Report No. 156

Report on a Detailed-Reconnaissance Soil Survey

of the

MUKAH - PENIPAH AREA

3rd. Division

by

Tan In Kok
(Soil Surveyor)

February, 1972.

Soil Survey Division
Research Branch

Dept. of Agriculture
Sarawak

HUNTING TECHNICAL SERVICES

Report on a Detailed-Reconnaissance Soil Survey
of the
Mukah - Penipah Area
Third Division

by

I.K. Tan

Contents

Mukah-Penipah Area

1. INTRODUCTION

Soil survey at a detailed reconnaissance level in the Mukah-Penipah area, Third Division, was carried out as a continuation of work in connection with proposed block planting of coconut in this part of the coast and to update the information available in terms of the soil classification at present in use. Previous work in this project has already been reported (Scott, 1970). The present report extends the coverage by approximately 19,800 acres. The area is located in Fig. I.

2. METHOD OF SURVEY

For the purposes of the soil survey, a 1:10,000 scale mosaic was prepared (by Land & Survey Department Headquarters) from sortie 2/69 of May, 1969 air photography and used as a base map.

Rentis lines were cut at intervals of either 32 or 48 tapes (one tape = 25 metres) and the soil was sampled and recorded at 50 metres intervals along each rentis. Mineral soils and shallow peats were sampled with a 48 inches auger, in deep peats a notched sapling pole was used as a probe. The soil information was plotted on a base map prepared from mosaic as field mapping. This detailed information is then used for mapping soil boundaries during a final air photograph analysis; interpretation being aided in some areas by the vegetation pattern. The final soil maps included with this report were based on reduction of details plotted on the original mosaic. Land use and potential maps were also compiled at the same scale as the soil maps for comparative purposes.

There was slight scale distortion due to lack of ground control and orientation to north is approximate only.

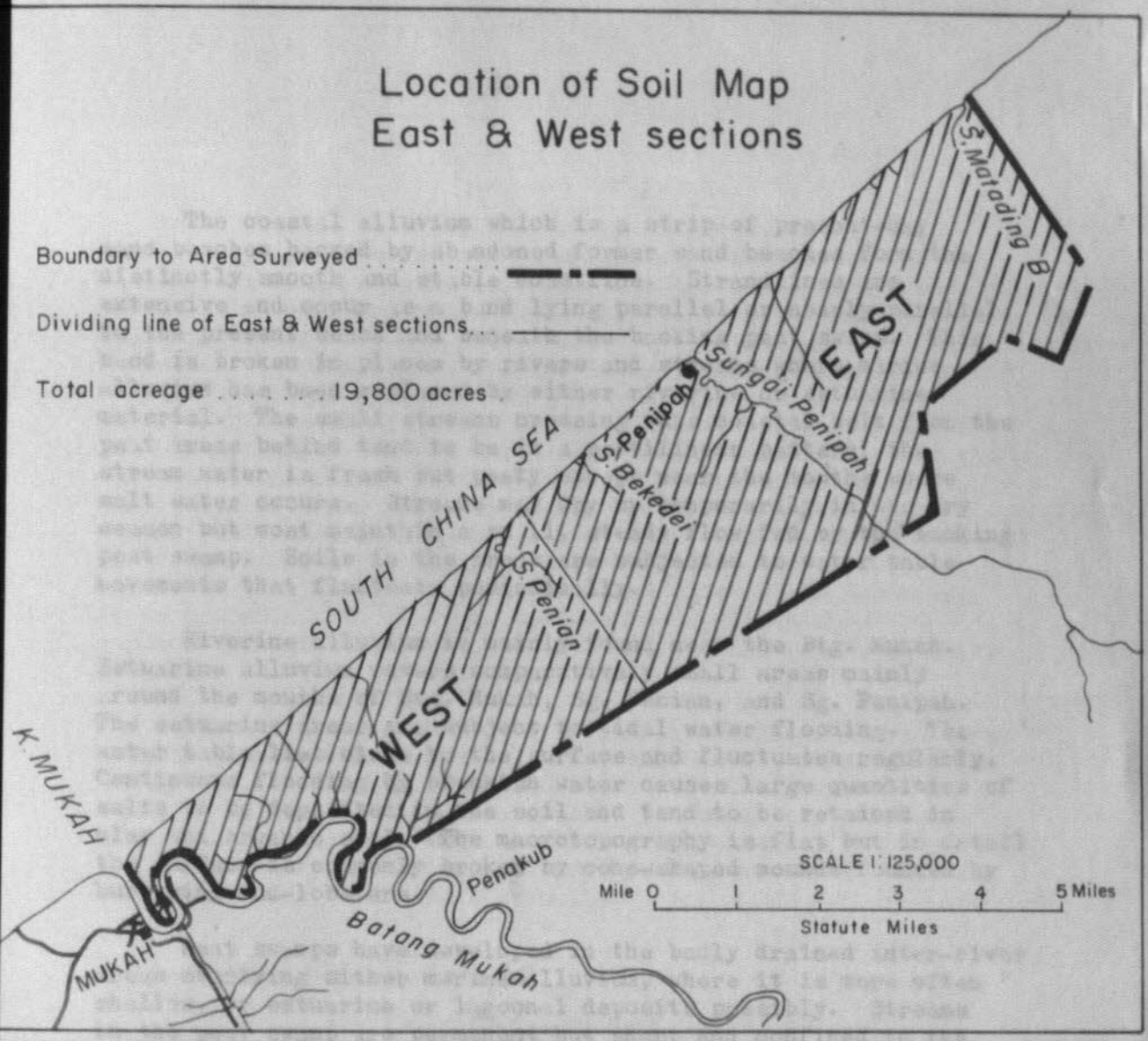
The soil surveys were undertaken from October to November 1971. Four assistants, Rosli bin Sahari, Bangchek bin Bero, Ismuni bin Haji Omon and one mando, Timothy Kinok, capable of leading a rentis cutting party and describing the main soil features, assisted the writer during the survey. The writer left the party during the later stages of the survey.

