DIVISION OF AGRICULTURE

SOILS AND

SOIL SURVEY REPORT NO.1

SEMI – DETAILED SOIL SURVEY OF THE SUNGEI TUNOH AND SUNGEI PILA AREAS SEVENTH DIVISION SARAWAK

S. PARAMANANTHAN

MINISTRY OF AGRICULTURE AND FISHERIES
MALAYSIA

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CONTENTS

PART I

INTRODUCTION

As a result of his visit to Sarawak, the Honourable Federal Minister of Agriculture and Fisheries, Tan Sri Haji Ghazali bin Jawi, directed the Soils and Analytical Services Branch, Department of Agriculture, Peninsular Malaysia to assist in the survey of four areas in the Seventh Division. Encik S. Paramananthan and Encik K. Selvadurai made a preliminary visit to Sarawak from the 8th to the 11th October, 1973 to assess the agricultural potential of the four areas. As a result of this visit two of the areas viz. – the Sungei Tunoh and the Sungei Pila Areas were recommended for further study.

This report together with the terrain, soil and soil suitability maps is an assessment of agricultural potential of the two areas. The survey was carried out in March 1974 by a team of four surveyors from Peninsular Malaysia consisting of Encik Chin Fatt, Encik K. Selvadurai, Encik S. Makeswaran and the author.

Location

The two areas surveyed are located in the Seventh Division and lie between longitudes 113°F and 114°E and latitudes 2°N and 3°N (See Figure 1). The Sungei Tunoh area is situated to the south and west of Bukit Mabong which forms the southwestern tip of the Hose Mountains. The area is situated along the banks of the Sungei Ulu Melinau and the Sungei Tunoh. Both these rivers are minor tributaries of the Sungei Melinau which is a tributary of the Sungei Mujong which in turn flows into the Batang Baleh and finally into the Batang Rajang. The Sungei Pila Area is situated along the banks of the Sungei Pila which is a tributary of the Batang Rajang.

Access

As the interior of Sarawak is undeveloped, access into the two areas is either by helicopter or by boat. The time taken to reach the areas from Kapit depends largely on the level of water in the rivers and on the size of the outboard motor used. At the time of the survey when the level in the rivers was low, the Sungei Tunoh Area was only reached after two days of travelling by longboats while the Sungei Pila Area was reached in one day using the express from Kapit to Naga Merit before changing to a longboat.

Present Land Use

A major portion of the Sungei Tunoh Area is under protective forest reserve. A small area totalling less than 1,000 acres has been cleared

FIGURE - I

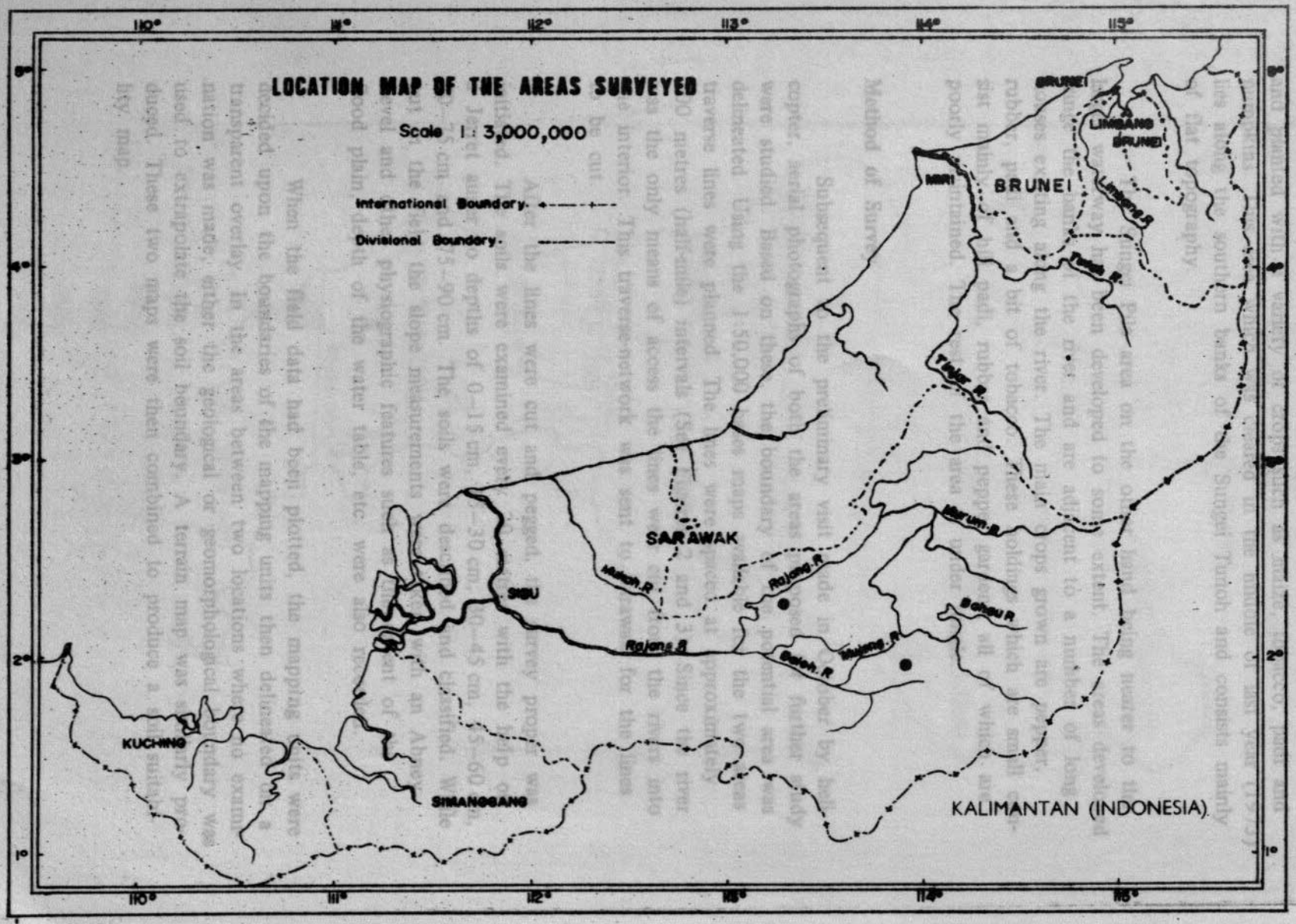

LOCATION MAP OF THE AREAS SURVEYED
Scale 1 : 3,000,000
International Boundary
Divisional Boundary
BRUNEI
LIMBANG (BRUNEI)
MIRI
BRUNEI
Limbang R.
Tutoh R.
Tinjar R.
Baram R.
SARAWAK
Rajang R.
Belaga R.
Rajang R.
Balui R.
Baleh R.
SIBU
KUCHING
SIMANGGANG
KALIMANTAN (INDONESIA)
110°
111°
112°
113°
114°
115°
5°
4°
3°
2°
1°

