

SOIL AND LAND POTENTIAL
OF
KUCHING - BAU - LUNDU
AREA

1 st. Division

by
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(Soil Surveyor)

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REPORT ON THE RECONNAISSANCE SOIL SURVEY
OF THE KUCHING - BAU - LUNDU AREA.
(1st Division)

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INTRODUCTION

1. Location

The Kuching-Bau-Lundu Soil Survey Area lies roughly between latitude $1^{\circ} 26' N$ and $1^{\circ} 50' N$, and longitude $109^{\circ} 45' E$ and $110^{\circ} 32' E$.

The area is bounded in the north by the South China Sea, in the east by the Sarawak river from its mouth to Batu Kitang, in the south by the Sarawak Kanan river from Batu Kitang to Kampong Suba Bau and from there almost by a straight line joining Kampong Suba Bau with G. Raya at the Indonesian border. In the east the boundary does not follow physiographic features and is formed by a straight line from Gunung Raya to Kampong Jangkar situated at Sungei Pasir and from there by a straight almost south-north line until it meets the coast at Sematan.

The area totals roughly 750 square miles.

2. History of the survey

During 1959, F.A.O. Soil expert Dames visited several areas in the Batang Kayan area (Lundu District). Two field reports on these visits were prepared namely: Soil Survey report No.1, on a soil reconnaissance of Tanjong Bemban and Tanjong Purun, and Soil Survey report No.25, on a reconnaissance survey of part of the Sempadi Forest Reserve and Gunung Kandai area. Both reports contain soil descriptions made along cutlines but no soil maps were prepared for the areas surveyed. It was therefore necessary to re-visit these areas during the present survey in order to re-classify the soils according to the system now in use and for collecting additional information so that a soil map could be compiled.

In 1960 a rough air photo interpretation of the whole Sempadi Forest Reserve and the coastal area to the north of it was made by the author to assess the potential of the area for agriculture with a view to a possible completion of the old Kuching-Lundu road which takes a course from Kampong Matang around the foot of Bukit Selang to Sungei Rayu. The conclusions of this survey are recorded in Soil Survey report No.25.

In the same year the area between Serayan and Sematan (Lundu District) was reconnoitred in connection with the construction of the feeder road from Lundu to Sematan. (Soil Survey Report No.19). Part of this survey area is included in the present map and this area was re-visited for re-classifying purposes.

The Tundong-Stinggang-Stungkor area (border Bau-Lundu District) was surveyed in 1962 and the results were recorded in Soil Survey report No.31. This area is complicated and several classification errors were made in that survey. The whole area therefore was re-surveyed and is included in the present map.

Several short visits were made in recent years to small areas in the Santubong region in an attempt to locate suitable soils for coconut planting. No official reports had been issued for such surveys and the information has now been incorporated in the present one.

Field surveys carried out in 1965 commenced in March and except for the period between the middle of May and the end of June survey parties were engaged in the area until the completion of the survey by the end of September. The surveyor was assisted during the early months by four Agricultural Assistants while in the later part of the survey only one Agricultural Assistant, Joseph Ingai, remained who had to take on himself considerable part of the survey burden. His sustained cheerful support in completing this survey within the scheduled period despite trying conditions and shortage of staff needs mentioning here.

For security reasons the areas in the east along the border could not be visited as scheduled, which is the reason why this zone had to be left unsurveyed.

3. Survey methods employed

Prior to field work, air photographs of scales varying between 1:20,000 to 1:30,000 were analysed with the object of studying terrain morphology and natural vegetation patterns. The geology was studied by using geological maps, prepared by the Geological Survey of the Borneo Region. Unfortunately contoured maps for the largest part of the area were not available in the beginning of the fieldwork but could only be made use of in the final preparation of the soil maps. The initial study of air photo's and geology of the area served as a basis for the field programme. Cutlines were planned and located in selected places where a possible correlation between terrain morphology, geology, vegetation patterns and soils could best be studied. This has generally proved to be successful except for very flat to low undulating terrain in the Stunggang-Bokar area where no correlation could be established between soils and other natural features because the vegetation was all secondary forest and the terrain very homogeneous on the photographs studied. Therefore the boundaries in this area are approximate and more field work will be required to locate them accurately.

The area between the foot of Bukits Snibong, Stunggang Bukit Tungal and the riverine land along the Batang Kayan proved to be equally difficult to map because of lack in land features which normally are indicative for soil boundaries. Most of this land is below 100 feet and almost flat and because of lack of contrast in terrain features here also soil boundaries are of a tentative nature and more detailed investigations will be required in future.

Although it has been attempted to obtain an equal coverage of observation in the whole area, for practical reasons this was not possible. That part of Sempadi Forest Reserve covering the upper catchment area of the Batang Kayan (beyond the confluence with Sungei Butan) appeared to be quite inaccessible. The river courses are too small and too dry for using river transport during the dry season and good tracks are non-existent. Surveying in that area was therefore restricted to observations along some hunting paths which were difficult to locate. The available information however was sufficiently indicative for allowing a reasonably accurate air photo interpretation on a reconnaissance scale.

4. Accuracy of maps

Owing to varying density of observations, complexity of terrain or soils and quality of air photographs used in the survey the soil map shows variations in accuracy. The accuracy obtained in the Sarawak river Delta, in the Sungei Tengah area, in the coastal area between Santubong and Sematan and in areas around Bukit Gading (Lundu) is almost that of a Semi-Detailed nature. On the other hand the accuracy in the most difficult areas mentioned above approaches that of a Broad Reconnaissance survey.

Bearing in mind that factors such as existing primary vegetation, homogeneity of terrain and geology in certain localities have also a bearing on the accuracy of the map, in general the density of outlines in a given area can be taken as a reasonable measuring stick for accuracy obtained. In all 415 miles of observation lines have been cut.

A small number of soil samples was collected since most soils had been studied in varying detail in other areas of the First Division or beyond. Samples were only collected from new soils found in the area.

For a location of observation lines and profile pits the reader is referred to map 3.

GENERAL DESCRIPTION

1. General Geography

The survey area embraces the western part of the Kuching Rural District, the eastern portion of the Lundu District while the southern part of the area is formed by the northern half of the Bau District.

The two administrative centres Kuching and Bau lie just outside the survey area while the third centre, Lundu is found in the west inside the area.

Communications between Kuching and Lundu are usually maintained by launch, approximately an 8 hour journey along the coast, but the journey can be done more quickly by special means such as speedboats (about 4 hours) or small aircraft which are able to land at the recently completed airstrip at Lundu. There is also an air strip at Sematan. Communication between Kuching and Bau is by road. A new overland route from Kuching leading to Lundu through Bau is being constructed, the road head at the time of surveying having reached the Kayan river at Bokah. (18th Mile from Bau). From there it takes a 2½ to 3 hours journey by longboat to reach Lundu.

The only internal roads of significance are the Lundu-Sematan road and the Matang road along which bus services are maintained. Many minor roads of short length serve the area lying between Sengghi and Kuching the longest being the Sungei Tengah-Sagah road which will eventually lead to Tundong near Bau. From Sagah to Tundoh only bridges and a small path have so far been constructed and only bicycles can make use of this road. Batu Kawa situated at the Sarawak river is a major shopping centre and many small bicycle tracks lead from this centre to its hinterland largely serving small holders of Chinese origin.

A further important road is the Matang road from Satok bridge leading to Sungei Rayuh, the headwaters of Sungei Rambungan. This road was intended to lead to Lundu but was never completed. Because of inferior land conditions along this route the project had been abandoned and been replaced by the present Bau-Lundu road. From the roadhead of the old Lundu route a well maintained hunting track leads to Bau which place can thus be reached from the sea by approximately a 7 hours walk. Communications in the Sarawak river Delta and the coastal belt are maintained by water transport, Rambungan, Sibulaut and Santubong being main trading centres. In the Lundu District, apart from the Lundu-Sematan road, there is a small bicycle path leading from Lundu to Kampong Siar at the coast. Communications are mainly maintained by water transport, the main routes being the Kayan river and Sungei Pasir, and overland routes which are small native paths, the main one being a route leading from Lundu to Biawak at the Indonesian border.

The Kayan river is navigable for longboats up to Kuala Stungkor (near the crossing of the Bau-Lundu road), but only during high tide in the dry season. During the wet season longboats can move upriver as far as the confluence with Sungei Butan. The upper Kayan areas are inaccessible for river transport because of the large logs blocking the river in many places and communications by land are only possible by using a number of hunting paths only known to the well travelled members of communities living at the perimeter of Sampadi Forest Reserve.

Finally, there is a well-trodden native route leading from Rasau over Stungkor and Stinggang to Bau but it has now been replaced by the first 18 miles stretch of the Bau-Lundu road.

Main trading centres apart from the administrative centres and the ones already mentioned are Tundong and Buso in the Bau District, Sungei Tengah in the Matang area and Sematan in the Lundu District. The number of bazaars in the Lundu district is surprisingly low which is probably due mainly to the sole dependence on water transport in the recent past. In the whole area there are however a great number of village shops serving the daily requirements of the surrounding communities. The charcoal industry is of main importance in the coastal belt where mangrove forest occurs in abundance. This industry is particularly concentrated along Sungei Rambungan, just outside the Mangrove Forest Reserve and along Sungei Sampadi in the Lundu District. Bauxite occurs in the Lundu District but is only mined in the Sematan area. The fishing industry is of importance along the whole coast but particularly at Sibulaut, Rambungan and Santubong.

2. Population

That part of the area which forms a portion of the Lundu District is relatively unpopulated. Population concentrations are in and around Lundu, mainly Malay and Sebuyau Iban, and in the mixed zone area at the foot of Bukit Gading where the population is mainly of Chinese origin. Chinese farmers are also dominant in the mixed zone land west of Bukit Gading, and in the valleys of Sungei's Serayan, Selarat, Perigi and Sebiris.

The catchment areas of Sungei Jangkar and Sungei Pasir are mainly populated by Selakau Dayaks. Along the Kayan river, Sebuyau Iban are found mainly downstream of Lundu, but a large concentration of Malays is found in Kampong Stinggang (Malay) near Lundu. The middle stretches of this river are not well populated, the main settlement being Sebandi Ilir and Ulu with Iban from Ulu Ai (2nd Division), who migrated in 1955. From Kampong Rasa upstream the population is mainly Dayak of Jagoi origin (Bau District). The Malay population is predominant along the whole coast with some Chinese farmers, particularly in the Stoh area. The Sungei Kual area is populated by a mixed Sebuyau-Chinese farming community.

The population in the Matang road and Sungei Tengah road areas is predominantly Chinese and Javanese farmers, the latter usually partly employed by the Sungei Tengah Rubber Estate. From Sagah onwards to Tundong the population is again predominantly Dayak, of Sengghi origin. West of Bukit Sengi up to Stungkor where the Dayak population is again of Jagoi origin the Sauh Dayaks are found who migrated from Mawang Sau (Bau District).

Finally, the triangular shaped area between Tundong, Sungei Tengah and Batu Kawa is mainly populated by Chinese farmers.

Although the population in all areas is mixed, the general trend which can be observed is: Malays along the coast, Chinese in the Mized zone areas, while the remainder of the area if not covered by primary jungle is populated by Dayaks of varying origin.

The most densely populated area is that bounded in the south by the Sarawak Kanan, in the west by the Matang road in the north by the Matang range and in the east by S. Selalang.

3. Climate

Long term temperature records for the whole region are not available but those given in table 1 are indicative for temperature ranges at the coast (Talang Talang island), and for areas at some distance from the coast (Kuching).

The mean maximum temperatures are generally slightly lower at the coast than those found more inland while in the whole area the period of November to March is slightly cooler than the remainder of the year. This cooler period coincides with a period of high rainfall. Mean minimum temperatures are lowest in the interior and there daily fluctuations in temperature are most pronounced. This is less so at the coast. Temperatures hardly ever fall below 70° F. in most of the area, but this may be the case at altitudes higher than 1,000 feet.

Fluctuations in daily temperatures are also dependent on relative humidity which is the reason why in the coolest time of the year when humidity is highest, daily fluctuation in temperature are smallest.

(Degrees Fahrenheit)

Month	Mean maximum	Mean minimum	Highest maximum	Lowest minimum	Lowest maximum	Highest minimum	Mean relative humidity
KUCHING	January	85.2	73.3	88.6	70.5	79.6	77
	February	86.0	73.1	90.5	71.5	79.2	76
	March	88.7	73.1	92.2	70.5	80.6	69
	April	89.9	73.0	93.8	70.0	83.0	70
	May	90.4	72.9	94.0	70.3	84.2	71
	June	93.0	71.9	96.4	67.0	87.8	61
	July	89.7	71.3	93.8	68.8	83.0	67
	August	90.2	71.6	94.0	69.8	82.4	63
	September	89.9	72.5	94.0	70.5	81.3	67
	October	89.0	72.7	93.0	70.7	80.7	67
	November	87.3	71.5	91.0	70.2	80.2	75
	December	85.3	71.5	89.0	68.5	79.4	76
TALANG TALANG ISLAND	January	84.1	76.5	87.2	74.0	80.0	92
	February	83.9	75.9	88.0	72.0	79.5	91
	March	86.3	77.3	91.0	74.0	81.0	90
	April	86.8	77.8	92.0	75.0	82.0	90
	May	83.1	77.9	91.0	75.0	79.0	89
	June	87.4	77.4	91.0	73.0	78.0	89
	July	87.5	77.2	90.0	75.0	84.0	88
	August	88.6	76.9	90.0	71.0	83.0	88
	September	87.3	76.6	91.0	74.0	80.0	89
	October	85.8	76.5	94.0	73.0	81.0	90
	November	86.0	76.1	91.0	74.0	81.0	91
	December	84.6	76.0	93.0	74.0	79.0	90

TABLE 2. MEAN MONTHLY RAINFALL FOR THE PERIOD 1951-1957

	January	February	March	April	May	June	July	August	September	October	November	December	Total
KUCHING	24.60	18.67	11.27	13.04	14.06	6.44	10.30	7.81	12.04	12.10	13.67	16.92	160.92
MATANG	26.26	17.99	9.79	9.79	8.94	5.94	7.94	7.49	9.77	12.79	12.23	18.35	146.79
SUNGEI CHINA	35.49	23.07	14.06	11.36	11.42	6.69	11.42	8.06	11.68	15.29	14.59	24.38	187.51
DAHAN ESTATE	20.23	16.49	10.63	13.21	11.99	8.37	8.76	10.46	11.81	15.36	15.73	16.79	159.83
LUNDU	24.48	18.24	17.18	7.94	8.42	4.90	6.06	5.74	6.97	9.61	9.83	14.95	134.32
TALANG TALANG ISLAND	24.29	16.29	10.84	4.16	7.14	5.81	6.19	6.19	7.09	8.31	14.99	16.12	127.42

Information collected from: Rainfall Statistics of the British Borneo Territories, period 1896 - 1957 compiled by the Department of Civil Aviation and Meteorological Services, Kuching, 1961.

