed through back flooding.

Little or no colluvial deposits were found at the foot of the many hills in this peat swamp. The hills formed by igneous rocks are rather steep and one would expect to find such deposits surrounding these hills. In fact in most places, the deep peat abruptly borders onto the steep hilly terrain. The only area where colluvial soils were found overlying peat deposits is between the foot of Bukit Ngili and S. Simunjan. A possible reason is that Bukit Ngili is an outcrop of soft sedimentary material which is easily erodable.

Between Batang Krang and S. Sebenkoi a low lying hilly landscape also consisting of soft rocktypes does not show this feature probably because the hills are too low to be able to contribute much to any colluvial deposition which may take place at the foot of these low hills.

The climate and topography would suggest rather intensive erosion on these steep hills. The only cause of this situation which can be offered at present is that the peat development must be rather recent and that the present forms of these hills were mainly shaped in a period prior to the peat development.

Levees along the main rivers are almost non-existent and where found are rather inconspicuous.

B. In the south and south-east the peat swamps grade into lowlying gently undulating hilly terrain, with small areas of peat deposits in minor valleys.

In the upstream areas of Sungei Simunjan Kiri and to a lesser extent of the Simunjan Kanan rivers old terrace alluvium forms part of this hilly terrain, the remainder being formed mainly by outcrops of soft sedimentary materials. Between S. Sebenkoi and the Batang Krang a considerable amount of old terrace alluvial was also found. In the upstream area of the Simunjan Kiri river this can be explained by the existence of a large massif of acid igneous rocks which is probably the source of this material, but in the latter area it is difficult to indicate the origin of the material. Perhaps the Klingkang Range may have been a possible source.

Most of this low lying terrain has been peneplained at one stage and the original surface is in most places only relatively weakly dissected. Strong dissection, however, was noticed between Balai Ringin and S. Kerait.

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C. Only along part of the eastern border and in the south near the Klingkang range is this relatively low lying terrain bordered by steep high lying terrain, with altitudes ranging from 350 feet to over 2,000 feet. The bulk of this high-lying terrain is composed of igneous massifs with a rugged topography.

This brief outline of the physiography indicates already the meagre prospects for agriculture in the area as a whole.

The largest part of the area is formed by a deep peat swamp of little agricultural significance. Only where there some riverine alluvium was deposited prospects are better. The relatively small areas of topographically suitable land have a large portion of old terrace alluvium on which inferior soil types have developed. The remainder of the area is largely too rugged for intensive development.

Therefore, physiographically the area is a most difficult one to develop.

4. Parent Materials

The geology and mineral resources of the area have been described by Haile (1954). Information from this reconnaissance survey has supplied most of the basic data for this section as far as the upland areas are concerned. A number of rock samples collected during the present soil survey have been examined by Geologist, A.C. Pimm and the assistance of the Geological Department is gratefully acknowledged. A small part of the area, namely that situated between Kerait and Balai Ringin was mapped in detail by Pimm (1965). The largest part of the area formed by swamps and floodplains is covered with recent quaternary deposits which on the soil map is subdivided into organic deposits (peat) and riverine deposits (recent clays and sands).

The organic deposits are mainly of a coarse woody nature ranging in depth from 0 to over 10 feet. Most riverine deposits are heavy clays and only in upper stream valleys the material is coarse-textured.

The lowlying terrain referred to as B in the previous section is mainly underlain by sedimentary rocks of possibly late Triassic Age consisting of iron poor sandstones and shales mainly interbedded by schists near Balai Ringin, but much of these rock formations are covered with Pleistocene deposits especially in areas situated below the 100 feet contour.

Near the Simanggang road in the south-east of the area sedimentary rock of Early Tertiary age is found in a slightly more dissected landscape. Much of these rocktypes is also iron-poor sandstone interbedded with red and blue-grey shales.

In the east near the divisional boundary mountainous terrain is formed by acid igneous intrusions of mainly Tertiary Age, the rocktypes being medium to fine grained diorites and granodiorites.

Between Munggu Air and Kepayang Tertiary sediments are again found, there consisting of thick sandstone beds mainly.

In the Triassic sediments conspicuous hills are found composed of basic to intermediate extrusive rocks belonging to the Serian Volcanic formation. (Bukits Antayan, Merbau, Punda). According to Pimm (1965, p.53) these rocks were possibly extruded under seawater and Triassic sedimentary rocktypes occur interbedded in the lava flows in certain localities. The soft sedimentary rocks did not withstand erosion as well as the harder volcanic rocks.

A number of such extrusions also form hills in the swamp land in the east, such as Bukit Semabang and Bukit Merabok.

Some hills in the swamp land between Sungei Simunjan and Sungei Kepayang are composed mainly of sedimentary rocktypes of Tertiary Age. Bukit Kaladang at the western side is covered with red coloured soils which show similarities with soils found elsewhere on the red mudstones in the Tertiary sediments. However, some chert-like gravel was found in the soil which may point to the fact that the soils are possibly chert-derived, since also chert-derived soils of similar properties were found in Second Division (Scott, 1963). The nearness of chert formations recorded by Haile (1954) makes it therefore possible that chert may be involved.

Bukit Ngili, the largest hill in the swamp land near Simunjan is composed mainly of sedimentary rocks of Tertiary Age; shales in which coalseams are interbedded outcrop at the slopes while the hill is topped by thick bedded iron-poor sandstones of late Tertiary Age. Also here volcanic rocktypes possibly of the Serian formation outcrop at Bukit Temiang and at Bukit Tunggal nearby.

Finally, in the north some large hills surrounded by peat swamps are formed partly by silicified volcanic rocks of the Sebangang formation of possibly Carbo-Permian age, and partly by Sebuyau granite of unknown age but possibly younger than Carbo-Permian (Haile, 1954). Soil types on these hills show some similarities with those found on Bukit Gading near Lundu which is composed of adamellite.