FIGURE-2

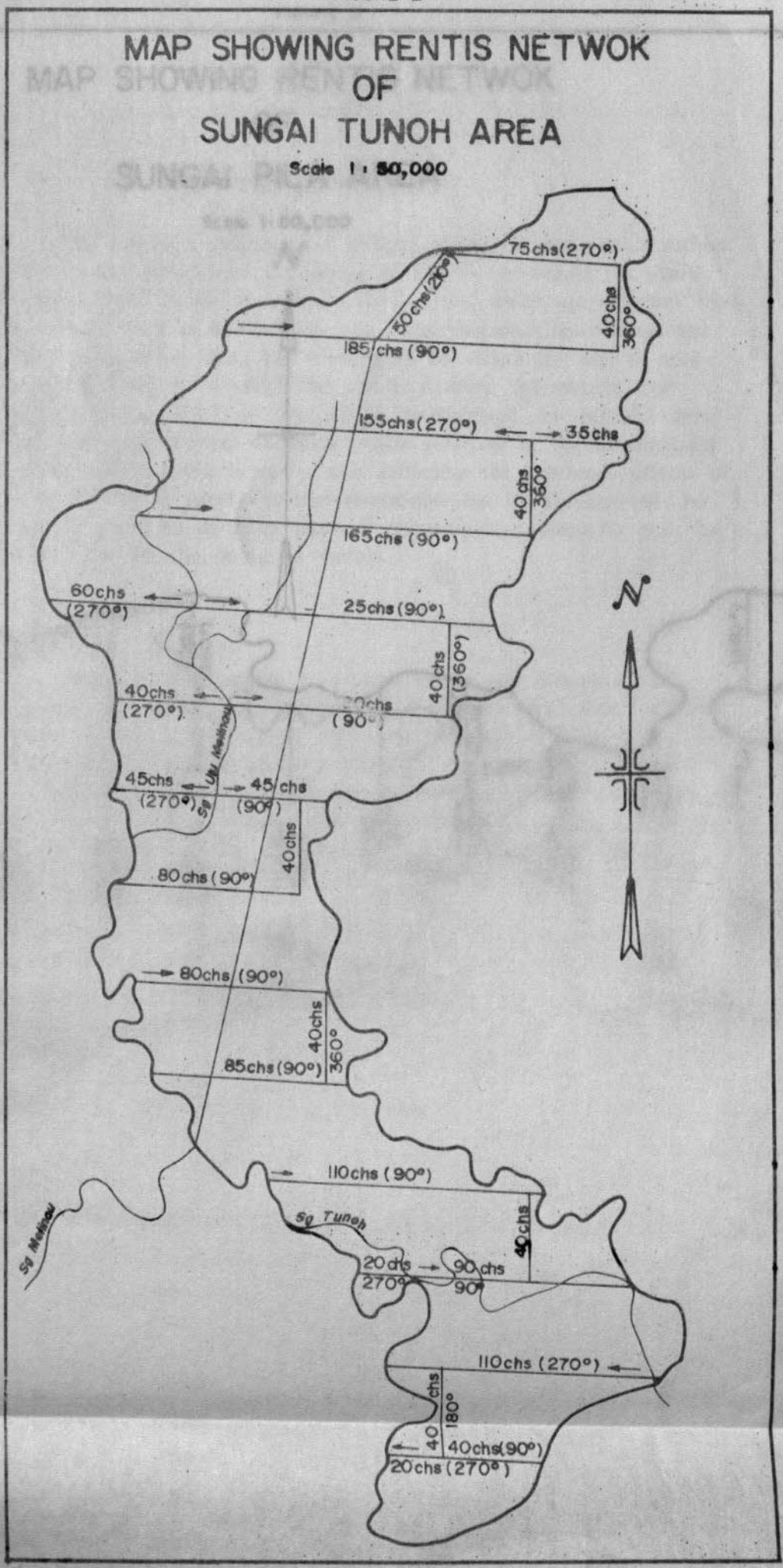
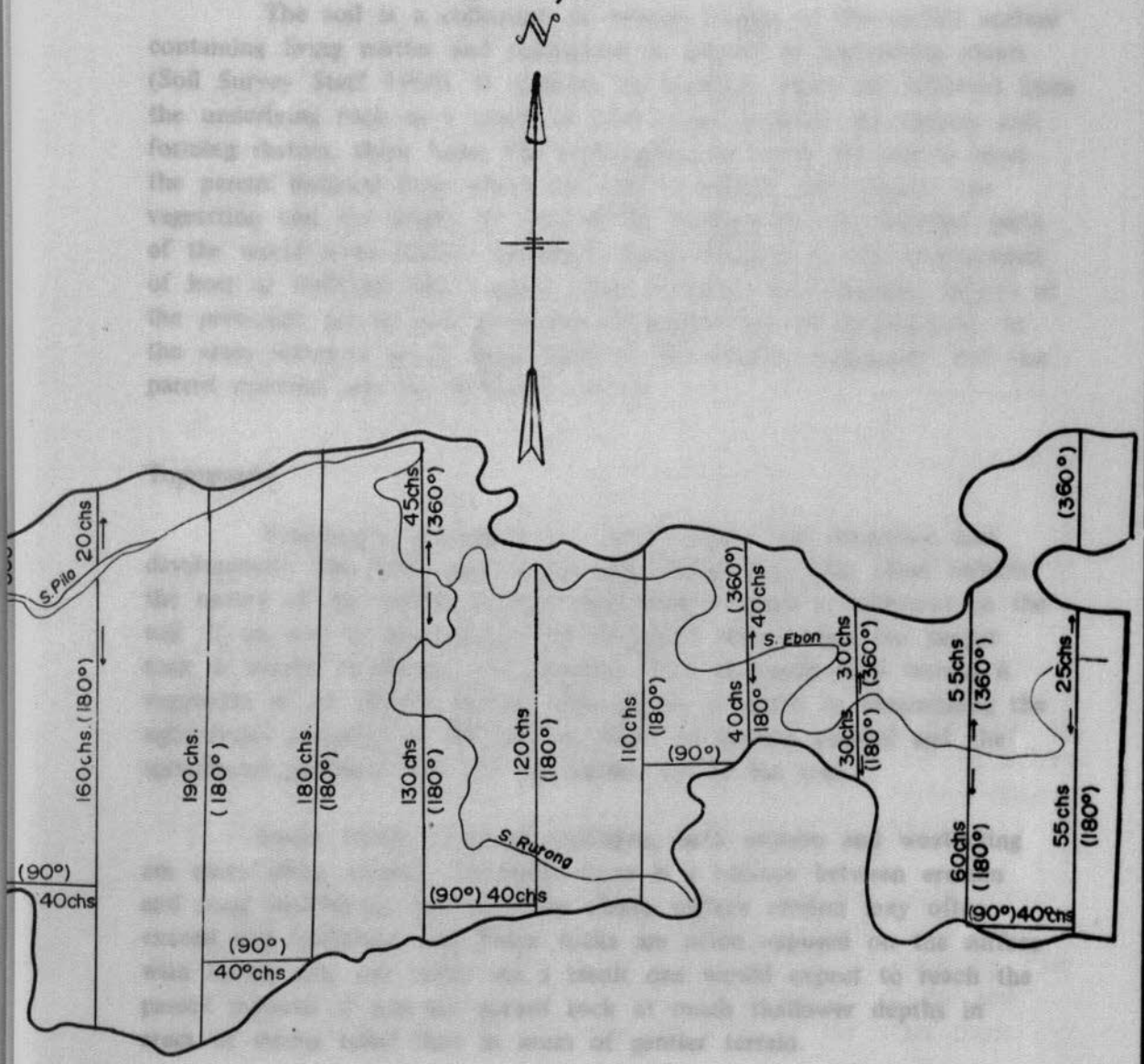

MAP SHOWING RENTIS NETWOK
OF
SUNGAI TUNOH AREA
Scale 1 : 50,000
75chs(270°)
50chs(270°)
40chs
360°
185chs (90°)
155chs(270°)
35chs
40chs
360°
165chs (90°)
60chs
(270°)
25chs(90°)
40chs
(360°)
40chs
(270°)
(90°)
45chs
(270°)
45chs
(90°)
40chs
80chs (90°)
80chs (90°)
40chs
360°
85chs(90°)
110chs (90°)
Sg Tunoh
40chs
20chs
270°
90chs
90°
110chs (270°)
40chs
180°
40chs(90°)
20chs (270°)
N

FIGURE-3

MAP SHOWING RENTIS NETWOK OF SUNGAI PILA AREA

Scale 1:50,000



PART II

THE ENVIRONMENT

The soil is a collection of natural bodies on the earth's surface containing living matter and supporting or capable of supporting plants (Soil Survey Staff 1960). It includes all horizons which are different from the underlying rock as a result of interactions between the various soil forming factors, these being the topography on which the soil is sited, the parent material from which the soil is derived, the climate, the vegetation and the length of time of its development. In different parts of the world some factors dominate others resulting in the development of host of different soil types – each reflecting the combined effects of the particular set of genetic factors responsible for its development. In the areas surveyed as in many parts of the tropics, topography and the parent material are the dominant factors.