There are eight rainfall stations in the area with long term records. However, to be able to compare the rainfall in different parts of the area, stations with coinciding recording years were selected.

Table 2 gives the average monthly rainfall over a similar 7 year period for 6 stations. Since Lundu was the only station in the western part of the area it was added to the list although the records for 1954 were missing and the average figures therefore relate only to a 6 year period.

Kuching lies at the south eastern border, Matang lies in the east of the area as does Sungei China. The latter station however is at the foot of the Matang range and is indicative to orographic rainfall which is largely responsible for the great difference in rainfall between Matang and Sungei China Stations.

Dahan Estate has been chosen to replace the nearby Bau Station for which the records of a number of years were missing. It lies to the south of the area. Talang Talang Island is indicative of coastal rainfall in the north-western part of the area.

The mean annual rainfall ranges from 187 inches for Sungei China to 127.42 inches for Talang Talang island. The high rainfall recorded for Sungei China is believed to be caused by orographic rain falling at the foot of the Matang range.

Annual rainfall seems to be decreasing slightly towards the west.

Monthly distribution for all stations follows the same trend, namely a peak in rainfall for the period November to March, and a relatively dry period for May to September. In no place however can one speak of a true dry period since the rainfall only very occasionally may be less than 4 inches per month in this drier period.

The climate as a contributing factor to soil formation can be regarded as uniform for the whole area. It is characteristic for a Humid Tropical Af climate according to Koppen's climate classification. The rainfall, according to Mohr's classification, is placed in the Ia group which is characterised by a rainfall which does not fall below the 4 inch mark in any given month of the year and which, in relation to soil development, is regarded as continuously wet.

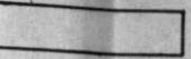
However, there may be differences in rainfall which are agriculturally of importance, such as the occurrence of local rainstorms, periods of drought and periods of persisting rain of low intensity which cannot be indicated with the present rainfall records.

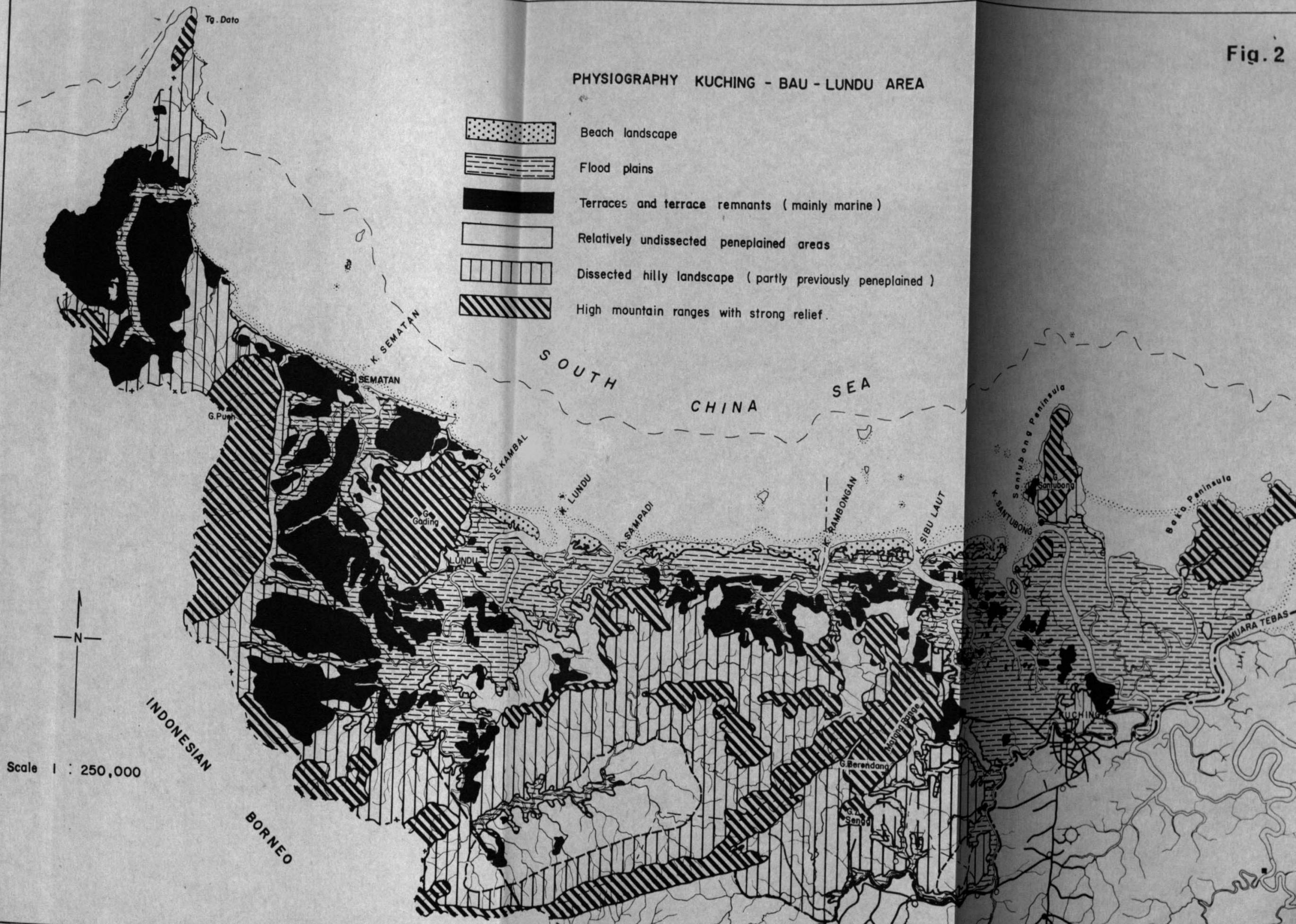
4. Physiography

In this section reference is made to figure 2: 'Physiography of the Kuching-Bau-Lundu area'.

Fig. 2

PHYSIOGRAPHY KUCHING - BAU - LUNDU AREA

-  Beach landscape
-  Flood plains
-  Terraces and terrace remnants (mainly marine)
-  Relatively undissected peneplained areas
-  Dissected hilly landscape (partly previously peneplained)
-  High mountain ranges with strong relief.



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Scale 1 : 250,000

The coastal belt

From Sematan to Kuala Sekambal the coastal belt is formed of a series of sandspits parallel to the shore and separated from each other by the mouths of small streams. They are usually attached at one side to small rocky headlands. From the coastline inland there is a succession of sandspits in which the soils show increasing podsolization with increasing distance from the shore.

The coast between Kuala Sekambal and Kuala Santubong is, following Johnson's classification (King, 1959, p.235), typically an emergent one, characterised by off-shore barriers (near the mouths of main rivers), sandbars and sandspits. No rocky headlands are found in this stretch of the coastline. An old, now emerged bar forms the present coast which is interrupted by a number of large estuaries of streams draining the hinterland. The old emerged bar is fronted by a succession of parallel running small ridges separated by swales, the elevation of the ridges being not more than 10 feet above the swales. The ridges show typical fulcrums near the mouths of large rivers. The ridges are backed by the much wider almost flat surface of the emerged bar which slopes down gently away from the sea. This landscape is usually intersected by small creeks running almost at right angles to the direction of the shore-line towards a large expanse of tidal mud flats which borders the bar at the landside. The tidal mudflats occupy an old large lagoon, now partly filled in and in which owing to tidal movements large channels remained open. At the western and eastern ends marine clays were deposited while in the middle it is filled in by peat deposits.

Between Kuala Santubong and Muara Tebas the coast is formed by two large peninsulas attached to the mainland by a section of the low-lying, partly submerged delta of the Sarawak river. The shoreline of the peninsulas is formed by a series of rocky headlands separated by bays. In the bays small beaches have commonly formed, in many places consisting of sandspits attached to one of the rocky headlands, and with small, partly infilled lagoons behind. The Santubong peninsular is characterised by the conspicuous peak of Gunung Santubong which rises to almost 3,000 feet above sea level. The Bako peninsula on the other hand is lower and contains flat to undulating parts with cliff margins, the highest point is not more than 1,000 feet above sea level. The peninsulas are backed by the extensive delta of the Sarawak river which has two main outlets, namely Muara Tebas in the east and Kuala Santubong in the west. The delta is very flat, periodically submerged in places and covered with Mangrove and Nipah forest. It is intersected by many tidal creeks and channels. A few rock outcrops in the east and west form conspicuous small hills in the otherwise monotonous expanse of mangrove and nipah forest.

The Terrace landscape

Behind the coastal belt of geologically recent deposits lies a much older and extensive terrace landscape. In the Lundu area this is relatively weakly dissected and extends far inland almost to the Indonesian border. Wolfenden (1963, p.49) regards these terraces as probably marine. Highest altitudes in this landscape in the Lundu area are about 100 feet above sea level farthest inland while near the coast the lowest elevation is approximately 20 feet. This flat to low undulating terrain is interrupted by small to moderately large recent riverine valleys draining the Pueh Mountains. Parts of older riverine channels in this landscape now contain deep peat deposits.

Towards the Sarawak river delta this landscape becomes increasingly more eroded and is in parts replaced by recent flood-plains with marine deposits. Between Kuala Sempadi and Kuala Sibu Laut the terrace landscape forms a narrow belt behind the partly in-filled lagoon mentioned above. On the landward side it is found more or less continuously at the foot of mountainous areas while at the seaward side the terraces are strongly eroded and remnants now form the core of small 'islands' surrounded by marine alluvium. In this area the height of the terraces varies between 20 and 50 feet above sea level.

In the eastern part of the area the terrace landscape backs the Sarawak river delta but many rivers have cut through this belt and only remnants of the terraces are found, also here surrounded by recent marine deposits. In this region the maximum height of the terraces is roughly 50 feet above sea level.

The floodplains

Apart from the Sarawak river Delta the only large floodplain is that formed by the Kayan river. This floodplain is funnel shaped and probably was once a large estuary of the Kayan river. Wolfenden (1963, p.51) reports a recent fall in sea level in the Lundu region of about 10 feet and the formation of this floodplain is probably a result of this fall. Kuala Sempadi, a wide estuary of a small stream with a very small catchment area is probably a preserved former mouth of the Kayan river but tidal movements prevent it from silting up.

The Kayan floodplain extends far inland to almost the border with Indonesia and tidal influence is felt far upstream. The plain is formed by low incipient levees usually backed by large swamps in which peat has developed. The peat is very fine in composition and is usually mixed with clay indicating flooding by riverwater. These deposits are at present still flooded by riverwater during the rainy season even far away from the river and it is therefore assumed that they are not domeshaped. Typical also of this floodplain is the occurrence of white clays at a slightly higher (roughly two feet) elevation than the present riverine deposits. They are possibly older floodplain deposits or are old estuary deposits.

Smaller floodplains are found alongside most secondary streams. They are usually flooded during the wet season mainly because of back flooding, and due to the relative dry conditions in these areas during the less wet season no peat has developed in these valleys.

The present floodplain of the Sarawak river upstream of Kuching is surprisingly small. Riverbanks are high there and only at times of exceptionally high floods does the river overflow. Air photographs however show the existence of a broad channel-like plain along the Sarawak river between Kuching and Bau but very little old alluvium was found in this possibly 'old floodplain'. Instead shallow residual soils were found, a feature which cannot be explained with the information available.

Finally, a large peatswamp between the terrace landscape and the hilly country in the Matang area, west of Kuching has formed in what may possibly have been an old lagoon which was cut off from the sea by the terrace landscape in the north and the deposits of the Sarawak river in the south.

The mountainous and hilly areas.

That part of the area not falling in any of the landscapes already described is discussed under this heading.

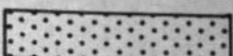
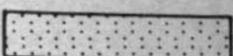
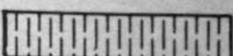
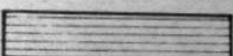
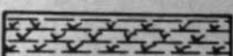
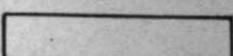
In Lundu it is mainly formed by two conspicuous massifs of igneous rocks namely the Puch mountains and the Gading Mountains. Both massifs rise to an altitude of about 3,000 feet above sea level. The terrain is deeply dissected with steep slopes. At the foot of both mountains, parts of a weakly dissected old peneplain which merges with the terrace landscape are found. The level of the dissected peneplain is slightly higher than the terrace landscape but varies depending on distance from the sea.