In the area the occurrences of igneous extrusive and intrusive rocktypes is most important for agriculture since on these rocktypes relatively better soils have formed than those found on the sedimentary rocktypes.

5. Land Use

a. Primary vegetation

The peat areas are mainly covered with Mixed Swamp Forest from which in most areas timber is extracted. In the centre of large swamps generally Alan Peat Forest is found. Only one small area of Padang Paya Forest exists between Temiang and Bukit Keladan. Agriculture is practised where peat soils tend to be shallow. Usually first a zone of clay soils existing along a river is reclaimed after which this zone is extended into the deep peat further away from the river. This practise has resulted in the reclamation of most land along river courses while the peat forest between the river courses is usually untouched. Only in recent years in certain localities, the deep peat areas are being reclaimed as well because of land pressure.

Large areas of Lowland Dipterocarp Forest can still be found on the mountainous terrain between the First and Second Divisions. Dipterocarp Forest of poorer quality exists in the south near the Simanggang road and forms there the Sabal Forest Reserve. In this Forest Reserve a considerable area of 'Kerangas' Forest can be found. The forest on the slopes of Bukit Garu is of better quality than the remainder of this Forest Reserve. Belian growth in some quantity along the small streams sprouting from the northern slopes of the Klingkang range.

Part of Balai Ringin Forest Reserve can be found in the south of the area between Balai Ringin and Kampong Telagus. The forest there is mainly of inferior quality, the majority being Kerangas Forest.

Bukit Ngili Forest Reserve on Bukit Ngili near Simunjan is also mainly Kerangas Forest.

6. Agriculture

Main crops in the area are:-

(i) Coconut;
(ii) Wet padi;
(iii) Rubber;
(iv) Pepper.

(i) Coconut is planted in the coastal area near Sebangan and along the Batang Sadong up to Simunjan.

A new drainage scheme situated at mid-Sadong aims to extend the growing of this crop to this area. Further, some coconut is planted near Gedong also along the Batang Sadong.

Areas along the Batang Sadong planted up with coconut are mainly riverine clays and shallow peat but near the mouth of this river also moderately deep peat soils are planted up. The coastal area near Sebangan is mainly covered with shallow and deep peat, and probably saltwater infiltration takes place during the drier part of the year.

(ii) Wet rice appears to be the most important crop in the area and is usually planted along most of the main river courses on clay soils and shallow peat soils.

Some very good wet padi land exists also in the upstream area of Sungei Simunjan Kiri near Munggu Air and Semalatong, although the land is mainly shallow to moderately deep peat. Flooding is here a major limitation.

Good padi land is also found between the foot of Bukit Ngili and Sungei Simunjan. Clay soils and shallow peat soils are used. Here padi cultivation has improved recently by the completion of drains under the assistance of the Padi Planters Subsidy Scheme.

Not all the land suitable for wet padi is used annually and often rotation periods are three or four years depending on fertility of the soils and availability of land. Much more wet padi land requires better drainage and it is suggested that with drainage improvement together with the use of fertilisers more wet padi could be grown on the same acreage of land used at present.

(iii) On the hilly land rubber and pepper are the main crops. Large areas of old rubber exist near Temiang on the slopes of Bukit Ngili, and in the upstream areas of Sungei Kepayang, Sungei Simunjan Kiri and Kanan. They are mostly Iban owned. Rubber Planting Scheme 'A' gardens in this area are not always well maintained but do surprisingly well in some localities as for instance at Bukit Kenyong, where the soils are of good quality. Although the trees have already reached tapping age, many gardens are not tapped at all because of labour shortage and the farmers rather like to spend their time by growing pepper, a more lucrative crop.

Rubber is, however, the main source of income in the upstream areas of S. Simunjan Kanan, notably Kampong Sabal and Kampong Sungei Pinang where soils are generally not suitable for pepper.

(iv) Pepper is planted in a great number of areas and almost every kampong which owns hill land has a number of farmers devoting most of their time to this crop. Very good gardens were seen at Kampong Temiang and on Bukit Tunggal which is virtually one pepper garden. In this area many acres of tappable rubber are left untouched because of the good income received from pepper.

In the last three years a great number of pepper gardens have been established along the Simanggang road particularly between S. Kerait and Balai Ringin. It is gratifying to note that people have followed the advice given during the soil survey of 1960 to plant the pepper on their better soils.

Although many Dayak pepper planters seem to have sufficient know-how they generally do not fertilise the pepper well which is the main reason for the generally sickly looking pepper vines at mature age.

The practise to fertilise the pepper with coal fragments as is done at the foot of Bukit Ngili near the old coal mines seems to have a favourable effect.

In general it could be noticed that the interest of the progressive farmer having hill land suitable for pepper leans more towards the planting of this crop than to the planting of more rubber, and one gets the impression that this is even more so when the farmer is backed by a number of acres of productive rubber sufficient to supply his daily needs.

Part 2. SOILS

1. Soil Classification

The classification used is that described in 'A classification of Sarawak Soils' (Soil Survey Staff, 1966).

The classification of the soils in the area is outlined in Table 1 and shows 9 Great Soil Groups subdivided into a total of 25 individual soil families. In addition one provisional soil series was mapped which place in the classification scheme is still undecided.

The Great Soil Groups are based on major morphological characteristics which are of a genetic nature while a subdivision into soil families within the Great Soil Groups is based partly on minor morphological characteristics and partly on some chemical characteristics which have genetic significance.

Apart from the one soil which could not be placed in the present classification scheme without obtaining more data on it, a subdivision into series has not been attempted.

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The basic mapping unit is the soil family or an association of soil families. The latter contains usually two main soil families while commonly some other minor families are present as well. Common practise is that if 80% of an area or more belongs to one family the area is mapped as being of one family.

Reconnaissance mapping in Sarawak entails the checking up of major soil groups or families occurring in an area, the boundaries being mainly deferred from either the topography, geology or natural vegetation which can be interpreted from air-photographs. Boundaries of map units are therefore most accurate near the localities where soil observations were made. Map 3 shows these locations and the map may be useful in showing where highest accuracy can be expected.