Topography

Topography influences to a great extent soil formation and development. The slope and terrain class of an area very often reflects the nature of the parent material and therefore often a difference in the soil. If an area is characterized by elongated ridges, then the parent rock is usually sandstone and quartzite. Flat or nearly level terrain is suggestive of an alluvial deposit. The terrain is useful in determining the agricultural potential of the area in terms of erosion control and the agricultural practices that can be carried out in the area.

Under humid tropical conditions, both erosion and weathering are quite often intense. Generally, there is a balance between erosion and rock weathering, but on steep slopes surface erosion may often exceed soil formation and hence rocks are often exposed on the surface with hardly any soil cover. As a result one would expect to reach the parent material if not the parent rock at much shallower depths in areas of strong relief than in areas of gentler terrain.

During the survey the slope of the land was measured with an Abney Level. The slope and terrain classes used in the survey are set out in Table 1. The lack of reliable topographic maps makes the assessment of the topography more difficult.

Areas having slopes greater than 20° have been delineated as steepland and are considered too steep for normal agriculture. The hilly

and rolling areas are normally found in areas with sedimentary parent material and often fringe the steepland. The level areas are situated along the floodplains of the rivers.

TABLE 1. SLOPE AND TERRAIN CLASSES

Slope in Degrees	*Terrain Classes*	
	Single Slopes	*Complex Slopes*
$0-6^{o}$	Level or nearly level (A_2)	Level or nearly level to undulating (C_2)
$6-12^{o}$	Strongly sloping (A_3)	Rolling (C_3)
$12-20^{o}$	Moderately steeply sloping (A_4)	Hilly (C_4)
$20^{o}+$	Steeply sloping (A_5)	Steep (C_5)

In the Sungei Tunoh Area (See Figure 4) most of the steepland occurs in the northern half of the area surveyed and in particular the eastern and western edges. Other small areas of steepland are scattered throughout the area. The hilly terrain consisting of slopes ranging from 12^{o} to 20^{o} occupies a major portion of the centre of the area and as fringes along the steepland. The heights in the Sungei Tunoh Area rise to above 200 feet above the local base level. Along the banks of the rivers and in the southern portion flat to very gently undulating terrain occur. These are made up of swamps and the floodplains of the rivers.

In the Sungei Pila Area (See Figure 5) steep topography occurs in the south-central and eastern parts of the area surveyed. Hilly terrain is rather limited and mainly occurs and fringes around the steepland. Flat and gently undulating topography occupies a large portion of the area. This occurs mainly as floodplains along the banks of the larger rivers.

Parent Material

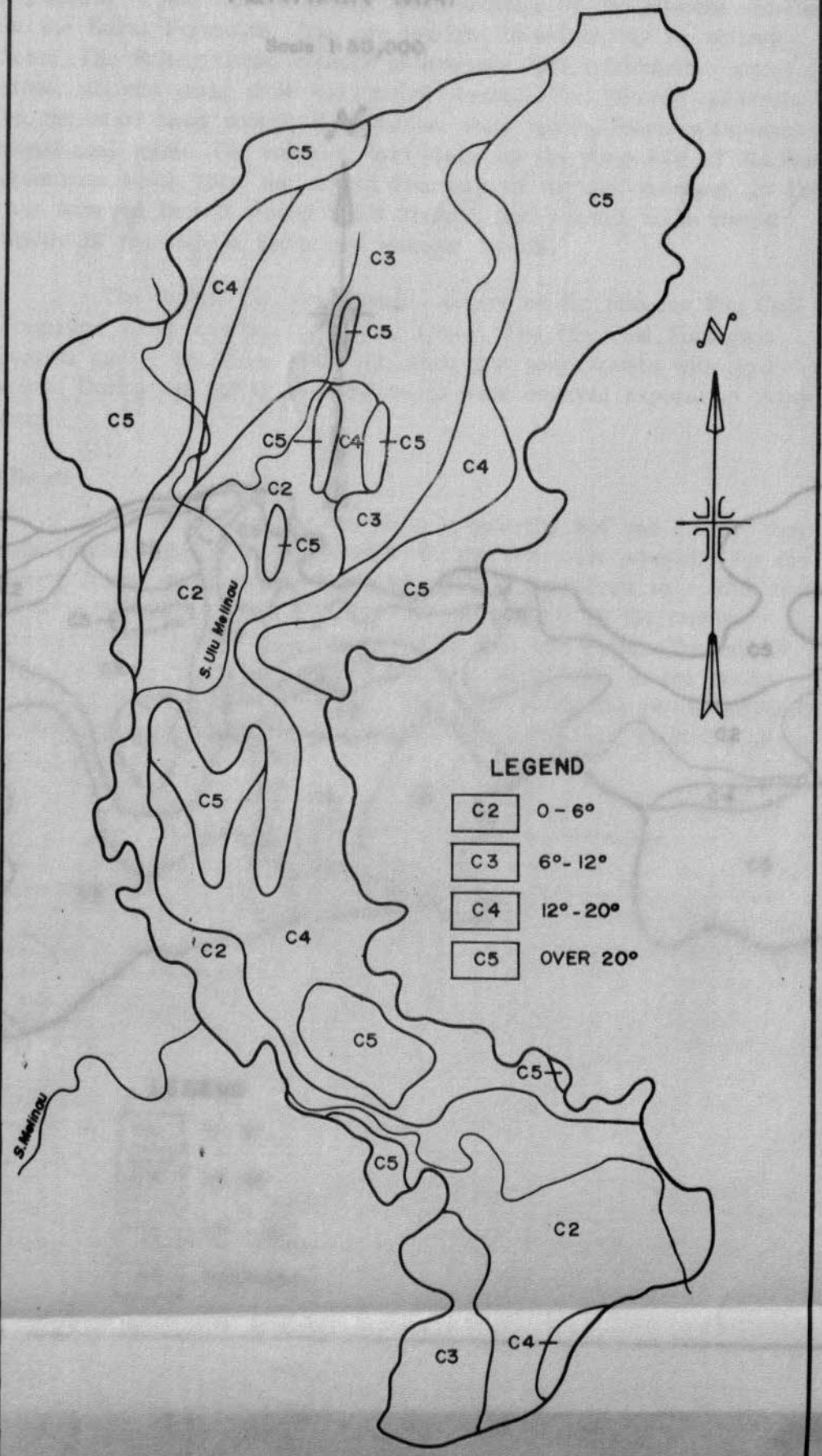
In the tropics it is generally found that the parent material from which a soil develops plays a very important role – not only in the profile development but also in the chemistry and nutrient status of the soil. The term parent material refers to the weathered rock material or unconsolidated rock or deposits from which the soil develops as different from the parent rock or the unweathered portion of the earth's crust.