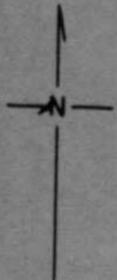
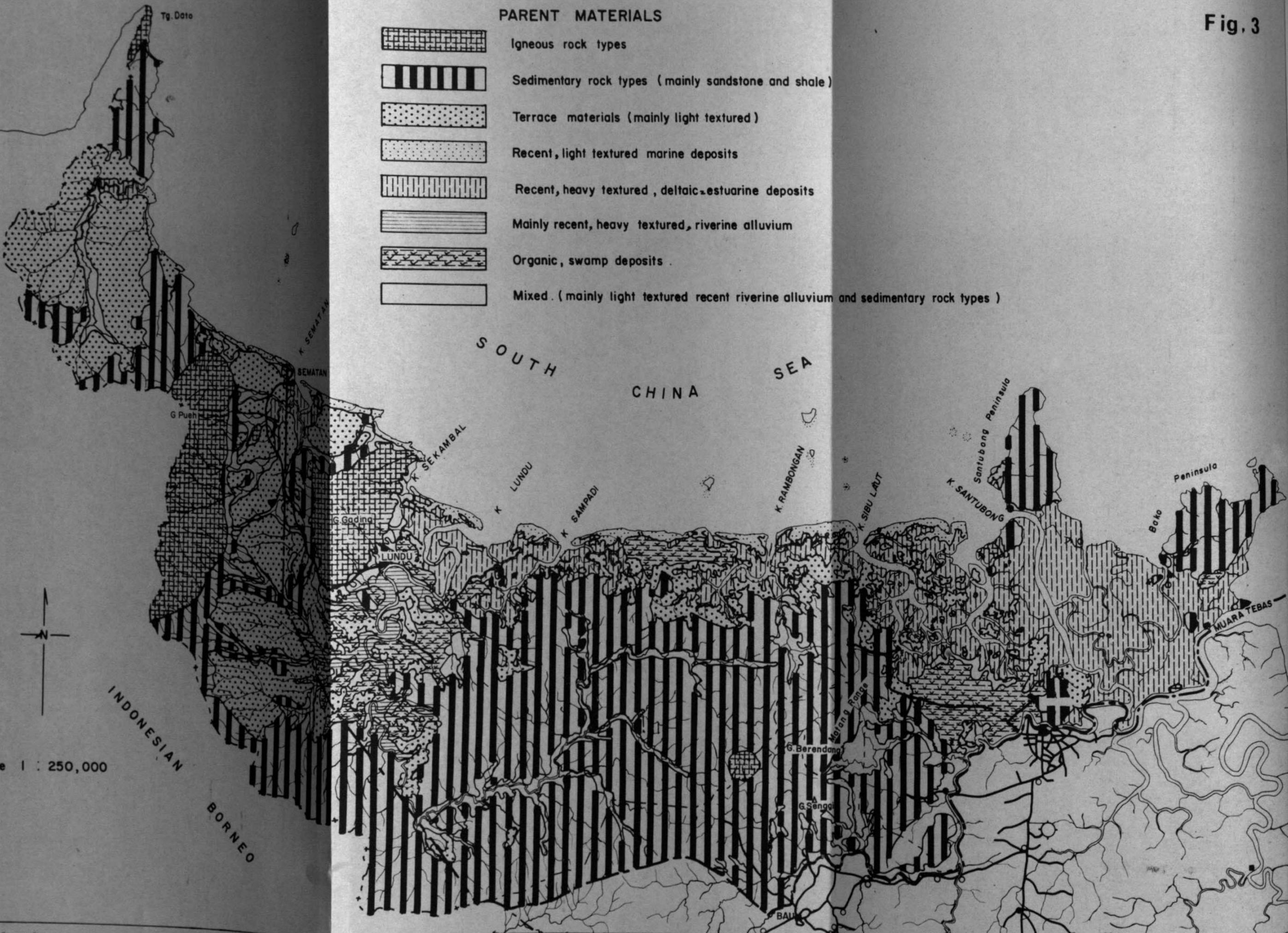
The middle portion of the surveyed area is formed by a basin-shaped landscape which is drained by the Kayan river. The edges of the basin form in the north, east and south an almost continuous three quarter of a circle of steeply dipping cuesta's with altitudes ranging from 350 feet to almost 2,500 feet, the latter altitude being reached in the Matang range in the south-east. Towards the centre of the basin the height of the hills is not more than 100 feet. The long dipslopes are usually interrupted by smaller secondary scarps formed by beds of sedimentary rocks which underly the whole basin.

In the south the basin is bordered by a strongly dissected peneplained area in which the former erosion level is approximately between 350 feet in the extreme east to 100 feet near Kuching.

Fig. 3

PARENT MATERIALS

-  Igneous rock types
-  Sedimentary rock types (mainly sandstone and shale)
-  Terrace materials (mainly light textured)
-  Recent, light textured marine deposits
-  Recent, heavy textured, deltaic-estuarine deposits
-  Mainly recent, heavy textured, riverine alluvium
-  Organic, swamp deposits
-  Mixed (mainly light textured recent riverine alluvium and sedimentary rock types)



Scale 1 : 250,000

In the north and north-east the basin is bordered by the terrace landscape. Here boulder fans have formed at the foot of the cuesta's and they overlie the terraces in places. In the north west the basin borders a very weakly dissected low lying peneplain, situated almost at floodlevel, while in the west the basin borders the floodplain of the Kayan river. The only conspicuous feature in these peneplained areas is Bukit Sengghi, in the south-east. This table-topped 1,843 foot high mountain resembles a monadnock in the dissected peneplain but probably once formed part of the Matang range, it being separated from it by intense dissection.

5. Parent materials

The nature of the parent material is a major contributing factor to the development of different soils in the area and is therefore discussed at some length.

The geology of the area is described by Wilford (1955) and Wolfenden (1963). The former concerns a reconnaissance survey covering the whole area while the latter is a more detailed study of only the western part of the area.

Since the lithology of the various rocktypes occurring in the area is regarded as of prime importance for soil development references to general geology are only made where necessary.

Information on rocktypes has largely been derived from the above mentioned sources, and no further reference is made to these in the following text.

Igneous rock types.

Major areas of igneous rock types occur as two large massifs consisting of Adamalite in the Lundu area. This coarse grained crystalline rock type, rich in ferro-magnesium minerals, particularly biotite, gives rise to the development of Lateritic soils of a nature usually found only on basic igneous rock types occurring in the First Division. In Sarawak, rocktypes of granitic stock are normally too rich in silica for the development of Lateritic soils under the reigning climate but presumably the biotite enriched Admalite is an exception. Because of the hardness of the rock the weathering zone is usually thin and this coupled with the steepness of the terrain gives rise to the development of usually shallow soils and rocky and bouldery land. Due to colluviation only at footslopes deep soils are encountered.

Igneous rocks are further of importance north of Bukit Gading where Hybridized Adamalite gives rise also to the development of Lateritic soils. Hybridization has in places resulted in the occurrence of rock types richer in ferro-magnesium minerals than the Adamalite. A small outcrop of gabbro, east of Bukit Gading, namely Bukit Gabong, is also covered with Lateritic soils.

Small outcrops of greenstone and related rocktypes are common in the Serabang formation which is the main geological formation in the lower Kayan river area. Usually Lateritic soils are found on these basic igneous parent materials. Some outcrops of such rocks also occur in the Sarawak river delta, such as at Sejingkat and Pulau Salak.

Small outcrops of acid igneous rocktypes occur in Sampadi Forest Reserve and also as minor intrusions in the sedimentary rocks of the Bau formation occurring between Bau and Kuching but soils on these rocktypes belong to the group of Red-Yellow Podsolics.

Sedimentary rocks

The largest part of the area is formed by sedimentary rocktypes which range from clay shales to coarse sandstones and conglomerates. Also chertbeds are of local importance in the Sarawak River Delta and east of the middle Kayan river area.

Shales are mainly found in the Bau area where they belong to the Bau formation of Cretaceous Age. Near Lundu, shale is only of minor importance in the Serabang formation. Of local importance is also the occurrence of shale beds in the usually much coarser grained Tertiary sediments in the Stinggang-Stungkor area (border Bau-Lundu districts). Soils developed over shale belong mainly to the Red-Yellow Podsollic group but if they are poor in iron Grey-White Podsolics have formed on them. This is particularly the case on shales of the Serabang formation (for instance in the Kuching area).

Fine to medium grained sandstones occur in all geological formations of sedimentary origin but are predominant in the consolidated Tertiary deposits forming the basin-shaped area discussed in section 4 under Physiography. Soils developed on such sandstones belong generally to the sandy types of the Red-Yellow Podsolics but if of Tertiary age they frequently form Grey-White Podsolics, which is caused by the generally iron poor nature of these sediments. Coarse grained sandstones and conglomerates are of major importance in the Tertiary Sedimentary rocks and give rise to the development of Podsolis if occurring on not too steep slopes. This is particularly so in Sampadi F.R. and Bako National Park.

Terrace materials

Terrace materials are predominantly coarse textured. It is difficult to indicate whether they were originally of marine or fluviatile origin but Wolfenden (1963, pg.49) indicates that in the Lundu area its origin is mainly marine. There, sandy beds alternate with white to blue clay beds, the latter giving rise to the development of Grey-white Podsollic soils of a peculiar bluish-grey colour. The sandy deposits in most places give rise to the development of podsolis, the most coarse material showing podsolization.

Gravel beds occur in some localities in these terraces, notably at Kampong Gelam (Lundu) where they occupy the summit of hills. These gravel beds do not show any profile development, the material being pure quartz.

The most coarse grained material of colluvial nature is found in boulder fans at the foot of the Matang Range in the South. Where this material was mixed with finer grained material, podsolis have formed on flat sites but normally Red-Yellow Podsolics or Skeletal soils have development over this type of material.

Recent Alluvials

Marine deposits of coarse texture are of importance in the beach landscape along almost the whole coastline. From Sematan to Kuala Santubong this is mainly fine to medium grained sand which originates from the Adamelite at Gunong Gading. The sand was distributed along the coast by long-shore drift and there is a decreasing amount of biotite and muscovite to note in the sands at increasing distance from it's source. These deposits invariably weather into reddish-yellow coloured sands which are characteristic for this part of the coast.

From Santubong to Muara Tebas coastal sand deposits are more quartzose, the material having mainly derived from quartzose sandstones of Tertiary age and or are outwash materials from terraces. If of sufficient age they weather into Podsolis.

Heavy textured marine deposits occur mixed with riverine clayey deposits in the old lagoons and river deltas, particularly in the Sarawak river and Lundu river deltas. They are in many places mixed with organic materials derived from decaying mangrove and nipah vegetation which usually forms the primary vegetation there.

Riverine alluvium is predominantly heavy clays deposited in flood plains and small interior valleys, the latter usually through backflooding. Coarse grained riverine alluvium is comparatively rare and is only of major importance along the upper stretches of the Kayan river and along some streams draining the Matang massif on the Kuching side. They are always related to the occurrence of medium to coarse grained sandstones in the catchment areas. The alluvium of the Adamelite massifs in the Lundu area is medium textured. The abundance of biotite and muscovite gives the materials a silty character. Near the sources usually bands of coarse material alternate with bands of a more loamy texture in the profiles. Soils on this material appear to be more fertile than on other alluvials in the area.

Organic deposits

Peat has developed in three localities. The largest expanse is formed by the Matang Peat Swamp, north-west of Kuching. The peat is there coarse textured and of a woody nature.

A second area is that behind the beach deposits in the old lagoon between Kuala Rambungan and Kuala Sampadi. The peat is of the same nature as that forming the Matang swamp.

A third locality is the floodplain of the Kayan river. Here the peat is soft and non-woody, fine-textured and of a mucky consistency. In many places clay is mixed with the organic deposits. The peats are here frequently flooded during the wet season and organic material is therefore accumulating together with mineral deposits.

Peats in the old river channels in the terrace landscape (see section 4 'Physiography') are usually of a woody nature.

Summarizing, it can be concluded that most parent materials are consolidated and unconsolidated sediments and being quartzose in nature form a poor start for soil development. It is not surprising that with the reigning climate podsollic weathering forms the main soil forming process in the area. Exceptions are the recent undeveloped soils and the soils derived from igneous rocks, rich in ferro-magnesium minerals, and alluvial soils derived from that material.

6. Land Use

This subject is discussed under two headings, namely, Primary Vegetation and Agriculture.

Primary Vegetation

A large part of the area is still covered by Primary Forest possibly mainly because of two reasons, inaccessibility and poor soil conditions. In some areas both factors may play a role.

The Pueh and Gading igneous massifs are almost completely covered with Mixed Dipterocarp forest. Magnificent trees can be seen in this forest. The steepness of the terrain and the rocky nature of the soil are the main reasons why these areas are still under a cover of primary vegetation. A large part of the terrace landscape, especially the centre parts of tracts between river courses is still under primary forest, although in recent years a considerable acreage has been cut down mainly for hill rice cultivation. The forest there is of a much lower quality than that found on the igneous massifs but varies with the soil types. On Podsolis true Kerangas Forest is found characterised by Keruing-Dipterocarpus Kutaienus, Bindang-Agathis Alba and Ru-Casuarina Sumabrana, while at sites with more clayey soils, usually at the edges of the terraces, better forest is found with penyian, urat mata, rusak and bintangor. An excellent and detailed description of the tree species in this terrace landscape is given by Brunig (1963). Although this report refers to an area bordering the present survey, conditions are similar and soils identical in both areas. Generally poor soil conditions are the reason why the local population has until recently not touched this forest on the terraces.

The peat swamps are for the greatest part still covered with Mixed Peat Forest and clearing has only been done at the edges where the peat merges with riverine clay soils. Most areas of Peat Forest have been intensively worked for timber.

The deltaic deposits are for the largest part still covered with mangrove and nipah forest. The largest expanse of it is formed by the Mangrove Forest Reserve between Sibu Laut and Santubong. In the Sg. Sampadi and Sg. Rambungan areas mangrove is extracted for the burning of charcoal which in these areas is a major industry.

The catchment area of the upper Kayan is almost completely covered by primary vegetation and forms the Sampadi Forest Reserve. The soils are poor and the forest they support is mainly of a 'Kerangas' nature. An intimate relationship exists between soil types and forest stands in this area, differences in vegetation patterns as seen on air photographs being indicative of special soil types. Only on scarp slopes in this region can good Mixed Dipterocarp Forest be found. Usually, riverine forest on recent alluvials of a loamy nature has dense stands of Belian timber, particularly along Sg. Stom Putih, and Stom Merah in the Stinggang-Stungkor areas.

Although the Sampadi Forest Reserve is near to the densely populated Kuching and Bau districts, not much settling had taken place in the past which must be contributed mainly to the adverse soil conditions which made shifting cultivation unprofitable.

Generally the primary vegetation in the whole area correlates well with soil conditions and full use was made of this in air photograph interpretation work. Only Mixed Dipterocarp Forest which covers quite a wide range of soil types, forms an exception.