Finally, it should be noted that when reference is made to fertility of soils both chemical and physical aspects of the soils are concerned. Most soils in Sarawak have low contents of nutrients and differences in natural fertility are commonly more related to the physical characteristics of a soil than to the present nutrient levels as assessed by soil analysis.

2. Descriptions of the Mapping Units.

The units are described in the order shown in Table 1.

Table 1

Outline of classification

Great Soil Group	Families	Series
LATERITIC SOILS	1.Tarat 2.Antayan	
RED-YELLOW PODSOLICS	3.Abok 4.Merit 5.Bekenu 6.Nyalau 7.Malang 8.Semilajau	9.Begunan
GREY-WHITE PODSOLICS	10.Triboh 11.Saratok 12.Kerait	
PODSOLS	13.Miri 14.Silantek 15.Bako	
GLEY SOILS	16.Bijat 17.Sebandi 18.Plan	
SALINE GLEY SOILS	19.Rajang 20.Pendam	
PEAT SOILS	21.Mukah 22.Anderson	
RECENT ALLUVIAL SOILS	23.Ramun 24.Kayan	
SKELETAL SOILS	25.Kapit 26.Sedong	

LATERITIC SOILS

1. Tarat family

The Tarat family is the major family in the group of Lateritic soils in the area. The family occurs widespread in association with the Sedong family in the Bukit Punda area, on Bukit Antayan and Bukit Merbau and in association with the Antayan family on the hills between Sebangan and Sebuyau. Minor occurrences are found as single hills in the peat swamps such as Bukit Tunggal or as outcrops in shale areas in the south of the area.

Soils in the family are characterised by usually strong brown reddish-yellow colours throughout the profile. There is no distinct horizon differentiation other than that between the dark coloured topsoil and underlying soil, and that between soil and parent material which is usually found at a depth of less than 48 inches. The soils are friable and usually have a good crumb to very weak blocky structure. Internal drainage is rapid and the soils are usually unmottled. Textures vary but are generally clay loams in the surface horizons and clays in the subsoils.

The soils are chemically poor, although total phosphate is among the highest figures recorded in Sarawak soils. The clay fraction is rich in iron oxides and the soils have a high phosphate fixation power. The soils in this family do not present any permanent serious limitation to agriculture, their low nutrient value being the main problem. The associated topography is generally steep.

2. Antayan family

This family is very similar to the Tarat family but for the colour and the structure. The colours are commonly more yellow usually yellow-brown to olive-yellow. The structure is better developed and is strong fine angular blocky in a dry soil. Internal drainage is therefore less rapid than in the Tarat family and slight mottling may be present in the lower horizons. There are indications that this family is found on less basic rock types than those forming the parent material of the Tarat family. Frequently also some fine quartz crystals are found in the soil. Available analytical data from other areas suggests that on average the soils are slightly better supplied with plant nutrients than the related Tarat family. This, however, is not always the case when comparing single profile pits. As is the case with the Tarat family, topography is the main limitation to agriculture, the slopes are frequently steep to very steep and the generally broken terrain is not well suited to intensive development.

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RED-YELLOW PODSOLIC SOILS

3. Abok family

This family is a minor family in the group but is of much local importance in the area. It is found on the intermediate to acid igneous intrusions and extrusions found in the mountainous eastern part of the area and to a minor extent on the hills between Sebangan and Sebuyau. Generally it is associated with Kapit family soils.

It has been separated from the other families in the Red-Yellow Podsolic Group mainly owing to its relatively high iron-oxide content giving it strong reddish-yellow colours throughout the profile.

The textures are medium, ranging from sandy loam to sandy clay loam in the topsoil to sandy clay loam to clay in the subsoil. Structures of the subsoils are commonly blocky. Consistency varies from friable to firm. The Abok soils are poor in all nutrients but total potassium (acid extraction) can be high on granitic parent material. Total phosphate is characteristically low which may help to differentiate this family from some transitional Tarat family soils. Between S. Kerait and Balai Ringin the Abok soils belong to the Bayur series which is derived from schist.

The topography is in the area generally moderately steep to steeply sloping and is therefore a major limitation for making full use of the otherwise physically good soils.

4. Merit family

Merit family soils are Red-Yellow Podsolic soils which have been separated from other families in this group on account of the heavy texture throughout the profile. Generally textures are clay loam in the topsoil and clay in the subsoil. Colours range from yellowish-brown in the topsoil to yellow or reddish-yellow in the subsoil. Most soils are moderately well-drained, although in certain low lying localities or gently sloping areas imperfectly drained soils occur which have a strongly mottled zone in the place of the B-horizon. Under natural vegetation the soils are friable in the topsoil, and firm in the subsoil, but under shifting cultivation the consistency is usually firm in the topsoil to very firm in the subsoil. Structures range from weak angular blocky to strong blocky, but this is often related to the state of wetness. In very dry conditions, such as in road cuttings, the structure is very strong blocky. The soils are generally deep with deep weathering zones of soft shale. Hard shale was never seen in deep road cuttings of more than 20 feet deep.

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The soils have moderately good physical properties if in moist condition. More demanding crops, such as pepper are difficult to establish but good farmers with the use of mounding and mulching are able to use this soil type for pepper. The main limitations are the low nutrient status and the low degree of permeability which results in periodically wet conditions during the wet season which may be of importance in pepper cultivation in connection with the occurrence of foot-rot.

In the area the Merit family occurs generally in association with the Saratok and Kerait family of the Grey-White Podsolic Soil Group. Topography is usually low-lying moderately sloping, hilly terrain, probably generally too steep for the planting of oilpalm for which the Malayan Capability Classification suggests 15 degrees (Leamy et al, 1966) as the maximum limit. This topography is, however, suitable for rubber.