FIGURE-4

SUNGAI TUNOH AREA

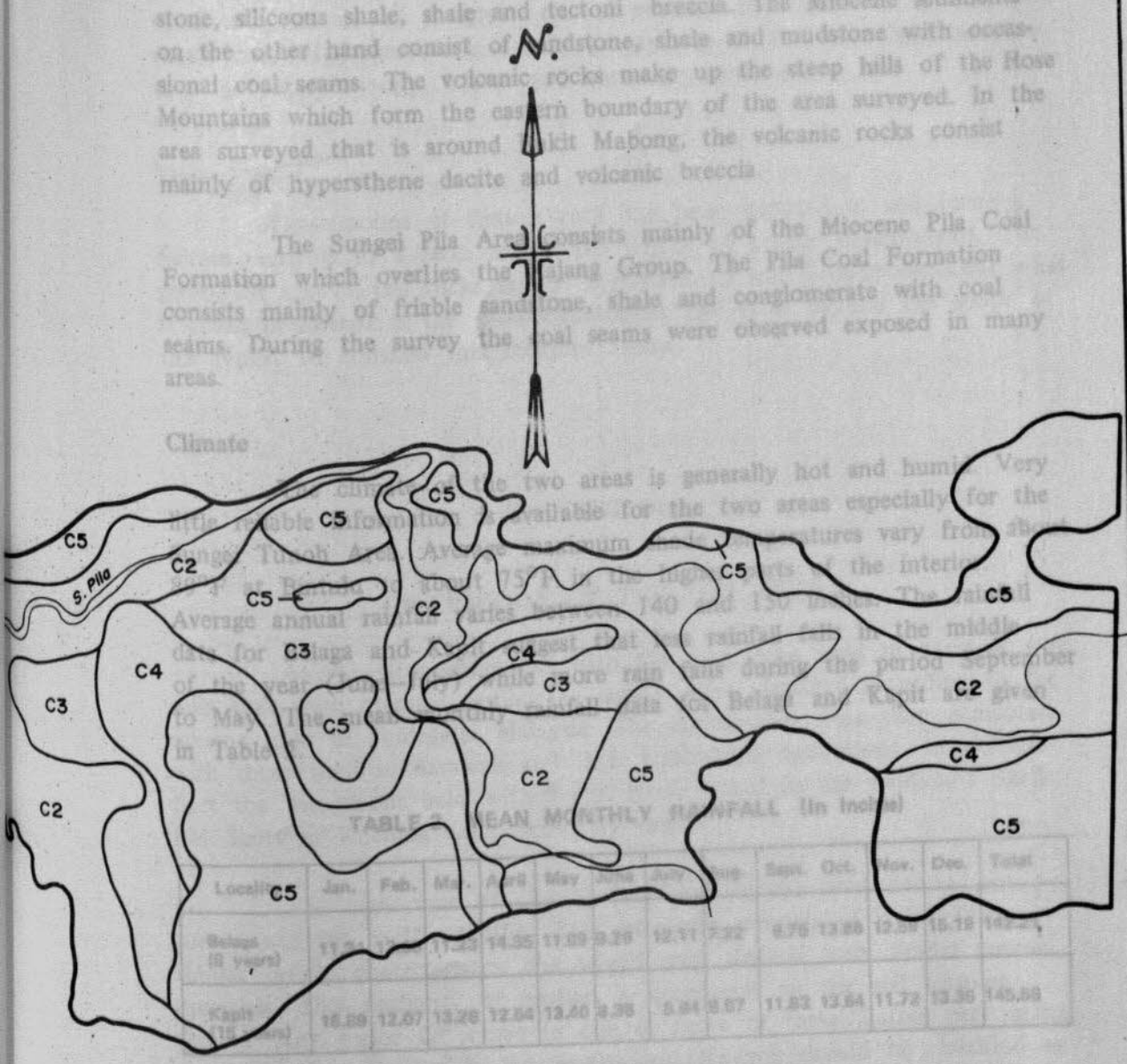
TERRAIN MAP

Scale 1:50,000



SUNGAI PILA AREA
TERRAIN MAP

Scale 1:50,000



LEGEND

C2	0 - 6°
C3	6° - 12°
C4	12° — 20°
C5	OVER 20°

The geology of the two areas has been described by Kirk (1957). The Sungei Tunoh Area has a geology which consists partly of Upper Cretaceous – Mid Eocene Rajang Group overlain by the Miocene sediments of the Kakus Formation. They are overlain unconformably by volcanic rocks. The Rajang Group consists of intensely folded feldspathic sandstone, siliceous shale, shale and tectoni breccia. The Miocene sediments on the other hand consist of sandstone, shale and mudstone with occassional coal seams. The volcanic rocks make up the steep hills of the Hose Mountains which form the eastern boundary of the area surveyed. In the area surveyed that is around Bukit Mabong, the volcanic rocks consist mainly of hypersthene dacite and volcanic breccia.

The Sungei Pila Area consists mainly of the Miocene Pila Coal Formation which overlies the Rajang Group. The Pila Coal Formation consists mainly of friable sandstone, shale and conglomerate with coal seams. During the survey the coal seams were observed exposed in many areas.

Climate

The climate of the two areas is generally hot and humid. Very little reliable information is available for the two areas especially for the Sungei Tunoh Area. Average maximum shade temperatures vary from about 89°F at Bintulu to about 75°F in the higher parts of the interior. Average annual rainfall varies between 140 and 150 inches. The rainfall data for Belaga and Kapit suggest that less rainfall falls in the middle of the year (June–July) while more rain falls during the period September to May. The mean monthly rainfall data for Belaga and Kapit are given in Table 2.

TABLE 2. MEAN MONTHLY RAINFALL (In Inches)

Locality	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Belaga (8 years)	11.31	13.65	11.23	14.35	11.69	9.26	12.11	7.22	9.75	13.86	12.59	15.19	142.21
Kapit (15 years)	16.89	12.07	13.28	12.54	13.40	8.36	8.94	9.57	11.83	13.64	11.72	13.36	145.58

Vegetation

Tropical rain forest, most of which is primary jungle covers the northern half of the Sungei Tunoh Area. This area is part of a forest reserve. The low lying areas along the Sungei Tunoh have been cleared and

a variety of crops grown. In the Sungei Pila Area it is estimated that about 30% of the area has been developed while the rest is still under forest.

Most of the natural vegetation is of hill-forest type and consists of almost entirely of evergreen trees d minated by species of the Dipterocarpaceae. Undergrowth is usually scanty due to the little light penetrating the forest canopy. Lianas and rotan are common.

Time

The amount of time a rock has been exposed to soil forming factors controls to a large extent the degree of profile development. The geological age of the rocks is not important to soil development but what is more important is the geomorphological age. It is beyond the scope of this report to consider this complex factor.

PART III

DESCRIPTION OF THE SOIL SERIES

As we were unfamiliar with the soil series used in Sarawak, the soils that were mapped during the survey were classified according to the scheme used in Peninsular Malaysia. The descriptions were then compared with those used in Sarawak and their equivalents determined. In this respect the discussions held with Encik Rosli Shaari in the field and Encik I.M. Scott in Kuching were extremely useful.

The basic unit of classification used in the field during the survey was the SOIL SERIES. The soil series consists of soils having similar profile characteristics and which were derived from similar parent materials. This similarity of profiles is dependent on the soil forming factors. Any major difference in one or more of these factors very often results in dissimilarities in the profile and the soil should be classified as a different soil series. The soil series names used in this report and the map are in accordance with the classification by Scott (1973).

Wherever possible the soils were delineated on the final map at the series level. However in many instances the soil pattern was more complicated and it was not possible to delineate the individual soil series.

As a result, a more convenient mapping unit – that of the SOIL ASSOCIATION has been used. The soils mapped in the two areas are described below in alphabetical order.

Bekenu Series

Soils of the Bekenu Series are non-accreting mineral soils derived from sedimentary parent materials. They have been mapped in areas dominated by shale and siltstone parent materials, and have been mapped both as a single series and in association with the Gumbang and Nyalau Series respectively. Soils of the Bekenu Series are generally found on rolling to hilly terrain ($6^{o} - 20^{o}$ slopes). In the northern part of the Sungei Tunoh Area they have been mapped in association with the Gumbang Series derived from dacite. The soils are characterized by silty to clayey textures, yellowish colours and well-developed medium to coarse subangular blocky structures.

The topsoil of the Bekenu Series is a friable to firm, yellow (10YR7/6) to brownish yellow (10YR 6/6) clay or silty clay possessing moderately developed subangular blocky structures. The subsoil is a firm to very firm, yellow to brownish yellow (2.5Y 7/6 – 10YR 6/6) clay to silty clay exhibiting well developed coarse subangular blocky structures with good clayskins. This grades at depth to a firm, highly mottled, yellowish red to reddish yellow (5YR 5/8 – 7/8) clay, grading down to fragments of weathered shale. The depth of the profile depends largely on the slope on which it occurs. On rolling topography the variegated zone is encountered below 70 cm while on the hilly areas it is encountered at about 50 cm.

The firm to compact subsoil which occurs between 50–75 cm depths are a moderate limitation to agricultural development. Erodibility on the steeper slopes can also be a limitation. On the gentler slopes these soils should be suitable for rubber, pepper, oil palm, fruit trees and other similar tree crops. Roots crops such as tapioca, sweet potato etc. can be grown with good management on the gentler slopes but are unsuitable on the hilly terrain.