Agriculture

In the coastal belt the most recent sand deposits if not flooded by tidal water are used for coconut planting. The less recent sands are partly planted up with this crop but with less success since the fertility of the soils is lower owing to leaching. Large areas are under lalang or other secondary vegetation. Small plots are used for vegetable growing, notably water melons and particularly at low sites where the watertable is near the surface. In some swales wet padi is planted. Most beach deposits in the area have been put to some use but especially on the leached soils agriculture could be much more intensive, given proper management.

Coconut is further cultivated on the weakly saline deltaic deposits with varying success, depending on the drainage conditions and salinity. At present coconut cultivation on such land is being attempted on a much larger scale than before and is frequently subsidised through the Coconut Planting Scheme.

Meander bends of the middle and lower stretches of main rivers but particularly of the Kayan river are used for wet padi cultivation. Especially downstream of the confluence with Sungei Pasir good crops are obtained if attention is given to drainage. Wet padi is also cultivated in a number of interior valleys existing at the foot of Bukit Gading and in the area between Bau and Matang. Also here drainage is a prerequisite for obtaining reasonably good crops.

Rubber is cultivated on the riverbanks of the middle stretches of the Kayan river, on recent alluvial soils from the Bukit Gading Massif, on deep peat along the Matang road, on hill soils along the first 10 miles of the Bau-Lundu road, between Bau and Kuching and on podsols on some terrace sites near Lundu. It is found under almost all conditions except for saline ones but is only doing well on the recent alluvial soils and on non-podsol hill soils. In area rubber is the most extensive crop planted. The whole area between the Matang road and Bau is nearly covered by it. Except for those in the coastal areas it forms the backbone of most farming communities.

Pepper is cultivated on the residual soils at the foot of Bukit Gading and on a variety of soil types in the Matang-Bau areas. Some recent alluvial soils along the Lundu-Sematan road have also been planted up with this crop. The growth is very variable. Although good soil conditions such as are present in the Bukit Gading soils and related recent alluvials are important, good management appears to play a major role and good stands were even seen on very sandy soils derived from Tertiary sandstones. More so in pepper cultivation than with the other crops it is the good farmer who counts and not primarily the soil type.

Shifting cultivation is practised mainly by the Dayaks along the Bau-Lundu road and by the Dayaks and the Sebuyau Ibans in the Lundu area. The latter, who have settled along the lower stretches of the Kayan river, travel far and wide to plant hill padi at the edges of the Sampadi Forest Reserve. One Iban community originally migrated from Ulu Ai in the 2nd Division settled at the confluence of the Sungei Pasir and Sungei Kayan rivers. A comparison of old air photographs with new ones shows that within a period of 10 years this community has consumed primary forest at roughly a rate of $\frac{1}{2}$ sq. mile per year. A considerable part of that area unfit for shifting cultivation could have been used for rubber cultivation under proper management.

SOILS

1. Soil Classification

The classification system used is that described in 'A classification of Sarawak Soils' which came into use in January, 1966. (Soil Survey Staff 1966). Because this classification has modified the definitions of some units used in the mapping of the area in 1965, some mapped soil units (families) contain certain areas of other newly defined units. Where this occurs reference is made to it in the text of the report.

The classification of the soils in the area is outlined in table 3, and shows 8 Great Soil Groups subdivided into a total of 41 soil families. As in Sarawak up to the present date 55 families have been distinguished it follows that the soil pattern of the area is quite heterogenous. All major soil families of Sarawak are represented.

The division at family level is mainly based on field characteristics or, rarely, on chemical characteristics. Although the characteristics are basically of a genetic nature they are, nevertheless, of agricultural significance. The relationships between the mapping units, parent materials and landforms are shown in the soil map key which is self-explanatory.

The basic mapping unit is the soil family or an association of soil families. These associations usually contain two main soil families, and commonly minor families may be present. To aid legibility of the map only the main families are indicated by symbols. Colours denote Great Soil Groups.

A number of new soil series, not recorded in previous surveys are mentioned in the text. For these new series descriptions and related analytical data can be found in the appendix of this report. In the following section indications are given where these series occur dominantly in the mapped families.

2. Descriptions of Mapping Units.

The units are described in the order shown on table 3.

LATERITIC SOILS

1. Tarat Family

The Tarat Family is the major family in the group of Lateritic soils in the area. Soils in this family are characterised by usually strong brown to 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

TABLE 3.
Outline of Soil Classification

Great Soil Group	Families
LATERITIC SOILS	1. Tarat
RED-YELLOW PODSOLICS	2. Abok 3. Merit 4. Bekenu 5. Nyalau 6. Matang 7. Sabangang 8. Malang 9. Semilajau
GREY-WHITE PODSOLICS	10. Saratok 11. Kerait 12. Triboh 13. Lubai *
PODSOLS	14. Bako 15. Silantek * 16. Miri 17. Buso * 18. Jerijeh
GLEYSOILS	19. Sebandi 20. Bijat 21. Plan 22. Embang 23. Gong 24. Tatau
SALINE GLEY SOILS	25. Rajang 26. Belat 27. Pendam 28. Nonok 29. Limbang
PEAT SOILS	30. Mukah 31. Igan 32. Anderson
RECENT ALLUVIAL SOILS	33. Ramun 34. Kayan 35. Seduau 36. Kabng 37. Sematan
SKELETAL SOILS	38. Meluan 39. Sadong 40. Kapit 41. Gaya

* Not shown on map

The soils are friable and usually have a crumb to very weakly fine blocky structure. Internal drainage is good 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 figures are among the highest encountered in Sarawak. The soils are rich in iron oxides, mainly in the clay fraction and 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.

RED-YELLOW PODSOLIC SOILS

2. Abok Family

This is a minor family in the group and occurs mainly in the 1st Division on igneous or metamorphic rock types, rich in silica. It has been separated from the other families in the Red-Yellow Podsollic group owing to its relatively high iron oxide content giving strong reddish-yellow colours throughout. Structures in the subsoil are weak blocky, in the topsoil crumbly. Consistency varies from friable to firm. Textures are light in the topsoil and range from a sandy loam to sandy clay loam while textures in the subsoil range from sandy clay loams to sandy clays.

The Abok soils are poor in all nutrients but total potassium can be high. They have generally very low total phosphate figures. Abok soils have no special problems for agriculture other than the low fertility. Topography is generally moderately steep to steeply sloping.

In the area some soils occur on Bukit Gading (near Lundu) which show similarities with both Tarat and Abok families. The profile morphology is very similar to Tarat family soils but the chemical features are those of the Abok family. These soils have been called Gading series and are mapped as Tarat family soils. In area, the Gading series is the most extensive in the Abok-Tarat family range in the surveyed region.

3. Merit Family

Merit family soils are Red-Yellow Podsollic soils which have been separated from other families in this group on account of the heavy texture throughout the profile. Generally, textures are clay loams in the topsoil and clays in the subsoil. Colours range from yellowish brown in the topsoil to yellow or reddish-yellow in the subsoil. Most soils are imperfectly to moderately well drained and have a weakly mottled zone normally starting below 18 inches from the surface. The soils are usually massive but when dry show a coarse blocky structure, particularly in the lower horizons. The soils are difficult to cultivate because of the heavy texture. The soils are generally deep, although in places shallow phases are predominant, for example, along the Sarawak river upstream of Batu Kawa.

The soils have moderately good physical properties but are poor in nutrients. More demanding crops, such as pepper are difficult to grow but good farmers with the use of much fertilizers are able to grow the crop on this soil type. A main limitation for agriculture is the low degree of permeability resulting in periodically wet conditions during the wet season which may be of particular importance in pepper cultivation in connection with the occurrence of foot rot. The low fertility and steep slopes in places are other adverse features.

4. Bekenu Family

This family is similar to the Merit Family but has coarser textures particularly in the upper horizons. The texture contrast between topsoil and subsoil may be great. Textures in the topsoil range from loamy sands to clay loams while those of the subsoil range from clay loams to clays. Permeability is not constant down the profile resulting in moderately well drained conditions above slowly permeable horizons. Generally Bekenu soils are somewhat better drained than those of the Merit Family. Levels of plant nutrients are low and this is the main limitation for agriculture. For some crops internal drainage is not adequate. Steep slopes are a limitation in some localities.

5. Nyalau Family

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

The Nyalau soils are poor in nutrients and because of the predominantly sandy textures are probably expensive to fertilize. Drainage is generally good. The Nyalau family is commonly found on steep slopes.

The family is locally important in the Sampadi Forest Reserve where it is mixed with podsols. On steep slopes only shallow phases are found.

6. Matang Family

Matang Family soils are rare in the area. They are very similar to Nyalau soils but have a pale coloured A2 horizon. Usually where the Matang Family occurs in this area it is under shifting cultivation and it is possible that the pale coloured A2 horizon is due to the loss of organic matter of a former A1 horizon through oxidation, following cultivation. A new surface organic layer is formed in this depleted soil after regeneration of the vegetation. The pale coloured layers are found under primary forest in other parts of Sarawak and it is also possible that a podsollic process may be partly responsible for their formation. For general agriculture Matang soils are rated as similar to the Nyalau soils.

7. Sebangang Family

This family is only important in the area between Matang and Bau. It is comparable to the Nyalau family in many aspects but Sabangang soils contain gravel which in some localities forms a large proportion of the soil material. In some deep road cuttings gravel beds can be seen in profiles which otherwise resemble Nyalau soils. For all practical purposes Sabangang can be considered comparable to the Nyalau family for cultivation.

8. Malang Family

Malang soils are important for agriculture because they are recent soils not showing the high base depletion of related upland soils such as the 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. Around Bukit Gading in the Lundu area, Malang soils have generally a high proportion of bleached biotite which is reflected in the high total potassium values. In the same area thick horizons of relatively unweathered riverine sands can be found at shallow depths in the profile (within 48 inches). Such soils belong to the Sekati series described in detail in the Appendix.

Malang soils are easy to cultivate because structures are crumbly to weak angular blocky but because of the flood risk they are best used for flood-tolerant perennials and annual crops. The local population prefer this soil type to all others in the group of Red-Yellow Podsollic soils for the planting of cash crops.

9. Semilajau Family

This family is similar to the related Malang family except that textures are more sandy throughout the profile. It is not widespread in the area and occurs mainly along the upper Kayan river. Its fertility is lower than that of the Malang soils although the less demanding crops, such as rubber, can be grown with success. The main limitations are a risk of flooding and low fertility, and in some localities poor subsoil drainage may adversely affect deep-rooted crops.

GREY-WHITE PODSOLIC SOILS

10. Saratok Family

The Saratok family soils are widespread in the area, particularly so in the Sampadi Forest Reserve. The Family occurs there on quartzitic sandstones; in the vicinity of Kuching and Lundu they occur on carbonaceous sandstones of the Serabang Formation.

The colours are pale throughout and range from pale yellow to white. Textures vary from sandy loam in the topsoil to sandy clay in the subsoil. The silt fraction is predominant in some soils. Characteristic features are the high total silica and very low total iron content. Weak mottling is usually present in the lower subsoil. Gleying, if present is usually not detectable against the pale matrix colours.

The Saratok family soils are poor in nutrients and because of the sandy nature of the profile are expensive to fertilize. They are used satisfactorily near Kuching on mixed-farming small-holdings for vegetables where an adequate supply of manure is readily available. This both builds up the low exchange capacity of the soils and supplies some nutrients.

Saratok soils commonly occur in association either with Nyalau family soils on steep terrain or with Podsolis on gently sloping to flat terrain. They are not recommended for large scale development.

11. 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 with the Saratok soils, are not fertile but usually grow better stands of rubber, possibly due to the higher clay content. The soils are sticky in wet conditions. Manuring may be more economic than on the Saratok soils, but imperfect drainage conditions restrict the variety of crops which can be grown profitably. Although better than the Saratok soils, Kerait soils are not recommended for large scale development. Steep slopes are a limitation in some areas.

12. Triboh family

The Triboh family soils have developed in old alluvium, poor in iron, and show features almost identical to the Saratok Family. In some localities, especially near flat sites it is extremely difficult to distinguish the two from each other, particularly if the parent material lies below augering depth. In the terrace landscape near Lundu the soils belong typically to the Rukam family, described in detail in the Appendix.

Rounded gravel pieces may aid the identification of this family but they are absent in some Triboh soils. The agricultural potential is the same as for the Saratok family soils, but topography is never a limitation.

13. Lubai Family

The Lubai family is only of importance in the terrace landscape near Lundu.

The Lubai family as far as agricultural significance is considered can be compared with the Kerait family, and they were mapped as such in the Lundu area prior to the change in definition referred to in Section III (Soil Classification). Much of the land mapped as Lubai family is according to the new classification Triboh family.

PODSOLS

14/15 Bako Family and Silantek Family

The Bako family is most widespread in the Sampadi Forest Reserve and on the Bako Peninsular. The family commonly occurs in complex with some families in the Grey-White Podsollic soils and the Silantek family of the Podsol group. According to the new soil Classification (Soil Survey Staff) the areas mapped on the Bako family in fact consist of a complex of Silantek and Bako soils. The Silantek family is locally dominant particularly on hilly terrain.

Bako and Silantek soils are both sandy with topsoils consisting almost of pure quartz sands mixed with raw organic matter. Both families show a humus accumulation layer (the Podsol B-horizon) at varying depths in the profile but in the Bako family this horizon consists of a hard pan not penetrable by auger while in the Silantek family the pan is soft. Therefore because of the existence of perched watertables Bako family soils are poorly to very poorly drained and are frequently wet in the rainy season. The Silantek family soils are usually better drained and occur on more steeply sloping terrain.

Both soil families are extremely poor in plant nutrients and this together with unfavourable profile characteristics make the soils unsuitable for normal agriculture. In exceptional cases the Silantek Family is used for vegetable growing and for pineapples but farming is difficult.

A typical series in the Silantek Family found in the Sampadi Forest Reserve is the Butan Series, described in detail in the Appendix.

16/17. Miri Family and Buso Family

Miri and Buso Families are closely similar to the Bako and Silantek Families respectively, except for the associated topography. Miri and Buso Families occur on almost flat to flat terrain and have developed in old terrace materials. Where Miri soils are mapped, generally both Miri and Buso soils are present in association, the Miri commonly at the highest points of terraces and the Buso at the edges. Agricultural suitability is the same as for the Bako and Silantek Families.