5. Bekenu family

This family is similar to the Merit family but has coarser textures particularly in the upper horizons. Textures in the topsoil range from sandy loam to sandy clay loam while those in the subsoil range from clay loam to clay. Generally Bekenu soils are somewhat better drained than the Merit family soils. Levels of plant nutrients are low and this is a main limitation for agriculture. Steep slopes are a limitation in some localities.

6. Nyalau family

These soils resemble those of the Merit family but they have the most coarse textures in the group of Red-Yellow Podsolic soils. Textures range from loamy sands to sandy clay loams and there is generally a distinct increase in clay content with depth.

The Nyalau soils are poor in nutrients and because of the predominantly sandy textures are probably expensive to fertilise. Drainage is generally good. In the area, the family is of minor importance.

7. Malang family

Malang soils are important locally particularly because they are recent soils not showing the high base depletion of related upland soils such as the Abok, Merit and Bekenu soils. Malang soils are mainly heavy loams to clays, generally with clay loam topsoil and clay subsoil.

Drainage in the top two feet of the profile is moderately good but below two feet it generally shows evidence of waterlogging. Malang soils occupy incipient levee positions and are liable to flooding during the rainy season. Nutrient levels depend upon the source of the parent materials. Near S. Semalatong, Malang soils have a high proportion of mica's and total potassium is high.

Malang soils are good soils, they are easy to cultivate because structures are crumby to weak angular blocky but because of the flood risk they are best used for flood-tolerant perennials and annual crops.

8. Semilajau family

This family is not important in the area. The soils are similar to the Malang soils but are more sandy throughout the profile. Parent materials are derived from siliceous rocktypes and the Semilajau soils are commonly less well supplied with plant nutrients than the related Malang soils. A limitation is flooding and in some localities poor subsoil drainage.

9. Begunan series?

The Begunan series is found on Bukit Keladang and on a number of small hills near Kampong Ensebang. The parent material is unknown but is probably either red mudstones or chert, the latter probably being mainly silicified volcanic rocks. The soils are of a dusky red colour throughout, structure is blocky and the texture is in the heavy clay range. The soils occur on rather steeply sloping terrain which is possibly the reason why the soils are not mottled. Commonly in such heavy clays internal drainage is imperfect and strongly mottled horizons are found. In this terrain most rainwater is disposed off as run-off water and very little may percolate. The soils appear to be suitable for pepper planting and rubber is doing very well. The total acreage over the whole area is, however, small.

A description and some analytical data on the series is given in the appendix.

GREY-WHITE PODSOLIC SOILS

10. Triboh family

Triboh soils occupy old terrace sites. The soils are characterised by pale colours ranging from white to pale yellow. Textures vary from sandy loam in the topsoils to usually a sandy clay in the subsoil. The silt fraction is predominant in most soils. Characteristic is further a very low iron content. Weak mottling is usually present in the lower subsoil but due to the absence of iron gleying, if present, is difficult to detect.

In some places Triboh soils are typical planosols in which coarse material abruptly overlies dense heavy clays. The soils are poor in all plant nutrients and heavy fertilising is necessary for a satisfactory growth of crops.

The terrain is commonly low, gently undulating and well suited to agriculture.

11. Saratok family

This family is very similar to the Triboh family but the parent material is derived from iron-poor sandstones and the soils are residual. Also the abrupt textural change common in some Triboh soils is never found in the Saratok soils. This family occurs widespread in the area in association with Merit and Bekenu family soils. It is frequently found in localities where iron-poor sandstone beds alternate with more iron rich shales so that both families develop on these parent materials in a complex fashion.

The agricultural significance of the Saratok soils is the same as for the Triboh soils and heavy fertiliser applications are needed especially for the demanding crops, since all plant nutrients are lacking. The topography is low, gently sloping to moderately steep hilly terrain.

12. Kerait family

Kerait family soils are in many aspects similar to the Saratok soils but for the texture. Kerait soils are heavy textured, topsoils having sandy clay loam textures while the subsoils are heavy clays. Structure is usually coarse blocky in the subsoil. The Kerait soils as is the case with the Saratok soils are not fertile but usually give better crops than the latter which is probably due to a higher clay content.

In wet conditions, the soils are very sticky and are difficult to handle. Manuring may be more economic than on the Saratok soils, but imperfect drainage conditions restrict the range of crops which can be grown profitably. Steep slopes are a limitation in some areas. The soils are of relative importance between S. Kerait and Balai Ringin where they usually occur in association with the Abok family (Bayur series).

PODSOLS

13. Miri family

This family is usually found on flat terrace sites built up by coarse-textured old alluvium.

Textures are commonly coarse sandy in the topsoil overlying sandy loams in the subsoil. A thick organic top horizon is usually present. The natural vegetation is poor Kerangas forest. The flat topography induces poor drainage condition which is aggrevated by the podsolic hard-pans found in these soils. The fertility of these soils is extremely low and they are unsuitable for normal agriculture.

14. and 15. Silantek and Bako families

These families usually occur in complex or in association on coarse sandstones in a flat to gently sloping topography. The soils are very similar to the Miri family, the difference being that the former are of a residual nature and are underlain by sandstone. The Silantek family has a non-cemented humus - B horizon, while the Bako family has a cemented hardpan which cannot be penetrated by auger. Usually the Bako family occurs in localities where drainage conditions are extremely poor while the Silantek family is found in somewhat better drained localities commonly on more sloping terrain.

Both families are extremely poor in plant nutrients and are not recommended for agriculture. The Silantek family may in certain localities be used for vegetable growing or pine-apples if situated nearby markets and sufficient organic and inorganic fertilisers can be obtained cheaply. This does not apply for most occurrences of this family in this area.