Bijat Series

Soils of the Bijat Series are variable accreting mineral soils found in depressions and along the floodplains of the rivers in the areas. They are generally clay textured and often gleyed with occassional mottles. These soils occur in area which are under water for prolonged periods of the year. They have been mapped in association with the Semilajau Series.

The surface soil is a pale brown (10YR 6/3) clay and moderately friable when dry. This passes gradually to a weakly structured sticky or firm very pale brown to white (10YR 7/3 – 8/2) clay to sandy clay. Mottling intensity varies from locality to locality and is sometimes profuse. The mottled zone grades gradually into a gleyed light grey to white zone at depth. The completely gleyed zone is often encountered below 75 cm. Rice is commonly found cultivated in these low-lying areas. The poor internal drainage and the weak structures exhibited by these soils make their crop suitability rather restricted. Rice is probably the best crop on these soils. With drainage other crops such as oil palm, rubber, vegetables and other cash crops can be cultivated.

Gumbang Series

These soils are non-accreting mineral soils derived from dacite parent material. They have been mapped both as a single series and in association with the Bekenu Series. They occur predominantly on the more hilly terrain in the northern part of the Sungei Tunoh Area. They are probably derived from the Hypersthene dacite and volcanic breccia mapped by Kirk in the Hose Mountains. The soils are characterized by yellowish red colours and clay loam textures. The soils are moderately deep and friable.

The topsoil is generally a friable dusky red to dark reddish brown (2.5YR 3/3 – 3/4) clay loam. This is underlain by a deep friable yellowish red (5YR 5/8) clay loam. Structures are moderately developed medium and fine subangular blocky. The consistency becomes slightly firmer with depth. Although the Gumbang Series occurs on hilly terrain the soil is moderately deep and the parent material was encountered at depths between 50–70 cm. The friable consistence, clay loam textures and the moderately deep rofile make this soil favourable for agriculture. Drainage which is somewhat excessive and the terrain are moderate limitations to agricultural development. These soils should be suitable for pepper, rubber and fruit trees. Oil palm would only be marginal on these soils.

Kapit Series

Soils of the Kapit Series are very shallow soils of limited distribution in the area surveyed. They are derived from sedimentary parent material with the weathered parent material being encountered within 30–50 cm depth. These soils are often found at the top of steep ridges which transect the area. Although only a small area has been shown on the map, smaller areas which occur as isolated pockets are not shown.

The Kapit Series has a topsoil which is a friable dark brown (10YR 4/3) fine sandy clay loam with weak medium subangular blocky structures. This is underlain by a friable to firm strong brown to yellowish red (7.5YR 5/8 – 5YR 5/8) clay loam to sandy clay loam becoming compact with depth. Pieces of weathered shale and sandstone are encountered at depths between 30 cm to 50 cm. Their sandy textures and erodibility are limitations to agriculture. These soils are best left under jungle.

Nyalau Series

Soils of the Nyalau Series are non-accreting mineral soils derived from sedimentary parent materials. They have been mapped as a single series in the central portion of the Sungei Tunoh Area. In the southern portion they have been mapped in association with the Bekenu Series. In the Sungei Pila Area they occur in association with the Peninjau Series. They occur on rolling to hilly topography. The Nyalau Series is characterized by a yellowish brown colour and a fine sandy clay loam texture. It has a deep profile and is derived from sandstone and shale parent material.

The topsoil of the Nyalau Series consists of a dark yellowish brown (10YR 4/4) fine sandy clay loam with weak fine subangular blocky structures. The subsoil is a friable brownish yellow, to yellowish brown (10YR 5/6 – 6/6) fine sandy clay to clay with moderate to well-developed medium subangular blocky structures. At depth the soil becomes firmer and exhibits a faint diffuse type of mottling.

These soils are deep and are fairly good soils for agricultural development. On hilly terrain these soils would have serious erosion problems during the rainy seasons and hence this is the only limiting factor. On the gentler slopes rubber, oil palm, pepper and fruit trees can be grown on these soils.

Peninjau Series

This soil is developed over sedimentary rocks which are predominantly sandy in nature. They have been mapped in association with the heavier textured soils of the Nyalau Series in the Sungei Pila Area. The Peninjau Series is a deep friable sandy textured soil which occurs on rolling to hilly terrain. Their sandy textures make them prone to erosion hazards.

The surface soil is a friable, yellowish brown to brownish yellowish (10YR 5/4 – 6/6) sandy to coarse sandy loam to loamy sand

with weakly developed fine to medium subangular blocky structures. This is underlain by a friable yellowish brown to reddish yellow (10YR 5/6 – 7.5YR 6/8) loamy sand, to sandy loam with weak to moderate medium subangular blocky structures. The sandy textures and weak structures make this soil extremely susceptible to erosion. However with proper management these soils can be cultivated to rubber and pepper.

Semilajau Series

Soils of the Semilajau Series are accreting mineral soils found along the banks of the rivers. They have been mapped in association with soils of the Bijat Series. The Semilajau Series are generally restricted to the better drained areas such as the levees. They are characterized by their better drainage, loamy textures and yellow colours. They occur on flat to very gently undulating topography.

The surface soil of the Semilajau Series is a friable, yellowish brown to light yellowish brown (10YR 5/4 – 6/4) sandy loam to fine sandy clay loam which possesses weakly developed subangular blocky structures. The subsoil is a deep friable yellowish brown (10YR 5/6) sandy to fine sandy clay loam with moderate to weakly developed subangular blocky structures. The soil is commonly porous, drainage is good and root penetration excellent. Occasional mica flakes may also be present. A variant of this soil showing siltier textures – the Bemang Series has also been observed. Soils of the Semilajau Series should be suitable for a wide range of crops including vegetables, tobacco, tapioca, sugarcane, rubber, oil palm and fruits.

Seratok Series

Soils of the Seratok Series are non-accreting mineral soils derived from sedimentary rocks. They have moderately deep profiles with fine sandy loam textures and generally pale colours. The soil is poorly structured. They occur on hilly terrain in the southern part of the Sungei Tunoh Area.

The surface soil under jungle consists of thin light yellowish brown to pale yellow (10YR 6/4 – 2.5YR 7/4) sandy to fine sandy clay loam which possesses weakly developed fine to medium subangular blocky structures. This is underlain by a friable very pale brown to yellow (10YR 7/8 – 2.5Y 7/6) sandy to fine sandy clay loam subsoil which is weakly mottled and exhibits weakly developed medium subangular blocky structures. Below 50 cm depth the soil often changes to a firm highly mottled clays which is light grey to pale yellow (2.5Y 7/0 – 7/8) in

colour. Quartz grits are common at depth. The soil is easily erodible and the presence of the firm layer below 50 cm also constitutes a limitation to crop growth. Only rubber and fruit trees can be recommended on these soils.

Steepland

This unit is defined as land occurring above the steepland boundary, being the line separating land with average slopes less than 20^{o} and topographically suitable for agriculture from land having average slopes exceeding 20^{o} and better suited to permanent forest. The soils are generally shallow and therefore extremely prone to erosion. These areas should remain under forest.

Soil Associations

In areas where the soil pattern was complicated it was not possible to map the soils at the series level. The convenient mapping unit of the soil association was used. The soil series described above were combined to give two member associations.

The alluvial soils of the Bijat and Semilajau Series were mapped only in association in both the areas. In the Sungei Pila Area the sedentary soils of the Nyalau and Peninjau were also mapped in association. The other associations which were mapped were the Bekenu-Gumbang, Bekenu-Nyalau and the Seratok-Bekenu Associations all mapped in the Sungei Tunoh Area.