18. Jerijeh Family

Jerijeh Family soils are important along the coast where they have developed in coastal sands. The whole profile consists of generally medium to fine sands. The soils are excessively drained but have high watertables in the wet season (between 24 and 36 inches). Iron accumulations in the form of soft concretions occur in the horizon above the highest ground-water level. A bleached A2 horizon is present. These soils have been impoverished through leaching and podsolization and the topsoils are very low in plant nutrients. In some localities unweathered coastal sand deposits are still found at depth of 3 to 4 feet, normally below the watertable.

It is suggested that the soils can be used for perennial crops such as coconut but heavy fertiliser dressings may be necessary. The typical series in the area is the Stoh Series described in detail in the Appendix.

GLEYSOILS

19/20. Sebandi and Bijat 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 there 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 of the Sebandi soils in most areas prevent this. Also rubber can be grown with success on some of the Bijat soils, while all Sebandi soils are unsuitable. Both families are suitable for wet padi cultivation but drainage improvement is needed.

Especially along the Kayan river (Lundu) these soils are of major importance for agriculture.

21. Plan Family

Plan Family soils are closely similar to those of the Bijat Family but are light textured. The total area of Plan Family soils is small, and they occur predominantly in small valleys at the foot of Bukit Gading (Lundu) where coarse-grained alluvium has been deposited. Agriculture is mainly confined to wet padi cultivation, but with improved drainage other crops could be grown in rotation with wet padi in the dry season. These light-textured soils are easy to cultivate although they may need fertilisers more frequently than the related Bijat soils.

22/23. Embang and Gong Families

The total area occupied by these soils families is small. They have developed in old alluvium mainly, for example, in low-lying places, at the foot of terraces. The Embang soils are heavy textured while the Gong Family soils are light textured. As far as drainage is concerned they can be compared with the Bijat and Plan Families respectively. Their agricultural value is, however, much lower because of the very low base saturation and low exchange capacity. If sufficient care is given to fertilizing, these soils can be used for the same crops as suggested for the Bijat and Plan Families. It is, however, emphasised that agriculture on Embang and Gong Families soils is economically unjustifiable unless cheap manures and fertilisers are available.

24. Tatau Family

The Tatau Family soils occur in the coastal area and occupy low-lying places in the beach landscape. The ground watertable is generally within 20 inches of the surface. Textures are generally medium sand to sandy loam throughout the profile. In the wet season, wet padi is cultivated in some places, while in the dry season watermelons and vegetables are grown. The total area of the Tatau soils is small but they are locally important for the population since in the coastal belt they are the only soils suitable for foodcrops and cash-crops such as melons and vegetables. (See Jerijeh and Sematan Families paragraphs 18 and 37).

For sustained high yields the soils need fertilisers regularly because the exchange complex is low and, therefore, fertilisers are quickly removed from the soil. The watertable is generally too high for coconuts and drainage is difficult as the soils are close to sea level.

SALINE GLEY SOILS

25/26. Rajang and Belat Families

Both families occur in coastal areas and have developed in marine sediments. They can generally be easily recognised by the natural vegetation growing on them, namely mangrove and nipah. Both families are strongly saline, having high amounts of soluble salts in the soil water. Fluctuations in salt content varies in relation to rainfall intensity and salt concentration of the tidal water which floods these areas frequently. The watertable is commonly high and is found at less than 20 inches from the surface. The Rajang Family is predominant and is characterised by heavy clay soils, while the Belat Family is light textured and only occupies small patches near terraces on sandy and gravelly outwash material.

Under natural conditions, the Rajang Family is not suitable for agriculture. To improve the soils, drainage is most necessary and bunding, aimed at keeping out floodwater is most essential. Although after drainage, coconuts can be grown, these soils do not provide optimum conditions to this crop, because drainage will appear to be ineffective during the wet season when rivers are in flood. It may be feasible to use such soils for wet rice during the rainy season, as at such periods the salt levels are suppressed by rainfall. The Rajang Family soils have a high potential for agriculture, but this potential can only be used after costly amelioration. Because of their sandy nature, the Belat soils are potentially less fertile than those of the Rajang Family.

27/28. Pendam and Nonok Families

These families occur in similar localities as the related Rajang and Belat Families. They differ from them in being weakly saline. The Pendam Family is characterised by clayey soils while the Nonok soils are light-textured. Due to artificial drainage or better natural drainage conditions than exist in the Rajang and Belat Families, salts have leached from the Pendam and Nonok Families to such an extent that they are generally free from harmful salts during the wet season at least. In the dry season the salt levels may increase because at this time of the year the salt content of river water flooding the soils through drainage channels is highest. Coconut is the main crop cultivated on both soil families.

Drainage is the main limitation for agriculture in both families. Saline conditions are of secondary importance and then only in the dry season. Both families are potentially good soils for agriculture, but they need improvement in drainage for making full use of their potential.

29. Limbang Family

The Limbang soils are organic soils having peat topsoils thicker than 10 inches. In this area the organic topsoil is thicker than 36 inches and in many places more than 72 inches. The groundwater is saline, a condition caused by infiltration of brackish water. The soils are considered to be unfit for agriculture.

PEAT SOILS.

30/31. Mukah and Igan Families.

Both families have peat topsoils of from 10 to 40 inches thick. In the Mukah Family the peat overlies clayey subsoils and in the igan family the subsoils are sandy. Both families occur in floodplains and normally in basins backing levees along the major river courses. The watertable is high and during the wet season is normally found at the surface. In this area they are used extensively in the Kayan River floodplain. The chemical fertility is low.

In their natural condition the soils are unfit for most forms of agriculture because of their very poor drainage. Improvements should, therefore, be aimed primarily at drainage, after which they would be suitable for annuals mainly.

32. Anderson Family

The Anderson Family comprises peat accumulations thicker than 40 inches. In certain areas depth phases have been mapped as follows:-

Anderson 1	...	40 - 80" deep
Anderson 2	-	80 - 120" deep
Anderson 3	-	> 120" deep.

Generally the peat is woody but in the Kayan floodplain fine organic materials are commonly found mixed with some clay. The watertable is normally high in this family and during the wet season it can be found at the surface. The soils are not recommended for agriculture because of the inherently very poor drainage and the difficulty of improving it.

RECENT ALLUVIAL SOILS

33. Ramun Family

Ramun Family soils are found at the foot of Bukit Gading, near Lundu, alongside streams draining this mountain range. They are commonly strong brown to reddish yellow coloured and do not show any clear profile development. They consist of recently deposited material derived from igneous rocks having a high proportion of ferro-magnesium minerals. The soils are light-textured, and range from sandy clay loam to sandy loam. In many places coarse sand beds alternate with heavier textured layers in the profile.

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 in the soils are generally higher than in other families in this soil group and the soils are considered well suited for agriculture, and specifically so for demanding perennials. A typical series in this family, occurring near Lundu, is the Siar Series described in detail in the Appendix.

34. Kayan Family

Kayan soils are similar to Ramun soils but the parent materials are mainly derived from coarse textured sedimentary rocks and are therefore less well supplied with plant nutrients. Base saturation and exchange capacity are generally low. Colours range from yellow to brownish yellow.

The soils are suitable for less demanding perennial crops. Flooding is a limitation.

35. Seduan Family

Seduan Family soils are found in localities where alluvium of a heavy texture is at present actively accumulated. They are young soils showing no profile development. Sources of the alluvium generally are heavy-textured sedimentary rocks (mainly shales). The soils are in many places difficult to distinguish from the related Malang Family soils described under number 8. The latter are somewhat older.

Seduan soils are imperfectly drained and are weakly mottled in the lower parts of the profile. They are suitable for agriculture but flooding may be a serious limitation (back flooding is frequently the cause of their development).

36. Kabong Family

The Kabong Family comprises soils found in the present beaches and in somewhat older beaches now beyond the influence of tidal flood waters. The soils are grey to pale yellow sands which have, particularly in the lower part of the profile, a considerable amount of shell debris. Except for calcium the soils are poor in most nutrients. The soils are excessively drained, and the watertable is in most places below 2 feet from the surface but may rise above this level in the wet season.

Generally, they are used for coconut planting; under natural conditions the vegetation is usually dominated by casuarina trees. Coconut thrives well on these soils although fruiting is not always satisfactory. Probably fertilizing would improve the yields of coconuts on this soil type. A typical series for the Rambungan area is the Rambungan series described in the Appendix. The high total phosphate figures are abnormal for Kabong soils.

37. Sematan Family

The Sematan Family is more widespread than the Kabong family on the coastal belt. The soils comprise reddish-yellow to strong brown sands (medium to fine sands) which are older than the Kabong family. Generally shell debris cannot be found in the topsoils of the Sematan but it is commonly present below a depth of 3 feet. Leaching occurs in the Sematan Family but not to the extent that the soils can be called podsolised as in the more strongly leached Jerijeh Family. Sematan soils in this respect, therefore, can be regarded as transitional between Kabong and Jerijeh soils (the latter is discussed under no.18)

Two soil series have been distinguished, namely the Sematan series, which is the ortho type in the family showing a weak accumulation of iron as mottles or soft iron concretions in the lower part of the profile, and the Chupin series showing in addition to iron concentration an accumulation of calcium at the normal watertable level. The calcium forms a cement around shell debris giving a 'calcrete' pan. Both series are described in the Appendix.

Chupin series is widespread near Kuala Sekambal, but towards Santubong the Sematan series becomes increasingly more important. Possibly the amount of shells in the original beach deposits was greater near Lundu than in the remainder of the coastal areas. The Chupin series soils are suitable for coconut but probably need fertilizers, particularly in the early years until the roots can reach the richer soil. In the Chupin series, however, drainage conditions should be improved since it is likely that watertables will be high in the wet season. This is not so necessary in the Sematan series.

SKELETAL SOILS

38. Meluan Family

The Meluan family soils occur only on the steepest slopes of Bukit Gading (Lundu), where the soil cover commonly is thinner than 10 inches and overlies hard rock.

They are of no agricultural importance.

39/40. Sedong and Kapit 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 (mainly on some hills in the Sarawak river delta and on Bukit Gading) and are generally brown coloured. Textures are commonly heavy, although on Bukit Gading where they occur in association with the Gading series (number 1) somewhat lighter textures are found.

The Sedong family is found on rocktypes high in ferromagnesium minerals and is 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.

Kapit family soils occur on steep slopes and the parent material is derived from rock types rich in silica and the soils are therefore low in plant nutrients. This, coupled with the usually steep terrain render these soils unsuitable for agriculture.

Kapit family soils are important on the Matang Range

and on all scarp slopes of cuestas throughout the area, but particularly in the Sampadi Forest Reserve. They occur there commonly in association with the Nyalau or Merit families (described under nos. 3 and 5)

41. Gaya Family

Gaya family soils are very shallow soils overlying boulders. This bouldery material is found in some places at the foot of the Matang Range or at the foot of scarp slopes in other localities where boulder fans have formed at debouching points of small streams. The bouldery material is commonly **mainly of sedimentary rock** origin and if sufficiently weathered Nyalau or Merit soils form on them. For this reason, Gaya soils generally occur in association with these families. The Gaya soils are normally poor in plant nutrients. Where the bouldery material is penetrable by roots the soils are cultivated at places where the terrain is not too steep. Rubber is the main crop. In some localities (Matang-Selang) pepper is cultivated successfully. The family is of little importance for the area as a whole since the total acreage is small.

3. Notes on Distribution of Soils and Prospects for Development

In this section the soil pattern of the various geographic regions is briefly described and prospects for development commented upon.

The coastal area

From Kuala Sekambal to Kuala Santubong a thin belt of recent coastal sands belonging to the Kabong Family is found along the shore. It is usually planted up with coconut but the natural vegetation is mainly casuarina trees which still exist at some parts of the coast. Behind this strip of recent sands of a grey to pale yellow colour, in most areas a wider belt of reddish-yellow sands exists which in many localities is also planted up with coconut, but the growth is often very stunted.

These soils belong to the Sematan family. Commonly between the recent sands and the reddish yellow sands a number of ridges exist which are separated by channel-like, low lying areas. On the ridges normally white sands are found with podsol features. They belong to the Jerijeh family, while in the low lying areas where the watertable is high, Tatau soils are found. The coconut on the ridges is doing badly because of infertile soils while those planted in the low lying areas suffer from bad drainage. In some places wet rice is planted in these low lying areas.

In the Chupin area (near Kuala Sekambal) the reddish yellow sands have often a hard pan at approximately a depth of 3 feet. The local people call this 'karang'. These pans are holding up the rainwater in the wet season and where they occur impeded drainage may occur during the wet season. The pan should be broken up if drains are constructed.

Behind the reddish yellow sands usually a wide belt of mangrove and nipah is found on clays belonging to the Rajang family.

A great number of flat hills exist in the mangrove and nipah forest occurring between Sampadi and Santubong. These are terraces covered with soils belonging to the Miri family and which are unsuitable for agriculture. Between Sematan and Kuala

sekambal, for instance at Kpg. Pueh, these Miri soils occur directly behind the reddish yellow sands. This family can be recognised by the kerangas vegetation, the white colour of the sands and a dark brown pan at about two or three feet deep. The coast between Sematan and Kuala Sekambal shows also the succession of Kabong and Sematan family soils but no mangrove and nipah forest is found behind it.

Between Santubong and Muara Tebas, with the exception of the area between Buntal and Bako the coastline is mostly rocky with only a few small bays with beaches which can be planted up with coconut. There is little scope for agricultural development on the Santubong and Bako peninsulars because of steep mountainous terrain and very shallow soil types.

Efforts aimed at developing agriculture in the coastal area should, therefore, be concentrated on the Sematan family soils which with proper management are able to support coconuts.

Except for the area between Sematan and Kuala Sekambal the whole coastal belt is backed by a large expanse of mangrove and nipah forest covering marine clays. The areas are most extensive between Muara Tebas, Santubong and Kuching and between Kuala Sekambal and Kuala Sampadi.