GLEY SOILS

16. and 17. Bijat and Sebandi families

These families occupy floodplains and are both characterised by a gley horizon within 20 inches from the surface. Both families comprise heavy clay soils in generally wet to moist conditions. The Sebandi family, however, has a peaty topsoil not thicker than 10 inches and is transitional to the peat soils. They generally occupy rather lower lying places than the Bijat soils and are grey throughout. The Bijat soils are normally found on incipient levees and are therefore somewhat better drained. The crop range on the Bijat soils can therefore be greater since in the dry season annual crops can be grown with success. The wet conditions in the Sebandi soils in most areas prevent this. Both families for optimum use requires improvement in drainage. Then, the soils are suitable for coconut, bananas and possibly oilpalm.

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18. Plan family

The Plan family is similar to the Bijat family but for the textures. In the Plan family soils the clay content is less than 15% and textures are usually in the sandy loam to silty loam range. The soils are suitable for the same crop range as recommended for the Bijat although they may need perhaps more fertilisers because of the more sandy texture.

SALINE-GLEY SOILS

19. Rajang family

This family occurs in coastal areas and has developed in marine and estuarine deposits. The soils can be easily recognised by the natural vegetation, namely mangrove and nipah. The soils are strongly saline, having high amounts of soluble salts in the soil water. Fluctuations in salt content can be expected. This is caused by a variable rainfall intensity and salt concentration of the tidal water which floods these areas frequently. The water table is commonly high and is found at less than 20 inches from the surface. The Rajang family is characterised by heavy clay soils.

Under natural conditions, the Rajang family is not suitable for agriculture. To improve the soils, drainage and bunding is most necessary. Salts should thereafter be leached for which the rainfall is normally sufficient as experience elsewhere in the country has shown.

The Rajang soils have a high potential for agriculture but this potential can only be realised after costly amelioration.

20. Pendam family

The Pendam soils are closely related to the Rajang soils. They differ from the Rajang soils in being weakly saline so that crops can more easily be grown. Due to artificial or better natural drainage than exists in the Rajang soils, salts have leached from the Pendam soils to such an extent that they are generally free from harmful salts at least during the wet season. In the dry season the salt level may increase because at this time of the year the salt content of river water is highest. Coconut is the main crop cultivated on the Pendam soils. The natural vegetation is commonly Nipah mixed with Nibong.

Drainage is the main limitation for agriculture. Saline conditions are of secondary importance and then only in the dry season. Off-season cropping is profitable on these soils as has been shown in other parts of the country.

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PEAT SOILS

21. Mukah family

The Mukah family consists of peat deposits of a depth ranging from 10 to 40 inches which overly clay soils. The soils occur usually in a narrow transitional belt between the Sebandi family soils and deep peat (Anderson family) and are therefore most widespread at swamp margins. The peat is commonly coarse woody with a water content approaching 95%. The water table is high and during the wet season flooding usually occurs.

In their natural condition the soils are unfit for most forms of agriculture because of poor drainage. Improvements should therefore primarily be aimed at drainage, after which the soil would be suitable for annuals mainly until the peat has consolidated which usually takes a number of years. Thereafter also perennials, such as coconut, could be grown.

The problems in drainage improvement should, however, not be underestimated as the land is very low lying and there is usually very little allowance for shrinkage until the peat subsides below the high tide water level in the river so that bunding becomes a necessity.

22. Anderson family

This family is in area the most important one but is agriculturally of little significance. The family comprises peat accumulations thicker than 40 inches. Certain depth phases are distinguished:-

Anderson 1	-	40 - 80 inches deep
Anderson 2	-	80 - 120 inches deep
Anderson 3	-	more than 120 inches deep.

Generally the peat is coarse woody, the watertable is normally high in the wet season but during the less wet season the surface may be dry. At present the soils are not recommended for agriculture because of their inherent poor fertility and the drainage difficulties. In certain cases Anderson 1 soils may be used if they can be properly drained.

Investigations into the use of these peat soils is in the planning stage and recommendations for possible uses of this land must await results of such investigations.

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RECENT ALLUVIAL SOILS

23. Ramun family

Ramun family soils are mainly found at the foot of hills and mountains formed by basic igneous rocks in alluvial fans or upstream areas of small rivers coming from such locations.

The soils are usually strong brown to reddish-yellow coloured and do not show any clear profile development. They consist of recently deposited material, they are light textured and range from sandy clay loam to sandy loam. The clay fraction is usually derived from eroded Tarat family soils while the coarser fragments, in many areas of gravel size, consist of partly weathered, or fresh basic igneous rock particles.

Ramun soils are well-drained to somewhat excessively drained and shallow rooting crops may suffer from a lack of water during the dry season. Nutrient levels are generally higher than in other families in this soil group and the soils are considered suitable for a wide range of crops, notably fruit crops although annual crops can also be grown with success. The total area is unfortunately small.

24. Kayan family

Kayan family soils are also recent alluvial soils but have derived from coarse textured, acid igneous or sedimentary rocks. They occur in upstream areas of secondary streams. The soils are commonly stratified with alternate sandy and loamy layers. No horizon differentiation other than some accumulation of organic matter in the top horizon can be noticed. Base saturation and exchange capacity are generally low. Colours range from yellow to brownish-yellow.

The soils are suitable for fruit crops, flooding is a limitation.

SKELETAL SOILS

25. and 26. Kapit and Sedong families

In both families weathered bedrock is found at less than 10 inches from the surface but the rock is either soft or so broken up that roots can penetrate it. Sedong soils occur on steep slopes of hills and mountains, and are generally brown coloured. Textures are commonly heavy clays mixed with gravel often of a colluvial nature. The Sedong family is found on rocktypes with a high content of ferro-magnesium minerals and the soils are generally well supplied with plant nutrients. For Sarawak it is a fertile soil but soil depth and steep slopes make farming difficult. Scattered development is, however, possible.

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Kapit family soils occur on steep slopes and the parent material is derived from rocktypes rich in silica and the soils have therefore a low content of plant nutrients. This, coupled with the usually steep terrain render most of these soils unsuitable for agriculture, although as is the case with the Sedong series, small areas could be used for some crops particularly if the family occurs in association with the Abok family derived from igneous rocktypes. In such localities pepper has proved to do well on these soils although the establishment of gardens is difficult because of the rocky nature of the land.