PART IV

SOIL SUITABILITY

The soil suitability maps enclosed shows the range of crops which are suitable, marginal and unsuitable in the two areas surveyed. In attempting to draw the soil suitability map an average level of management has been assumed. The crops which have been assigned as marginal in any locality can probably be grown with reasonable success if a high level of management is used or if simple modifications such as drainage or terracing are carried out. It is not possible in this report to select from the range of crops suitable which crop is optimal. In order to do this many other factors have to be considered. These would include economic, marketing, social and transportation problems just to name a few.

The areas suitable for agriculture readily fall into two broad groups:–

(i) Areas covered by sedentary soils.
(ii) Areas covered by alluvial soils.

Most of the areas covered by sedentary soils are more suited for the cultivation of perennial crops such as rubber, oil palm, pepper and fruit trees. On the hilly terrain these crops may be marginal as erosion may become a problem. In the case of oil palm the total acreage suitable is too small for the establishment of an oil palm mill. In addition to this transportation to another mill is also not possible in view of the poor communications in the areas at present. It appears therefore that of the common crops rubber and pepper offer the best possibilities.

The areas covered by alluvial soils offer the best opportunities for diversification. These alluvial soils can support a wide range of cash crops such as vegetables, tobacco, maize, sorghum, groundnuts and padi. Drainage in these areas may have to be improved if these areas are to be utilized beneficially.

It is pertinent to point out that most of the areas which are under primary forest – especially those in the Sungei Tunoh Area have valuable timber resources. Before these areas are developed this valuable commodity should be extracted. Once logging is introduced then possibly road transport would become available and then marketing of the produce would become easier.

Tables 3 and 4 show the acreages of the various soils on the different terrain classes.

TABLE 3. ACREAGES AND PERCENTAGES OF THE MAPPING UNITS OF THE SUNGEI TUNOH AREA

Soil Series/Association	*Terrain Class*	*Acreage*	*% of Total*
Bekenu Series	Rolling	625	8.44
Bekenu Series	Hilly	115	1.55
Gumbang Series	Rolling	195	2.63
Gumbang Series	Hilly	267	3.61
Nyalau Series	Hilly	625	8.44
Kapit Series	Hilly	68	0.92
Bekenu–Gumbang Association	Rolling	418	5.65
Bekenu–Gumbang Association	Hilly	195	2.63
Bekenu–Nyalau Association	Rolling	275	3.71
Bekenu–Nyalau Association	Hilly	36	0.49
Seratok–Bekenu Association	Hilly	159	2.15
Semilajau–Bijat Association	Flat and Undulating	1,982	26.77
Steepland	Steep	2,444	33.01
TOTAL		7,404	100.00

TABLE 4. ACREAGES AND PERCENTAGES OF THE MAPPING UNITS OF THE SUNGEI PILA AREA

Soil Association	*Terrain Class*	*Acreage*	*% of Total*
Nyalau–Peninjau Association	Rolling	991	15.27
Nyalau–Peninjau Association	Hilly	601	9.26
Semilajau–Bijat Association	Flat and Undulating	2,364	36.42
Steepland		2,535	39.05
TOTAL		6,491	100.00

CONCLUSIONS

A soil survey of the Sungei Tunoh and Sungei Pila Areas of the Seventh Division Sarawak was carried out by a team of surveyors from Peninsular Malaysia in response to a directive made by the Federal Minister of Agriculture and Fisheries.

Of the 7,000 acres surveyed in the Sungei Tunoh Area about 5,000 acres or 67% of the area was found to be suitable for agricultural development. About 3,000 acres were covered by sedentary soils derived from sandstone, shale and dacite parent material. These soils are suitable mainly for perennial crops of which rubber, pepper and fruit trees are best suited. The remaining 2,000 acres consists of alluvial soils which may be flooded in places in some part of the year. With improved drainage these soils offer the best possibility for agricultural diversification with vegetables, padi, maize, sorghum and groundnuts all being suitable.

In the Sungei Pila Area about 4,000 acres or 61% of the 6,500 acres surveyed are suitable for agricultural development. About 1,600 acres are covered by sedentary soils derived from shales and sandstone. These areas are suitable for perennial crops and rubber, pepper and fruit trees can be cultivated. Alluvial soils occupy about 2,400 acres and can be cultivated with padi, vegetables, maize, sorghum and groundnuts with adequate drainage.

ACKNOWLEDGEMENTS

The author wishes to record his grateful thanks to the Director of Agriculture, Sarawak for providing the finance for the survey; Encik I.M. Scott, Soil Surveyor, Sarawak for the assistance in arranging the details of the survey such as cutting rentises and also for the valuable discussions on the classification of Sarawak soils.

Grateful thanks also to Encik Mohamed Ali b. Othman, draughtsman, for the preparation of maps and figures; to Mrs. Betty Hew for typing the report, to Encik Yusof bin Bahali for the printing and binding of the report. Thanks also to the other soil surveyors Encik Chin Fatt, Encik K. Selvadurai and Encik S. Makeswaran for their constructive, critical comments of the draft report.

Special thanks also are due to the four Assistant Surveyors led ably by Encik Rosli Sahari, Encik Ismuni Hj. Omon, Encik Hilary Wan Laing and Encik Olak Jalamin for leading the rentis cutting teams and all the other assistance given to the survey team while in the field without whose help the survey would not have been completed.

REFERENCES

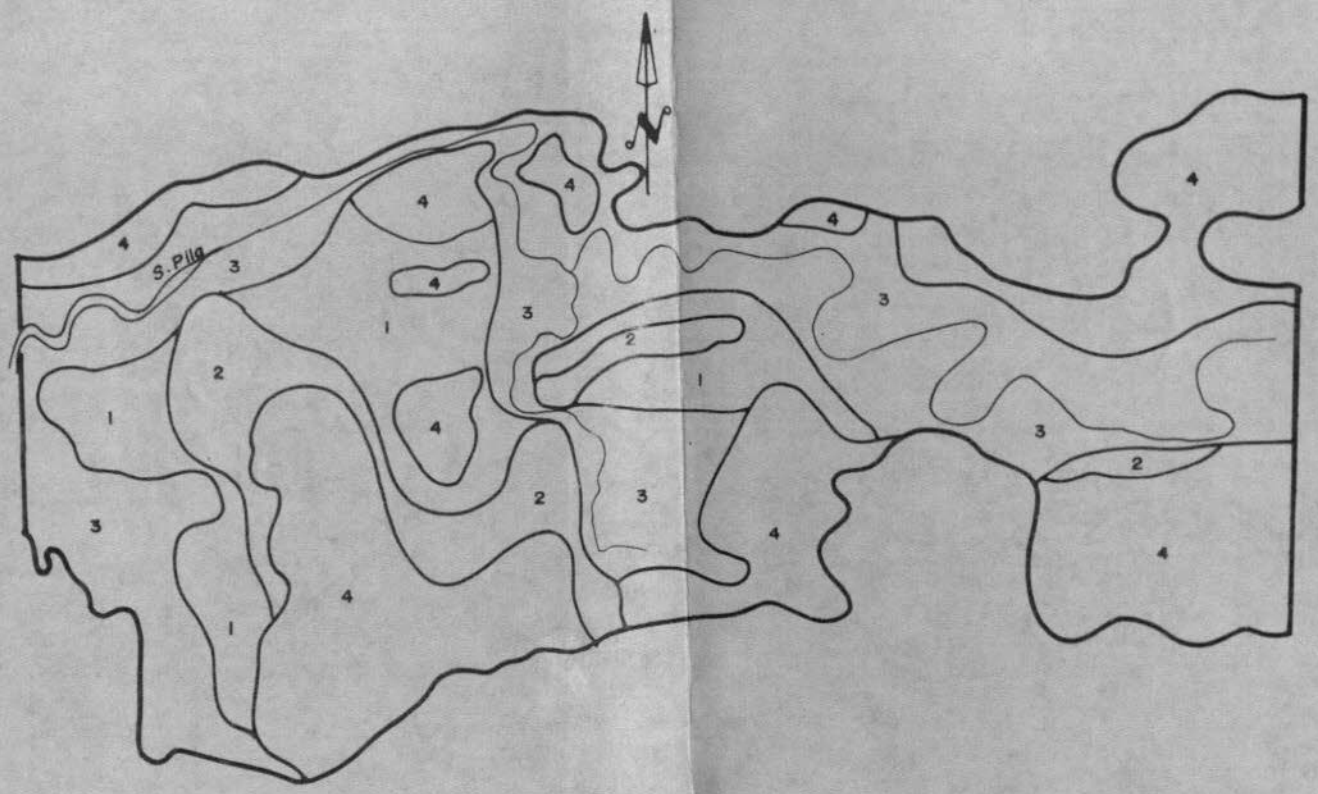
Soil Survey Staff, 1960 — Soil Classification. A Comprehensive System. The 7th Approximation. Soil Conservation Service, U.S.D.A.