Only those areas covered by nipah or nibong justify further investigation for possible coconut planting schemes, since the areas covered with mangrove are too low lying and the salinity hazard is too great.

Between Batu Malang and Sungei China the coastal sands are backed by a peat swamp which is unsuitable for agriculture except for a thin strip near Sungei China where the peat is not too deep. With proper drainage these soils could be utilised.

Bukit Gading and surroundings

The soils of Bukit Gading are very shallow and stony. They belong to the Sedong and Meluan families. The terrain is too steep for agriculture. Only at the foot slopes where the soils are deeper and the slopes more gentle can the land be cropped. Most areas are already in use for rubber or pepper but near the Lundu-Sematan road some scattered pockets of land can still be opened up for either rubber or pepper.

The land surrounding Bukit Gading is generally gently sloping and yellow coloured soils can commonly be found on the hills while along a great number of small streams coming from Bukit Gading brown loamy soils are found. The soils on the hills are mainly Nyalau family soils while those along the streams are Malang soils. Near the mountains the soils along the rivers become more sandy and gravelly such as at Kpg. Sekati near Lundu where the Ramun family is found. These areas are all highly suitable for agricultural development but most of the land is mixed zone land and already cultivated. Small bottom lands such as occur along the Kpg. Siar road are occupied mainly with sandy paya soils, (Plan family) which are suitable for wet padi and off-season cropping if the drainage is improved. The difficulty is to stop the occasional floods from damaging drainage works such as for instance happened at Titi Akar.

North of Bukit Gading at Bajo and Ulu Sungei Blunchi lateritic soils of the Tarat family are found. Here there is scope for development but in places the topography is steep and terrace soils of the Miri family occur mixed with the Tarat soils.

Good soils exist also along S. Perigi and S. Selaran; they belong there mainly to the Malang family.

The area between the Lundu Sematan road and Kpg. Selampit (ulu Kayan)

A large proportion of this area is formed by terraces. The grey to pale yellow sandy soils are not really suitable for organised development but at the edges of the terraces normally better soils are found which are suitable for rubber. This is particularly the case between Sungei Pasir and the Lundu-Sematan road. A large area of good riverine soils belonging to the Malang family can be found at Kpg. Rukam, Kpg. Karangga and Jangkar. The soils are suitable for rubber and off-season cropping. The main limitation is the risk of flooding in these areas.

Large areas of good wet padi land comprising Bijat soils exist at Kpg. Stunggang Malayu and Kpg. Sejirin. Here, drainage improvement is needed to make full use of the potential. Except for a thin strip of good clay alluvium (Bijat soils) along Sungei Pasir the remainder of the area is mainly deep peat with little prospects for development.

From Sungei Pasir to Kpg. Selampit most of the land is deep peat and there is little prospect of development. A number of small hills existing in this peat area is covered with sandy soils belonging either to the Nyalau soils which are suitable for rubber or Miri soils which should not be used for agriculture.

The area between Batang Kayan and Sungei Sampadi up to Bukits Snibong-Stunggang.

Along the Kayan river commonly a thin strip of clay soils is present, (Bijat soils) which if properly drained can be used for rubber, particularly upstream of Kpg. Sebandi. Flooding is a limitation. Down stream of Kpg. Sebandi the strip of clay soils is usually wider and at Tjg. Sebandi and Tjg. Purun the soils are very suitable for wet padi if properly drained. Behind the clay belt peat soils are normally found which if shallow may be used for annual crops if properly drained. A main limitation also here is extreme flooding during the wet season. Hilly land in the Lower Kayan area is usually of bad quality. This is covered with infertile terrace soils, (mainly Miri soils) only in a few places small areas of either Bekenu or Nyalau family soils can be found.

More prospects for development exist at Ulu S. Snibong, Ulu S. Stunggang, Ulu S. Keribong and S. Chapin. Here, hilly terrain with moderately steep slopes can be found with soils belonging to the Merit and Nyalau families. Part of these areas is still under Primary Forest. These areas are suitable for large scale rubber planting. This is also the case with the hilly land between S. Kualu and S. Chapin which comprises mainly Merit soils.

Sampadi Forest Reserve

The soils in Sampadi Forest Reserve belong mainly to three families, the Bako, Saratok and Nyalau families. The first mentioned occurs on flat to gentle sloping terrain and has no agricultural potential. On steeper slopes either the Saratok or Nyalau family is present, of which the former has a low agricultural potential. It should not be used for large

scale development but it may be possible to find small localised areas which can be developed by small-holders. The Nyalau soils occur commonly on the steepest slopes and are there generally shallow. The hill land in the Sampadi Forest Reserve therefore, does not offer much prospect for development. Some good land can be found along the Kayan river and particularly near the confluence of Sungei Butan with the Batang Kayan and at Sungei Bawang. Here, alluvial soils of the Malang Family occur as a wide belt along the river, while the neighbouring hilly terrain covered with Nyalau soils is not too steep. The main limitation here is flooding on the alluvial soils. The southern foothills of Bukit Snibong and Bukit Stinggang are other small areas which can be used for agriculture. An area of better soils also exists at Ulu Sungei Pungeh (S. Butan area) but this is a present inaccessible. With the exception of these areas most of the Sampadi Forest Reserve does not justify opening up for agricultural development. Most of the land could, however, be used for plantations of soft woods.

The Bokah-Rasau-Stinggang area

This low-lying undulating terrain has a complex soil pattern in which alluvial soils belonging to the Malang and Semilajau families occur along the rivers, while in the south on the low hills Merit and Nyalau soils are predominant. Nearer the Batang Kayan, on the hills, Saratok soils are found in association with Nyalau soils.

Along the Batang Kayan flooding is a serious limitation to development particularly in the Bokah area but away from the river towards the south prospects for large scale development become better. Topography is ideal, and the majority of the soils are suitable for rubber and possibly also for oil palm.

For an accurate location of the various families occurring in the area more detailed work is necessary.

The mountain range at the south of this area extending from Gunung Raya to Gunung Sekoris is unsuitable for agriculture because of steep terrain and poor soils.

This is also the case with the extension of this range towards Gunung Kayan and Gunung Serapi (Matang Range) in the west.

In general the terrain here is very steep and the soils very shallow and stony so that planned development must be ruled out, but in scattered localities suitable soils for agriculture can be found.

Sungei Selalang-Senggi-Temawang Sau area

Most soils in this area are suitable for agriculture. The hills are commonly not too steep for agriculture. Bekenu and Merit family soils are most common. Along the many small streams good alluvial soils are found which in some localities are used for wet padi. The Senggi area is already intensively developed mainly for rubber cultivation but the area between Temawang Sau and Selalang is still partly under shifting cultivation. Rubber and pepper cultivation could be promoted in this area; prospects for the latter are particularly good along the first eight mile stretch of the Bau-Lundu road.

The area between Bau and Opar shows a similar topography as existing along this stretch of road and the soils are identical. Also here, there are good prospects for the development of pepper and rubber. There is possibly a chance for development of oil palm on a small scale in the latter area.

The area between the Matang Range, Sengghi, Sarawak river and Matang road.

At the foot of the Matang Range, bouldery land mixed with Nyalau soils exists in many places. If not too steep the land can be used for rubber or pepper. Most of the land between the footslopes of the Matang Range and the Sarawak river is suitable for agriculture, the land is generally moderately steep to gently sloping and there are no major limitations to agriculture but already much land has been planted up with rubber. Where the hill soils belong to the Bekenu and Merit families pepper can also be planted up with advantage as is shown by the farmers living at S.Tengah and Batu Kawa.

In the west of this area, the hilly terrain borders a large swamp filled with deep peat deposits. In the past the greatest part of this swamp had already been planted up with rubber but because of bad drainage this land is not suitable for this crop. Possible a switch over to annual crops may be advantageous.

Most of the land in this whole area has already been alienated and been put to some use.

The area between the Matang road, old Matang-Lundu road and the Sarawak river Delta.

Most of this land is formed by deep peat soils of the Anderson family or by very poor soils belonging either to Miri or Saratok family soils. Only near the foot of the Matang Range some Nyalau soils can be used for either rubber or pepper while in scattered locations small hills with Bekenu soils, commonly surrounded by Miri family soils can be used for these crops.

It would take a considerable amount of detailed work to locate all these small areas.

Finally, at the end of the old Lundu road, across Sungei Rajuh a comparative small area of good hill soils (Merit and Nyalau families) mixed with good alluvial soils (Malang family) can be found. This is the only location in this region, suitable perhaps, for a small development scheme.

LAND CAPABILITY

1. Introduction

The land capability classification is a means of evaluating the properties of the land for agriculture. Only inherent land characteristics have been taken into account and economic factors, such as accessibility and distance from markets have not been considered since, apart from being complex, such factors are variable and are not suitable, therefore for a scheme embodying more or less permanent factors.

The system used is that outlined by the U.S. Department of Agriculture in Handbook 61, 'A Manual on Conservation of Soil and Water', but modified to suit Sarawak conditions (Andriess, 1966). The modification has not yet been standardised.

Ideally, the classification should only be used in large-scale mapping where detailed information is available; at smaller scales it would be difficult to map the commonly complex pattern of units, despite being able to classify satisfactorily most soil units in terms of land capability units.

The scheme was tried experimentally for this report at reconnaissance level and has proved largely satisfactory, except that insufficient data was available on flooding frequency and intensity, salinity levels and inherent fertility. The result is a map differentiating clearly between good and bad land, although in places it was not possible to map land capability units at the subclass level, and in other areas associations of units have had to be used.

2. Principles of classification

Each soil unit (family) was classified primarily on its diagnostic features using a rating as outlined in table 4.

Since factors such as flooding and salinity were not studied in detail it was not possible to place some families with certainty in the proper capability class. The contoured 1:50,000 topo-maps were useful for obtaining indications on steepness of the terrain.

The subclasses indicate the nature of the limitation or limitations and are shown in table 4 and on the map by the letter suffixes. If the limitation can be remedied the symbols are underlined, if the limitation cannot be altered the symbols are not underlined. In a number of units both types of limitations are involved. In these cases both symbols are shown indicating what limitation remains if the non-permanent one has been removed. From this it is possible to deduce what will be the optimum capability class of the land after improvement. E.G:

Class III f. - is land which is frequently flooded but the floods are of short duration. This limitation cannot be remedied.

Class IV sd. f. - is land which is very poorly drained and which is flooded occasionally but with floods of long duration. Although the drainage can be improved the land will remain in Class IV because of the flood risk.

Table 5 shows the capability rating of the soil families in the capability classes and subclasses.

Capability Class	Classifying Factors										Reaction	
	Slope (t)	Erosion	Effective depth of soil (d)	Natural soil drainage (sd)	Wetness (w)	Salinity (sa)	Flooding (f)	Textures of soil profiles (tx)	Depth of organic horizon (o)	Inherent fertility (n)*		
Class I	gently sloping 0 - 5	none *	deep >36"	well drained	slightly wet	none	no floods	moderately heavy to moderately light	shallow 0 - 10"	(n)*	(r)	weakly acid
Class II	Moderately sloping <10	slight		moderately well drained	moderately wet	weak	occasional of short duration	heavy to light	shallow 0 - 10"	moderate		acid
Class III	strongly sloping 10 - 15	moderate	Moderately deep 30-36"	poorly drained	wet	moderate	frequent of short duration	very heavy to light		low		
Class IV	steep 15 - 25°	severe	10 - 20" shallow	very poorly drained	very wet	strong	occasional floods of long duration		moderately deep 10" - 40"	very low		strongly acid
Class V	-	-	-		extremely wet	severe	frequent of long duration	very heavy to very light	deep 40"	-		-
Class VI			shallow 10 - 20"	-	-	-	-		-	extremely low		-
Class VII	very steep >25	very severe	very shallow <10"	-	-	-	-		-	-		-

* based on crop behaviour, non-fertilized; no defined, arbitrary limits have been chosen.

Table 5.
Capability rating of the soil families

Classes and Subclasses	Soil Families
Class I	not present
Class II t	Tarat - some
Class II f	Malang - some, Ramun - all
Class III t	Tarat, Abok
Class III d	Sedong and Kapit - some
Class III <u>sd</u>	Bijat - all, Plan - some
Class III <u>sd.sa</u>	Pendam and Nonok - all
Class III f	Malang - some, Seduau - all Kayan-some
Class III tx	Similajau - all
Class III n	Sabangan - all
Class III n.t.	Merit, Bekenu, Nyalau - some
Class IV t	Tarat, Sedong, Abok, Nyalau, Merit, Bekenu, Kapit.
Class IV <u>sd</u>	Sebandi - all
Class IV <u>sd.sa</u>	Rajang and Belat - some
Class IV <u>sd.o</u>	Mukah and Igan - all
Class IV <u>sd.tx</u>	Tatau - all, Plan - some
Class IV <u>sd.n</u>	Embang and Gong - all
Class IV <u>w.n</u>	Lubai and Triboh - all
Class IV tx	Kabong and Sematan all
Class IV tx.f	Kayan - some
Class IV tx.n	Jerijeh - all
Class IV n	Saratok, Kerait and Matang - all
Class V <u>sa</u>	Rajang and Belat - some
Class V <u>sa.o</u>	Limbang - all
Class V <u>o.sd</u>	Anderson - all
Class VI t	Tarat, Sedong, Kapit, Abok, Nyalau Merit, Bekenu, Matang, Saratok - some
Class VI n	Miri and Bako - all
Class VI d.n.	Gaya - all
Class VII d	Meluan - all

Limitations

Symbol

slope/erosion
depth of soil
soil drainage
wetness
salinity
flooding
texture
depth organic horizon
inherent fertility

t
d
sd
w
sa
f
tx
o
n

non-continuing limitations are underlined.
permanent limitations are not underlined.