MISCELLANEOUS

A considerable part of the area had to be mapped as associations or complexes of more than one, usually two main soil families. For a description of such map units the reader is referred to the descriptions given for each of the component soil families.

Only in one map unit four major soil families occur in association. This is the area formed by the rugged mountainous terrain found along the eastern border of the area. Here Tarat and Abok families occur together with their corresponding shallow, skeletal soil members namely the Sedong and Kapit families. This association is caused by a mixed occurrence of intermediate and acid igneous rocktypes combined with steep topography. Detailed geological investigations would be required for separation of the Abok and Tarat families.

In swampy lowlands an association comprising all depth phases of the Anderson family and perhaps also the Mukah family was mapped in areas where the boundaries between the phases were found to be very irregular, so that interpolation became impossible. In such areas usually Anderson 1 and Anderson 2 are dominant meaning that these areas are partly suitable for agriculture and partly unsuitable. The mixed occurrence of such soils makes it very difficult to exclude too deep peat soils from otherwise suitable areas and such soils will have to be included in any endeavour to reclaim such land.

Part 3 - LAND POTENTIAL

1. Land classification

In this section an attempt is made to interpret information of a pedological nature presented in foregoing sections in terms of agricultural usefulness of land with particular reference to the immediate requirements for agricultural development as is at present envisaged in Sarawak.

Any method which aims to classify land in terms of suitability for agriculture must be based on experience with the soils to be classified and crops to be grown. Commonly such experience is gained by long term studies of crop behaviour on specific and selected soil types and if such studies are to be of practical value calculations of management costs should form part of this research. While such information may be readily available in developed countries with a permanent settled agricultural society in less developed countries such as Sarawak this is not the case. It is only during recent years that such studies have been started and results will only become available after some years.

The Soil Surveyor can therefore only base his classification on experience which may either be available from other countries or which has to be obtained from personal field knowledge in Sarawak. In both cases a certain amount of subjective judgement is involved which cannot be avoided.

Apart from the immediate soils problems with which the agriculturist is confronted and which must be taken into consideration in a classification system, the improvement of certain soil conditions such as drainage, fertilisation etc. must be taken into account as well.

The cost if improvement of bad land is dependent on a number of economic factors such as labour costs, capital costs of materials, and transport which may range widely depending on accessibility. Also the location of the area is of importance and it may for instance pay better to improve bad land near a port or market than to develop good land which is remote from such facilities.

For these reasons it is impossible to indicate for a given area what soil types are suitable, marginal or unsuitable for agriculture.

Even in case this was possible such a rating of land should take into account the crops to be grown and the world market prices.

Given the unlikely situation that pineapple would become a highly priced crop, soils which are normally not recommended for agricultural use would suddenly become very suitable since pineapple may be the only profitable crop to grow on such a soil type.

Every land rating therefore is only of value for the present day and may need revision from time to time.

The large majority of the soils in the area at present under study need improvement, improvement which although technically possible may be very expensive.

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It can be seen from this table that no soil on account of topography was placed in category four. Only on account of very inferior soil properties or serious drainage difficulties were soils placed in this lowest category.

It can be stated that the Department does not at present normally recommend the agricultural use of soils placed in this category although it should be recognised that in abnormal cases, there may be no other alternative than to use them.

This system further allows the compilation of an easily understandable land potential map (map 2) which shows the relative value of all the land in this area together with the limitations which were responsible for this rating.

From this map it can be deduced where the best land is and where land can be cultivated at the lowest costs.

Table 2

LAND RATING

Categories		Sub-categories (limiting factors)	
red -	Category I	a -	drainage
yellow -	Category II	b -	soil
green -	Category III	c -	topography
white -	Category IV		

THE RATING OF LAND INTO CATEGORIES IS BASED ON THE INCREASING AMOUNT OF EFFORT, TIME AND EXPENSE NEEDED TO REMOVE MAIN LIMITATIONS FOR AGRICULTURAL USE AS INDICATED BY THE SUBCATEGORIES.

CATEGORY IV REPRESENTS LAND OF THE LOWEST VALUE IN SARAWAK.

Table 3

Rating of Soil Map units in Land Categories

Category	Sub-category	Soil Map Units
I	a	Bijat, Pendam, Sebandi
	b	Merit, Nyalau, Bekenu, Begunan, Kayan
	c	Tarat, Antayan, Abok
	-	Malang, Ramun
II	a	Mukah, association of Mukah, Bijat, Sebandi, Pendam
	ab *	Plan
	b	Association of Merit, Nyalau, Bekenu and Kayan with either Kerait, Saratok or Triboh Kerait, Saratok and Triboh
	c	Association of Tarat, Antayan and Abok with either Sedong or Kapit
III	a	Anderson 1, Association of Anderson 1 with Bijat, Pendam, Sebandi or Mukah, Rajang
	b	Association of Saratok and Triboh with either Bako, Miri or Silantek
	c	Kapit, Sedong
IV	a	Anderson 2 and 3
	b	Miri, Silantek, Bako

* Note:- Combinations of sub-categories for land with more than one main limitation are possible.

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2. Conclusions and recommendations

Firstly in this section, the land potential of the area as a whole is commented upon. Thereafter the potential of the area of immediate interest namely that situated along the proposed feeder road to Simunjan is discussed. In general the picture shown by the Land Potentiality Map (map 3) is not a very bright one. It is immediately obvious that the largest portion of the area falls into category 4 because of very bad drainage conditions. This category comprises mainly deep peat swamps which are very difficult to reclaim.

Apart from these deep peat areas, category 4 land with extremely low fertility of soils, is found in the east and south of the area.

For present development planning it is recommended that category 4 land should be regarded as being of very little value for agriculture and that attention should be given to category 1 to 3 only, but it should be noted that if category 4 land is situated along an existing road or near a market it may be worth looking into prospects for improvements.