Kirk, H.J.C., 1957 — The Geology and Mineral Resources of the Upper Rajang and Adjacent Areas, Sarawak. Brit. Borneo Geol. Survey Mem. 8. Govt. Printing Office, Kuching, Sarawak.

Scott, I.M., 1973 — A Draft Reclassification of Soils in Central and North Sarawak 2nd Edition. Tech. Paper No. 3 Res. Branch, Dept. of Agriculture, Sarawak.

SOIL SUITABILITY MAP
OF
SUNGAI PILA AREA

Scale 1 50,000

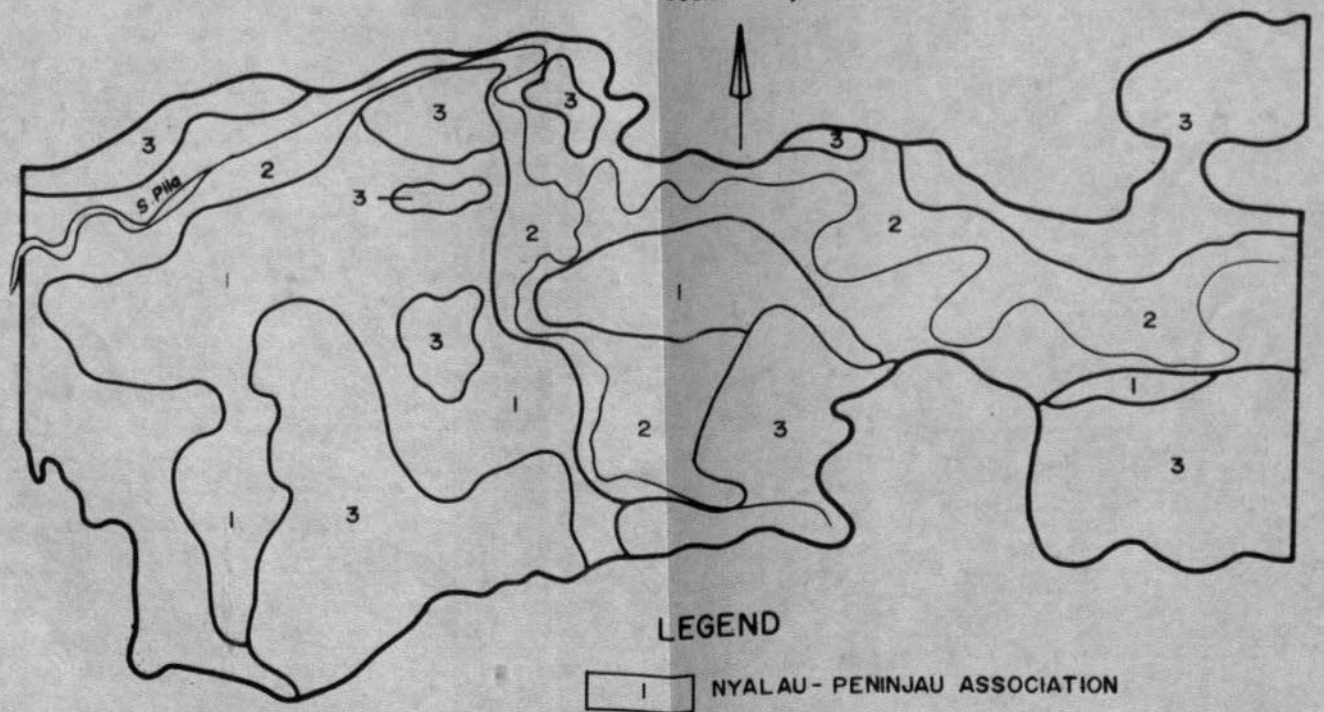


NO.	ACREAGE	DURIAN MANGO JACKFRUIT	COCONUT	OIL PALM	COCOA RAMBUTAN	RUBBER NUTMEG	BANANA	COFFEE	TEA	CLOVE	PAPAYA	TOBACO	CITRUS	GINGER	SUGAR CANE	TOPIOCA MAIZE	SORGHUM	PEPPER	GROUND NUT	VEGETABLE SWEET POTATO	PADI (WET)	FODDER	PASTURE
1	991	S	S	S	S	S	S	M	M	S	M	U	S	M	M	M	M	S	M	U	U	S	M
2	601	S	M	M	M	S	M	U	U	S	U	U	M	U	U	U	U	M	U	U	U	M	U
3	2,364	M	M	S	M	M	M	M	M	M	M	S	M	S	S	S	S	S	S	S	S	S	S
4	2,535	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