The seven capability classes can be defined as follows:

- Class I land - Land with no specific problems other than low fertility which can be remedied easily. It is suitable for a wide range of shallow and deep-rooting crops both annuals and perennials.
- Class II land - Land with no problems other than a slight risk of flooding, or slightly saline conditions with imperfect drainage, both of which can be easily remedied. Low fertility may be a problem in some areas. It is suitable for most annual and perennial crops.
- Class III land - 1. Land in which the crop range is restricted because of poor drainage, moderately saline conditions or a moderate risk of flooding.
2. Land which demands moderate conservation measures and which is mainly suitable for perennials only. Generally both land types are of low fertility.
- Class IV land - 1. Land in which the crop range is severely restricted because of very poor drainage, strongly saline conditions or a severe risk of flooding.
2. Land which requires intensive conservation measures, such as terracing, and which is only suitable for perennials
3. Land with very low fertility
- Class V Land - Land which is excessively wet, or severely saline, or in which a severe risk of flooding exists. It is only suitable for crops with a high tolerance to these conditions.
- Class VI land - 1. Very steep land with a shallow soil cover, unsuitable for normal agriculture. It is only suitable for some perennials with intensive conservation measures.
2. Land with extremely low fertility, unsuitable for normal crop production.
- Class VII land - Land which is very steep and with a very shallow soil cover, not suitable for any form of cultivation.

CONCLUSIONS

In this section only those conclusions which are of direct importance for large scale development planning are summarised. For conclusions of a general nature the reader is referred to the text of the report.

1. Class I land is not present in the area.
2. Class II land occurs only in the vicinity of Lundu where it is almost all used for pepper and rubber and little or none of this land is available for development since it is found in a mixed zone area and has already been alienated.

3. There is a fair amount of Class III land in the area. This can be found partly between Kuching and Bau in the Batu Kawa area and it is there used for pepper and rubber cultivation. This area is mixed zone land and there is little prospect for further development.

Part of it is in the Selalang-Sengghi area and in the Grog-o-Opar area. Here it may be possible to find land for oil palm development on a small scale. A large part of this land is either under shifting cultivation or used for rubber, much of it being old seedling rubber which could be re-planted. The largest single block of Class III land is straddled along the 12th to 16th mile stretch of the Bau-Lundu road. There most of the land is under shifting cultivation. It is calculated that there is a minimum of 5000 acres of this land available in one continuous block. More detailed investigations are, however, required to locate accurately the best land. Available evidence points to the fact that in addition to these 5000 acres another 5000 acres may be found.

The area around Bukit Gading near Lundu is another location, where Class III land can be found but it occurs there mixed with other land classes so that large continuous blocks of this land class are non-existent. A block of sufficient size for a R.P.S. 'A' Scheme can be found in the Bajo area (Lundu). This land is under Primary Forest. Further investigations are required to locate the area accurately and for assessing the total acreage available.

Class III land occurs widespread along the Kayan river but here drainage schemes are required to make full use of the potential of this land. Wet padi and coconut could be grown with success in such schemes. The development of this land is strongly recommended. In the Rukam Jangkar area good Class III land can be found mixed with Class II land but flooding is the main limitation.

4. The majority of the land in the area falls in Class IV which is land having one or more serious problems. This may be slopes, drainage, salinity or very low fertility.

If slopes are a limitation then Class IV land is mainly of use for rubber planting only. A large continuous block of this land occurs north of Bukit Snibong, approximately between Sungei Snibong and Sungei Keribong. This area will be opened up by the Bau-Lundu road if this reaches the 25th milestone. Since part of this area is still under primary forest it is justified to investigate in more detail how much land actually could be used for rubber planting. With the present evidence available it is likely that 5000 acres of reasonably good land for rubber can be found there.

Along the whole coastline a considerable area of class IV land can be found which is all suitable for coconut. If attention is given to fertilization. Investigations into the feasibility of using all this land for coconut with the use of fertilizers are strongly recommended. At present this land is only partly used and without fertilizers only average yields are obtained. It could develop into a major coconut growing area.

5. A large part of the area which is covered by Mangrove and nipah forest is classified as class IV and V land. Here salinity and drainage are the great problems. No general rule can be laid down on the usefulness of this land for agriculture

since much depends on the economics of a possible amelioration scheme. This land needs foremost an intensive drainage system to lower the watertable and to leach out the salts with the aid of the rainfall. Recurrence of saltwater infiltration should be prevented. If this can be achieved at moderate cost parts of the areas can then be used for coconut and possibly wet padi.

Attention should first be given to the areas under Nibong or those under a mixed Nibong-Nipah vegetation since these areas are least difficult to drain.

Prospects seem to be greatest in the Lundu area; especially between Sungei Sekambal and the Batang Kayan. There, a large area with this mixed vegetation can be found.

6. Class V land is too wet for cultivation and only if no other land is available attempts could be made to improve the drainage. It is normally not recommended for cultivation.

7. Class VI and VII land are unsuitable for cultivation and should not be considered for development. It may be possible to find small areas of single-lot size inside class VI and Class VII land.

8. Finally, the soil survey indicates that the last 10 miles of the projected Bau-Lundu road leads through very difficult swampy terrain and terrain which is usually flooded during the wet season. The soil map indicates where dry land can be found along this stretch so that a less difficult route can be chosen.

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A P P E N D I X

Parat Family

Gading series

Code Number: 1202

Profile

Topography: hilly terrain, foothills, at site sloping down 15°

Site: Up stream Sungei Setumban Lundu, 1st Division + 30 feet from cliff, falling down to present floodlevel ± 50 feet high.

Vegetation: old rubber garden with weed undergrowth

Parent material: adamelite of Bukit Gading.

Profile

0 - 5 inches 10 YR 4/3 dark brown, weak subangular blocky sandy clay loam, friable. Organic matter present, well rooted, gradual but distinct change to

5 - 16 inches 10 YR 5/8 yellowish brown, sandy clay loam, smeary. Individual coarse sand grains, (gritty) possibly sandy clay. No apparent structure, friable. Very few roots. Moist. Very gradual change to

16 - 44 inches 7.5 YR 6/6 reddish yellow sandy clay loam, slightly plastic, structureless to weak crumbly. Slightly firm, no visible roots. At lower depth slightly more reddish coloured but no boundary can be given until

44 - 56 inches 5 YR 5/8 yellowish red sandy clay loam, in places gritty, weak crumbly, slightly firm. No roots, gradual change to

56 - 60+ inches 2.5 YR 5/6 red gritty clay (sandy clay) smeary. Much glimmers in rock debris. Material in this horizon can be separated into partly weathered rock, desintergrated but coarse particles not yet weathered and red clay material. No roots visible. Moist, structureless.

Analyses

Lab. No.	Depth of sample in inches	P Total	% Ca Total	% Mg Total	% K Total	% Gp. III
S 4601	0 - 2	90	0.03	0.01	0.07	9.96
4602	9 - 14	30	0.02	0.01	0.07	11.36
4603	26 - 32	45	0.03	0.01	0.08	17.42
4604	46 - 50	30	0.04	<0.01	0.09	19.79

Analyses from profile 5th Mile, Sekambal road.

Lab. No.	Depth of sample in inches	p Total	Ca Total	Mg Total	K Total	% Gp. III
S 4590	0 - 6	90	0.02	0.01	0.07	10.84
4591	6 - 15	70	0.02	0.01	0.07	11.14
4592	13 - 33	65	0.03	<0.01	0.07	16.88/
4593	33 - 48	80	0.03	<0.01	0.08	19.76
4594	48 - 58	55	0.03	<0.01	0.07	20.50

Jerijeh family

Stoh series

Code Number: 4113

Profile

Topography: on beach ridge, sloping gently down towards swale.
 Site: Almost on the top of a ridge near Kpg. Trombol (Kuching District)
 Vegetation: Scattered stands of dying coconuts, lallang undergrowth, with some Kaju Leban bushes.
 Parent Material: Old beach deposits.

Profile

0 - 2 inches 5Y 7/1 light grey, dry, loose, medium sand with bits of organic litter, no roots. Irregular boundary to
 (0-2) - 9" dark greyish brown, 10YR 4/2, medium sand, well rooted, weak crumbly, slightly moist, irregular boundary to
 9 - (11-29)" very pale yellow, 10YR 8/3 medium sand, loose, slightly moist, very few roots, irregular boundary which slopes down steeply to one side of the pit.
 (11-29) - yellowish brown, 10YR 5/8, medium sand, with
 (13- +38) hard to firm dark brown concretions, irregular boundary to
 13 - +38 " brownish yellow 10YR 6/8 medium sand, moist, with mottles and streaks of a strong brown colour.
 38 inches Watertable

Analyses

Laboratory No.	Depth of sample in inches	P Total	Ca Total	Mg Total	K Total	% Group III
S 4495	0 - 2	45	0.02	<0.006	<0.05	0.34
4496	2 - 9	35	0.01	0.006	<0.05	1.34
4497	9 - 11	15	0.04	<0.006	<0.05	0.08
4498	11 - 29	65	0.01	0.01	<0.05	1.60
4499	29 - 38	70	0.04	0.006	<0.05	0.66

Ranun Family

Siar series

Code number: 4403

Profile

Topography: alluvial flat to low undulating terrain, levee position. Probably flooded occasionally during wet season.

Site: approximately 500 feet upstream of saline alluvium, \pm 100 feet from stream and bordering hilly terrain. Sungei Bajo, Lundu, 1st Division.

Vegetation: Good secondary jungle. Scattered coconut, pinang and rubber

Parent material: Source material most likely mainly hybridised adamlite ranging from gabbro to adamlite

Profile

0 - $\frac{1}{2}$ inches Weak angular blocky, fine loamy sand, abundant roots.

$\frac{1}{2}$ - 5 " 7.5 YR 4/4 dark brown loamy fine sand, weak crumbly loose many roots, distinct over

5 - 25 " 7.5YR 5/6, strong brown loamy fine sand, weak crumbly, loose moderately well rooted, distinct but gradual change to

25 - 32 " 10YR 5/6, yellowish brown sand with brown mottling, few glimmers, loose, structureless, slightly moist, gradual but distinct change to

32 - 40 " 2.5 YR 5/4 light olive brown, moist loamy fine sand, more glimmers than 25-32", slightly firm. Structureless, few roots, distinct but gradual change to

40 - 48+" 10YR 4/2 dark greyish brown loamy sand, fine organic debris present, moist, lenses of bluish grey clayey material present. Slightly firm, structureless, no roots.

Remarks: Recent alluvium with weak gleyzation in the lower subsoil.

Analyses

Lab. No.	Depth of sample in inches	P Total	Ca Total	Mg Total	K Total	% Group III
S 4586	0 - 3	170	0.04	0.14	0.14	1.60
4587	10 - 16	90	0.03	0.15	0.18	12.51
4588	25 - 30	50	0.03	0.14	0.14	7.52
4589	34 \approx 38	70	0.02	0.15	0.15	8.74

Malang Family

Sekati series

Code number: 4320

Profile

Topography: flat to low undulating riverine valley
 Site: approximate 100 feet from Sungei Lundu, Lundu 1st Division, near hospital.
 Vegetation: Good secondary forest
 Parent material: alluvium of adamalite (Bukit Gading)

Profile

- 0 - 9 inches 10YR 4/4 dark yellowish brown clay loam, weak angular blocky to crumbly. Slightly firm, well rooted, clear over
- 9 - 24 " 10YR 5/8, yellowish brown clay, weak fine angular blocky to crumb, glimmers present. Translocation of material from topsoil visible in wormholes and root channels, gradual change to
- 24 - 38 " 10YR 5/8, yellowish brown weakly mottled with 7.5YR 5/8, clay, firm, weak to fine angular blocky. No visible roots. The mottling becomes more intense with depth until its highest intensity is reached in
- 38 - 44 " 10YR 7/4, very pale brown clay with strong 7.5 YR 5/8 mottles. Firm, no apparent structure, moist, distinct change to
- 44 - 51 " 2.5YR 6/2 light brownish grey sandy clay, much glimmer rich material present, with reddish and brown mottles. Red mottles of 38 - 44" is gradually replaced by brown colours. No apparent structure, moist. Clear over
- 51 - 62+ Coarse sand, fresh riverine sand with many glimmers

Remark: Red-Yellow podsollic with gleyzation in lower part of the profile owing to nearness of groundwater table in the wet season (+ 40")

Analyses

Lab. No.	Depth of sample in inches	P total	Ca total	Mg total	K total	% Group III
S 4595	0 - 2	480	0.06	0.20	0.27	18.02
4596	14 - 21	180	0.04	0.24	0.40	27.38
4597	29 - 35	235	0.03	0.24	0.42	34.42
4598	30 - 44	300	0.03	0.27	0.44	38.60
4599	46 - 56	145	0.04	0.28	0.44	25.86
4600	58 - 62	115	0.03	0.25	0.36	9.20

Sematan family.

Chupin series.

Code number: 4112

Profile

Topography: Low, flat to gently undulating terrain (old beach).

Site: Approx. 250 feet from nearest lagoon
Chupin area, Lundu, 1st Division.

Vegetation: Lallang, weeds. Field normally used for hill padi,
now fallow.

Parent material: Subrecent marine deposits (beach).

Profile

- 0 - 8 inches 10 YR 4/3, brown fine sand, feeling loamy because of organic matter. Slightly crumbly, loose, many small roots, moist abrupt over.
- 8 - 16 " 10YR 6/8, brownish yellow fine sand with weak mottles (7.5YR 5/8, strong brown) which are becoming more intense and darker at depth. Structureless. Loose, few small roots. Slightly moist; gradual but distinct change to
- 16 - 30" 10YR 6/8 brownish yellow medium to fine sand with strong dark brown (7.5YR 3/2) staining and streaks with some harder concentration of probably massive-iron compounds. Most intensive between 19 and 30". Loose, structureless material. Slight gleying along root channels and some grey mottles present between 23 and 30".
Abrupt change to
- 30 - 42" Light brownish grey sand with much shell debris and calcrete (cemented silica and shell remains) in puppet form.
There is a thin sheet of this material at the bottom of 16 - 30" horizon, which is easily broken up by chankoling. Groundwater is below this sheet and the sandy material behaves like drift sand.
- 42" - ? Shell rich recent beachsand.