Category 1 to 3 land comprises subcategories a, b and c. For development purposes it would be best to consider subcategory 'a' separate from the other subcategories since land in this subcategory requires drainage schemes for improvement while land in subcategories b and c do not require any special improvement which can only be given through a scheme.

The Lowlands

It can be readily seen from map 3 that most land found along the rivers can be put to agricultural use if attention is given to drainage. The majority of this land is already in use for agriculture but because of drainage difficulties the productivity is very low.

It should be realised that the productivity of all lowland in this area cannot be raised primarily by opening up new land. Already category 1 to 3 is mostly in use and opening up new land would mean taking into production category 4 land. It is suggested that:-

(a) the increase of productivity should be realised by more efficient land use of the present area under agriculture by improving drainage and using fertilisers so that no good land is lying fallow for a number of years.

(b) drainage schemes should only take in category 4 land if this is justified by location and economic feasability. It is mainly through the improvement of category 4 land that new land can be made available for agriculture in these lowlands.

In this connection the feasability of draining and bringing into production all the land situated between Nanas road (Simunjan), the southern foot of Bukit Ngili and the Simunjan river would be worth studying. The area is indicated on map 4 (Annotated map for development). The situation justifies reclamation of deep peat since the Simunjan feeder road is planned to go through this area and transport and marketing are then factors in favour of developing this land. The construction of the road through the peat and the planning of a drainage scheme should be studied simultaneously so that possibly considerable savings can be made on expenses required for major earthworks if a drainage scheme were to be implemented after the road had been built.

Another area shown on this map is the upstream area of the Simunjan Kiri river. This is at present a good wet padi area but flooding is the major limitation. It is suggested that the area should be studied with a view to improvement of natural drainage so that water could be quickly disposed off.

A third area worth receiving attention comprises the good alluvial soils near Bukit Punda which are flooded for long periods and which resemble lakes during the wet season. Although it may be too expensive to improve conditions to such an extent that this land may be used throughout the year, if only the land could be drained sufficiently for cropping during the off-season then already a considerable acreage of land could be added to the cultivable land.

The Uplands

The uplands contain a larger portion of soils suitable for cultivation. Only the true podsols are considered to be too poor for normal cropping. (category 4)

Category 1 and 2 land in the uplands is found mainly concentrated in the Bukit Punda area and in the north on the hilly terrain near Sebangan.

Unfortunately steep slopes render these areas unsuitable for intensive development and although much of this land can be put to good agricultural use siting of gardens is much dependent on slopes and depth of soil so that these areas are best developed by individual farmers who select the best places for their own use. The more flat to undulating terrain is covered with category 3 land mainly and poor soil types are here dominant. The better topography in this part of the uplands does not coincide with better soils and rather the reverse is the case. Reason is that steep terrain in this area usually indicates volcanic rock types which is here synonymous to superior soil types.

Although topographically there is room for a R.P.S. 'B' size scheme the soil types in this flat to low undulating terrain are generally not favourable for such scheme development.

There is a large area of category 2 land between Gedong and Punda which has more or less been abandoned by the local population because of its remoteness from communication lines. It may be possible to use this land for rubber planting if a road could be brought into it from either the Gedong side or the Balai Ringin side. Most of the area is under secondary forest.

The large area of category 2 land in the east and which is mainly under primary forest has for a large part difficult topography (c) for scheme development and agricultural development there should be done by careful selection of suitable land and block alienation of say, 200 acres or less in suitable areas.

Much detailed work will be required to sort out suitability of this land in detail because of the complex variations in slope and soil depth. Given proper development planning this area could accommodate a large number of farmers who with intensive cropping methods could make a good living on the superior soils found in this area.

Finally, a suggested road alignment for the Simunjan road is given on map 4. Comments on the agricultural potential of areas along this alignment are directly quoted from the preliminary report on the soil observations in the projected Simunjan-Bukit Punda feeder road survey issued in May, this year.

" Between Simunjan and Kampong Temiang (approximately eight miles) the alignment is an obvious one since it is the most direct route leading over the only high lying land giving access to Simunjan which is surrounded on all sides by

peat swamps. The stretch between Simunjan bazaar and the secondary school at the foot of Bukit Sadong is mainly deep peat (approximately two and a half miles), a partly constructed road is already present. There is as yet little prospect for intensive agricultural development along this stretch of the road. From the secondary school to Kampong Temiang the road alignment follows an existing footpath at the foot of Bukit Ngili. Along this five mile long stretch of road there is some prospect for pepper planting on the dry land (especially at Kampong Lubang Empat) but the majority of the dry land is only suitable for rubber cultivation. Ngili Forest Reserve lying to the north of this road stretch is mainly on category 4 land unfit for intensive cultivation.

The hill land between Kampong Emplas and Kampong Temiang is of much better quality and here prospects for pepper cultivation are brighter. Gunung Temiang itself has excellent soils for pepper cultivation and Kampong Temiang is a thriving agricultural community with pepper cultivation as the main source of income.

Apart from the good prospects for intensive agricultural development on the hill land at G. Temiang, the flat land lying at the south of the hill land along this five mile stretch of road could be developed into good productive padi land. There are already some minor drainage schemes but they could be joined up to form one block. At the foot of the hill land clay soils overly peat in many places. Towards Sungei Simunjan this clay cover becomes increasingly thinner until it disappears and only deep peat is found. Nearer Sungei Simunjan another clay deposit is found which becomes increasingly thicker towards Sungei Simunjan. The clay covered peat is excellent for padi cultivation but when drained one should avoid exposing the peat to air as much as possible so that subsidence of the land can be restricted to a minimum.

From Kampong Temiang to the hilly mainland the only logical alignment of the proposed road is over the hills which can be found lying in the midst of what is one large expanse of peat deposits extending from the Batang Sadong to the Batang Lupar.

There are two alternatives:-

(a) from Kampong Temiang over Bukit Keladan to Bukit Biru;

(b) from Kampong Temiang over Bukit Tunggal to Bukit Biru.