SUNGAI PILA AREA

SOIL MAP

Scale 1:50,000

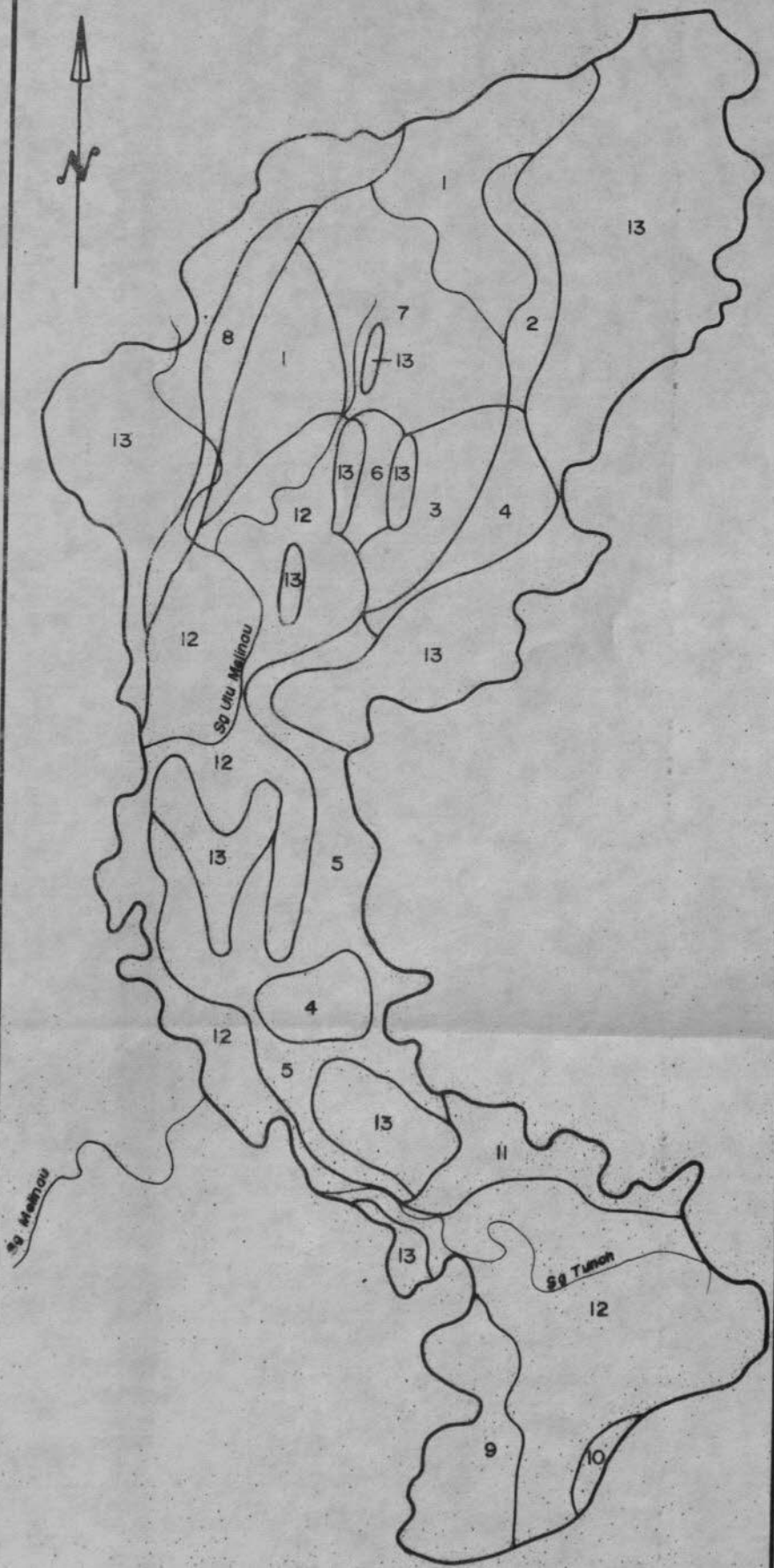


LEGEND

1	NYALAU - PENINJAU ASSOCIATION
2	SEMILAJAU - BIJAI ASSOCIATION
3	STEEPLAND

SOIL SUITABILITY MAP OF SUNGAI TUNOH AREA

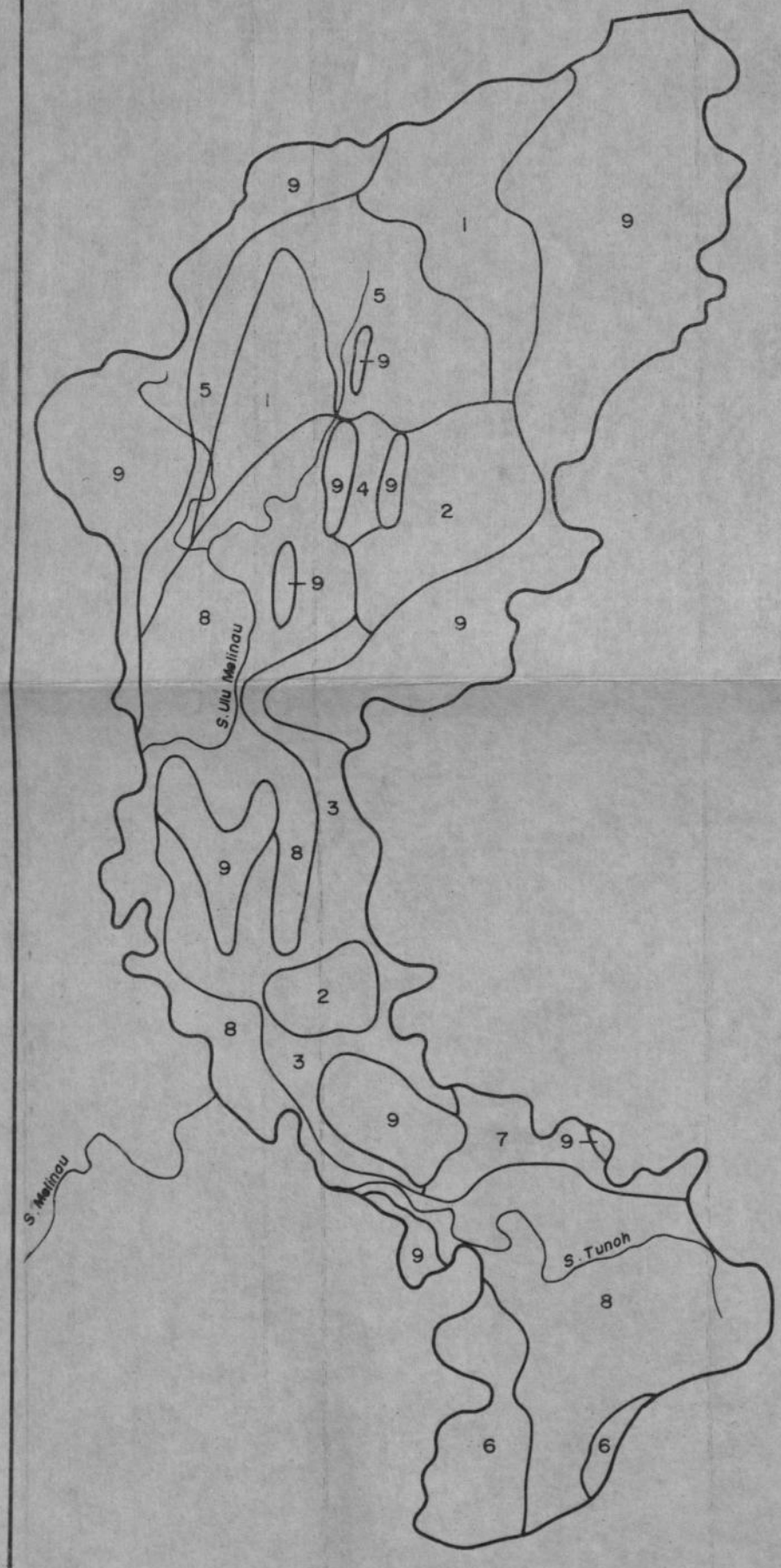
Scale 1 : 50,000



NO.	ACREAGE	DURIAN	MANGO	JACKFRUIT	COCONUT	OIL PALM	COCOA	RAMBUTAN	RUBBER	NUTMEG	BANANA	COFFEE	TEA	CLOVE	PAPAYA	TOBACCO	CITRUS	GINGER	SUGAR CANE	TAPIOCA	MAIZE	SORGHUM	PEPPER	GROUND NUT	VEGETABLE SWEET POTATO	PADI(WET)	FODDER	PASTURE
1	625	S	M	M	S	S	S	S	S	S	S	S	S	S	S	M	S	M	M	M	M	M	S	M	M	M	M	M
2	11	M	C	C	M	M	M	M	M	M	S	S	N	S	M	C	M	C	M	C	C	C	C	C	C	C	C	C
3	195	S	M	M	S	S	S	S	S	S	S	S	M	M	C	C	M	C	M	C	C	C	C	C	C	C	C	C
4	267	M	C	C	M	M	M	M	S	S	S	S	C	C	C	C	M	C	M	C	C	C	M	C	C	C	C	C
5	625	S	M	M	M	M	M	M	M	M	M	M	C	C	S	C	M	C	M	C	C	C	M	C	C	C	C	C
6	68	C	C	C	C	C	C	C	C	M	C	C	C	C	M	C	C	C	C	C	C	C	C	C	C	C	C	C
7	418	S	M	M	S	S	S	S	S	S	S	S	M	S	S	C	S	C	M	C	C	C	S	C	C	C	C	C
8	195	M	C	C	M	M	M	M	S	S	C	C	C	C	S	C	M	C	M	C	M	M	S	M	M	M	M	M
9	275	S	M	M	S	S	S	S	S	S	M	M	M	M	S	M	S	M	M	M	M	M	S	M	M	M	M	M
10	36	S	C	C	M	M	M	M	S	S	C	C	C	C	S	C	M	C	M	C	C	C	S	C	C	C	C	C
11	159	S	C	C	C	C	C	C	S	S	C	C	C	C	S	C	M	C	M	C	C	C	S	C	C	C	C	C
12	1,982	M	M	M	C	C	C	C	M	M	C	C	C	C	S	C	M	C	M	C	C	C	M	C	C	C	C	C
13	2,444	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

SOIL MAP OF SUNGAI TUNOH AREA

Scale : 1 : 50,000



LEGEND

1	BEKENU SERIES
2	GUMBANG SERIES
3	NYALAU SERIES
4	KAPIT SERIES
5	BEKENU-GUMBANG ASSOCIATION
6	BEKENU-NYALAU ASSOCIATION
7	SERATOK-BEKENU ASSOCIATION
8	SEMILAJAU-BIJAI ASSOCIATION
9	STEEPLAND