Analyses

Lab. No.	Depth of sample in inches	P Total	Ca Total	Mg Total	K Total	% Group III
S 4581	0 - 4	140	0.02	0.02	0.07	8.44
4582	11 -15	180	0.04	0.03	0.10	6.34
4583	16 -20	225	0.03	0.03	0.10	5.92
4584	20 -25	290	0.05	0.07	0.09	4.78
4585	32 -40	280	3.66	0.32	0.10	3.78

Sematan family

Sematan series

Code number: 4107

Profile

- Topography: Almost level terrain of old beach sloping down towards lagoon.
- Site: At kampong Loba (M) Kechil, (Kuching District).
- Vegetation: Coconuts, undergrowth: Some lallang, rumput ikat ikat, daun bering.
- 0-6 inches: Dark yellowish brown, 10YR 4/4 fine sand, weak angular blocky, to crumbly. Many roots (coconut mainly), moist, gradual change to
- 6-11 inches: Strong brown 7.5YR 5/6 find sand with weak yellow mottling and some humus staining, weak angular blocky. Light mottling along roots. Moderately well rooted. Gradual irregular change to
- 11-25 " Strong brown 7.5YR 5/8 find sand, strongly mottled pale yellow and pale yellow streaks indicative to old root channels (yellow colours strongest along existing root channels). Accumulation of iron in pockets of strong reddish brown colour. Few roots, gradual change to
- 25-42 " Strong brown, 7.5YR 5/8, wet, few yellow mottles mainly along root channels, stuctureless, firm.
- 42 inches Watertable, Greyish white sand with dark brown spots (organic matter?), more densely rooted than at 25-42".

Analyses

Lab. No.	Depth of sample in inches	P Total	Ca Total	Mg Total	K Total	% Group III
S 4500	0 - 3	140	0.04	<0.006	<0.05	0.66
4501	5 - 9	115	0.02	0.02	<0.05	2.56
4502	12 -18	180	0.01	0.03	0.08	4.18
4503	30 -36	445	0.02	0.07	0.09	8.38

Kabong family

Rambungan series

Code number: 4114

Profile

Topography: Flat, subrecent beach.

Site: 1 mile from Kpg. Rambungan, Lundu District.

Vegetation: Mainly lallang.

0-6 inches Dark greyish brown, 10YR 4/2 fine sand, dry, abundant roots, few very fine yellow brown mottles. Structureless. Indistinct boundary to

6-9 inches Very pale brown, 10YR 7/4 fine sand with abundant coarse pale brown staining along root channels, few roots, dry structureless, porous, diffuse boundary to

9-17 " pale brown, 10YR 6/2 fine sand with very few fine yellow brown and pinkish white mottles, dry crumbly, few roots, porous. Diffuse boundary to

17-30 " brown, 10YR 5/3 fine sand with many fine pale brownish yellow mottles. Dry, friable, porous, diffuse boundary to

30-38 " grey brown 10YR 5/2 fine sand with abundant staining of humus, wet, smeary.

38-48 " Watertable at 40 inches. Grey 5Y 5/1 fine to medium sand, wet, smeary. Abundant fine shells and fine layers of organic debris.

Analyses

Lab. No.	Depth of sample in inches	P Total	Ca Total	Mg Total	K Total	% Group III
S 4522	0-6	455	0.11	0.14	0.09	5.44
4523	6-9½	435	0.22	0.20	0.09	5.52
4524	9½-17	475	1.89	0.28	0.09	6.36
4525	17-30	328	5.10	0.55	0.10	5.30
4526	30-38	375	4.49	0.43	0.11	5.42
4527	38-48	358	8.06	0.55	0.10	5.80

Triboh family

Rukam series

Code number: 6001

Profile

Location: Rentis 22, Lundu, tape 36.
 Topography: On gentle slope nearby summit of terrace.
 Vegetation: Kerangas Forest of open nature. Some large trees present.
 Parent Material: Uncertain, but either quartzitic shale of the Serabang formation or the massive alluvium.

0-1 inch Dark brown surface litter, small and large roots.
 1-3 " 10YR 4/1 dark grey silt loam, organic matter with
 Al weak crumbly, soft, well rooted, friable, distinct change to
 4-7 " 10YR 5/1 grey loam mottled dark grey (leached down
 Al/2 material from Al). Moderately well rooted, friable, soft, structureless. Clear over
 7-25 " 2.5Y 6/0 (N/6 - grey) fine sandy silt - very
 A2 compact, hard. When broken friable, structureless, olive coloured, mottling sporadic and concentrated at some places. Very few roots, slightly moist. Humus material from top has leached into this horizon through channels to about 9" deep. Abrupt change to
 25-34 N7, light grey, silty clay, very compact, small
 B quartz pieces. Weak olive mottling in places. Distinct change to
 34-45+ N7, light grey clay with large pieces of quartz
 B/C clear and opaque quartz 1/2-2 inches in size. (Possibly broken up quartz vein). Some yellow brown mottles in places. Very compact, hard and almost impossible to dig. Water in auger hole 3 days after rain still present.

Analyses

Lab. No.	Depth of sample in inches	pH H ₂ O	P Total	Ca Total	Mg Total	K Total	% Group III
4619	1-2	4.3	90	0.01	0.04	0.09	2.62
4620	3-7	5.0	10	0.02	0.01	0.08	1.96
4621	14-21	5.4	10	0.01	0.02	0.08	2.58
4622	28-33	4.8	20	0.01	0.03	0.33	8.06
4623	45	5.0	30	0.01	0.02	0.34	8.44

Silantek Family

Batan series

Code number:- 3206

Profile

- Topography: Moderately steep dip slope (approx. 10°)
- Site: Almost on top of hill. Path Stinggang to S. Punguh (1st Division, Lundu District).
- Vegetation: Kerangas forest. Dominant species: Jatau, Bajau, Kaban Mila, Chemara.
- Parent Material: Tertiary sediments, quartzitic sandstones mainly.
- 0-2 inches Partly decomposed, 5YR 2/2, dark reddish brown, organic matter with few sand grains, mixed with dense rootmat of fine roots mainly, some large roots, Slightly moist. Clear over.
- 2-5 inches 5YR 3/2, dark reddish brown, sand, with much organic matter, friable, crumbly, moist. Individual sand grains are white in colour and clear. Abrupt but in places wavy boundary to
- 5-9 inches 5YR 5/2, reddish grey, medium sand (humus stained), with few roots, moist, single grain, firm clear but wavy change to
- 9-13 inches 10YR 7/1, light grey, medium sand with reddish grey staining in places (75% light grey - 25% reddish grey). Single grain, firm. Some veins of humic material run through this horizon without any apparent direction. No roots, abrupt over.
- 13-18 " 5YR 2/2 and 3/2, dark reddish brown loamy, medium sand, weakly cemented. Some fine roots at boundary with horizon above. Sand grains are bleached and glitter in cemented material. Irregular but clear change to
- 18-22 " 10YR 6/4, light yellowish brown; fine sandy loam, slightly wet. Many old decomposed roots. Small pockets of 5YR 2/2 colour where material is cemented. Platy structure with humus accumulation between structure elements laid; distinct change to
- 22-33 " 10YR 7/3, very pale brown, loamy sand - sandy loam, compact, structureless, slightly wet. Many old root channels with organic material (5YR 2/2). Some organic material, accumulated along fracture planes. Clear change to
- 33-44 (52) inches 2.5Y 8/4, pale yellow sandy clay with 10YR 6/6 mottling, in some places as lateral bands in others along old root channels. Sticky and plastic. Some quartz pebbles (rounded), at 44 inches becoming more sandy and resembling sandstone.

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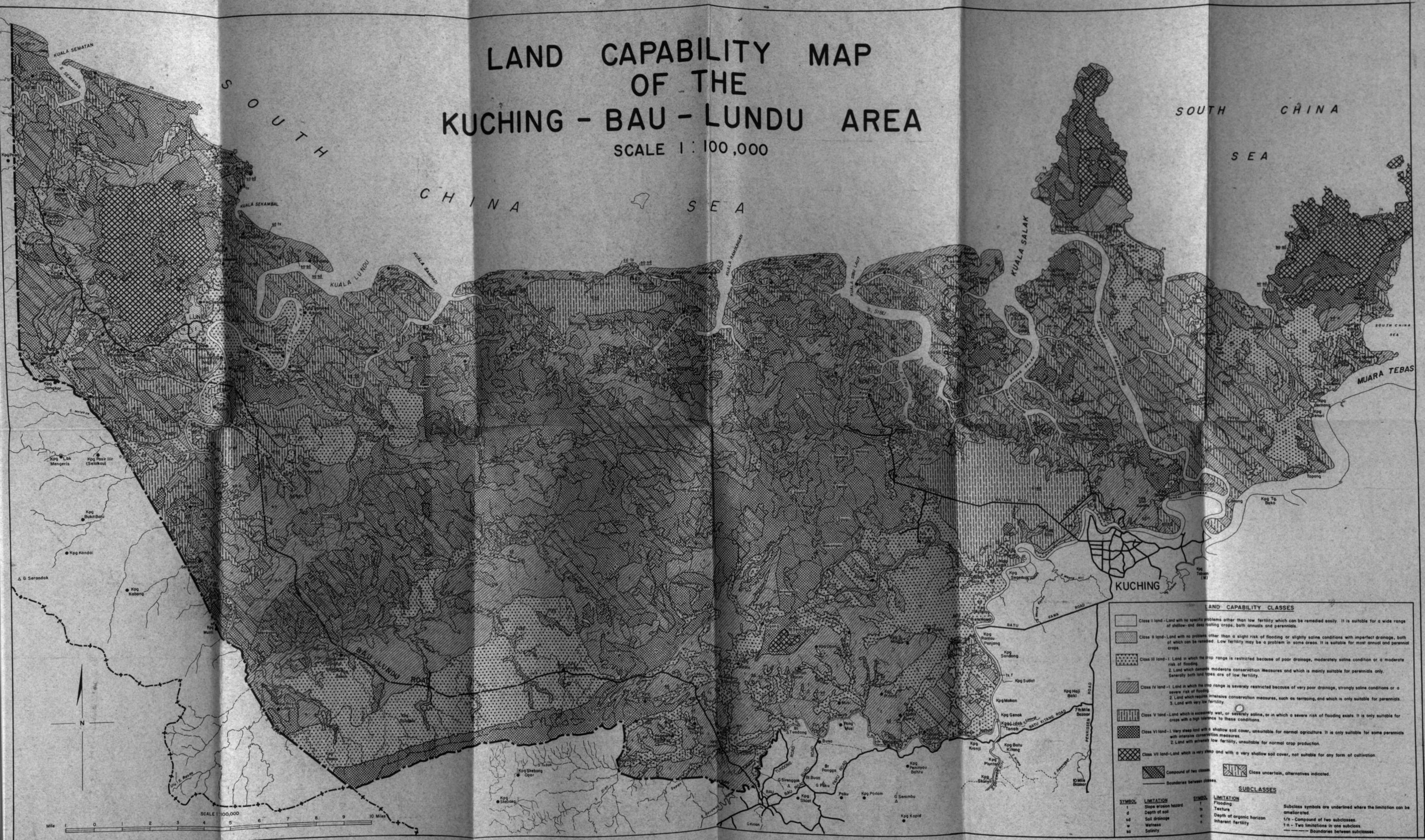
2-68 inches White medium sandstone. (Deep augering confirms occurrence of white clay bed at 68-76 inches). Perched watertable at 48 inches.

Analyses

Lab. No.	Depth of sample in inches	pH Water	C.E.C meq	Exch Ca meq	Exch Meq	Exch K meq	Exch Na meq	% C
4369	0-2	3.0	14.5	0.54	0.24	0.25	0.4	25.82
4370	2-5	3.3	6.4	0.42	0.24	0.17	0.39	4.82
4371	5-9	4.2	3.0	0.30	0.18	0.05	0.33	0.46
4372	10-13	4.7	0.5	0.12	0.18	0.05	0.32	0.14
4373	13-18	3.6	4.7	0.19	0.18	0.06	0.36	4.52
4374	18-22	3.9	7.5	0.12	0.18	0.06	0.27	2.64
4375	22-33	4.3	1.0	0.19	0.18	0.06	0.33	0.57
4276	33-40	4.3	0.5	0.19	0.11	0.06	0.33	0.18
4277	52-68	4.1	0.5	0.42	0.11	0.07	0.33	0.05

LAND CAPABILITY MAP OF THE KUCHING - BAU - LUNDU AREA

SCALE 1 : 100,000



LAND CAPABILITY CLASSES	
	Class I land - Land with no specific problems other than low fertility which can be remedied easily. It is suitable for a wide range of shallow and deep rooting crops, both annuals and perennials.
	Class II land - Land with no problems other than a slight risk of flooding or slightly saline conditions with imperfect drainage, both of which can be remedied. Low fertility may be a problem in some areas. It is suitable for most annual and perennial crops.
	Class III land - 1. Land in which the crop range is restricted because of poor drainage, moderately saline condition or a moderate risk of flooding. 2. Land which demands moderate conservation measures and which is mainly suitable for perennials only. Generally both land types are of low fertility.
	Class IV land - 1. Land in which the crop range is severely restricted because of very poor drainage, strongly saline conditions or a severe risk of flooding. 2. Land which requires intensive conservation measures, such as terracing, and which is only suitable for perennials. 3. Land with very low fertility.
	Class V land - Land which is excessively wet, or severely saline, or in which a severe risk of flooding exists. It is only suitable for crops with a high tolerance to these conditions.
	Class VI land - 1. Very deep land with a shallow soil cover, unsuitable for normal agriculture. It is only suitable for some perennials with intensive conservation measures. 2. Land with extremely low fertility, unsuitable for normal crop production.
	Class VII land - Land which is very steep and with a very shallow soil cover, not suitable for any form of cultivation.
	Compound of two classes.
	Class uncertain, alternatives indicated.

SUBCLASSES	
SYMBOL	LIMITATION
<u>1</u>	Slope erosion hazard
<u>2</u>	Depth of soil
<u>3</u>	Soil drainage
<u>4</u>	Wetness
<u>5</u>	Salinity
<u>6</u>	Texture
<u>7</u>	Depth of organic horizon
<u>8</u>	Inherent fertility
Subclass symbols are underlined where the limitation can be omitted.	
1/2 - Compound of two subclasses.	
1a - Two limitations in one subclass.	
--- Boundaries between subclasses.	