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Although Bukit Keladan is partly covered with good soils, suitable for pepper and rubber cultivation and prospects for agricultural development on this hill are quite good, it may be too expensive to lead the road over this hill since a most difficult long stretch of deep peat (at least two and a half miles) will have to be crossed. An advantage would be the opening up of land at Bukit Keladan and at Bukits Nyelu and Sembau. The costs, however, may be too high.

The other alternative is to bypass Bukit Keladan and to follow the direct route over Bukit Tunggal to Bukit Biru. Although this route is shorter it nevertheless involves the crossing of at least two miles of peat which cannot be avoided. Bukit Tunggal itself is covered with excellent soils for pepper cultivation but they are for the greatest part already in use for this purpose. The surrounding peat has as yet no agricultural value.

The suggested alignment follows then Bukit Biru which on all sides is enclosed by deep peat unsuitable for agriculture. The soils of Bukit Biru are in the north suitable for pepper and rubber but to the south mainly for rubber only. Land lying just below the fifty feet contour is generally of very poor quality.

There is a choice of crossing S. Singkalan either at Kampong Kenyong or at Kampong Singkalan. At both places large 'padangs' exist which are both deeply flooded during the wet season. Probably the crossing of this river will need a moderately large bridge. Rocky outcrops are present at both sites. Possibly the upstream site would be cheapest.

After the crossing of S. Singkalan the road alignment then follows Munggu Apeng. This hilly land up to the headwaters of S. Munggu Air is covered with good soils. Much rubber and pepper has already been planted in this area but the pepper needs more and better fertilisers. Prospects for intensive agriculture are good in this area. Also here, land below the fifty feet contour is generally of very poor quality, being either deep peat or white sands of low fertility.

From the headwaters of S. Munggu Air to Kampong Spaoh the road could best follow a trace lying between the 150 and 200 feet contour. Commonly the hilly land above the 150 feet contour is of good agricultural value (category 2), the steepness of the land becoming the main limitation at altitudes not much above the 350 feet contour. Land below the 150 feet contour is generally of poor quality for agriculture, (category 3), except for the riverine soils along S. Mawang, S. Semalatong and S. Spaoh

which are all of good quality in particular for fruit trees. Also, the construction of the road at this place would avoid a number of small valleys with deep peat soils and the crossing of some secondary streams too far downstream which would necessitate the construction of large bridges.

Although the majority of the land fit for intensive agriculture lies above the 150 feet contour along this stretch of the road an exception is Bukit Semabang which lies as an island in the middle of good productive padi land and which peak dominates the scene between Kampong Munggu Air and Kampong Gayau.

The soils on this hill are of very good quality, especially for pepper cultivation. Perhaps unfortunately, most of the land is already in use for R.P.S. 'A' rubber.

The existing three and a half mile long footpath between Kampong Gayau and Kampong Spaoh lies between the fifty- and one hundred feet contour. Although the topography of the land along this footpath may be favourable for road construction, most of the land alongside this path is unfit for agriculture.

From Spaoh to Kampong Gawang the road must follow approximately the one hundred feet contour leading over Kampongs Ruan, Binong and Kesindu so that the 1,000 feet high crossing of Bukit Milas can be avoided. All the hill land in this area is of very good quality and this area can become a major agricultural area if opened up. Particulars can be found in report No.47 on the survey of the Bukit Punda area.

For linking Kampong Gawang (Bukit Punda area) with the main Serian-Simanggang road there are two major alternatives.

(a) leads from Kampong Gawang to Kampong Mawang and from there to the main road near Bukit Garu;

(b) leads from Kampong Gawang to Nyalitak and from there to Kampong Sabal Kruin.

Land along both alternative routes is of equal quality for agriculture, meaning that there is little prospect for intensive agricultural development. There are some pockets of soils with average quality, which are, with a lot of care and fertilisers, suitable for pepper, but the majority of the soils is of poor quality and either only just suitable for rubber or unfit for agriculture.

The first alternative requires the crossing of approximately half a mile of deep peat between Kampong Gawang and Kampong Mawang and a river crossing of secondary importance (S. Sabal Kruin), the second alternative requires the crossing of a number of tertiary streams and some difficult wet land between Nyalitak and Sabal Kruin. The second alignment is also longer."

The construction of the road through Sabal Forest Reserve may lead to development of land along this road and route 'a' would then open up a higher proportion of reasonably good land for alienation than route 'b'.

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APPENDIX

Family:- (probably Abok)

Bogunan series ?

Profile (augering)

Location: Bukit Keladan, Simunjan District, First Division.

Topography: on saddle western side of Bukit Keladan, slope 5 degrees.

Vegetation: approximately nine years old secondary forest.

Parent material: uncertain.

0 - 2 inches	5YR 4/3, reddish brown clay, weak angular blocky, moist, many small roots. Gradual change to
2 - 12 inches	2.5YR 4/8 red clay, firm, angular blocky structure. Gradual change to
12 - 20 inches	2.5YR 4/6, red clay, firm, angular blocky, some small purple coloured weathered rock pieces. Gradual change to
20 - 30 inches	2.5YR 4/6, red clay as above with more weathered rock pieces, small quarts and white veins.
30 - 40 inches	as above
40 - 48 inches	as above but much quarts.

Analyses

Lab. No.	Depth of sample (inches)	P Total	Ca Total	Mg Total	K Total	Gr. III	Fe Total
		in p.p.m.					
S4665	0 - 2	315	300	1000	4400	12.92%	4.30%
S4666	2 - 12	235	200	1100	4000	14.40%	4.90%
S4667	12 - 20	210	100	1000	4000	14.68%	5.10%
S4668	20 - 30	215	100	1000	4400	12.54%	4.90%
S4669	30 - 40	135	200	1000	4200	28.96%	5.65%
S4670	40 - 48	110	100	900	4300	16.90%	6.82%

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