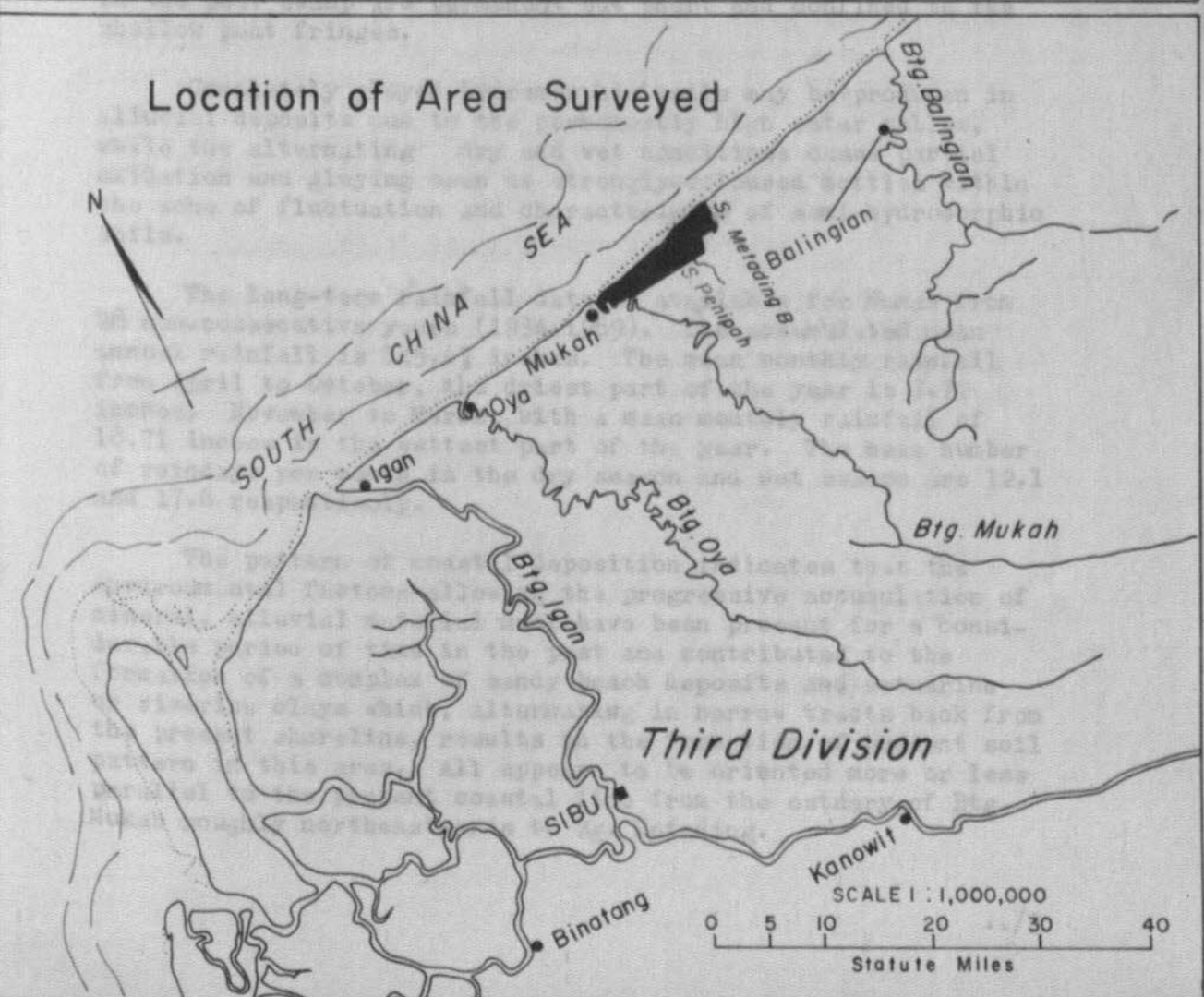
3. SOILS

3a. General

The whole survey area is covered by unconsolidated Quaternary deposits consisting of either alluvium or peat. The alluvium is of three types; coastal (marine), riverine and estuarine.

../2


Location of Soil Map
East & West sections
Boundary to Area Surveyed
Dividing line of East & West sections
Total acreage ..... 19,800 acres
EAST
WEST
S. Matading B
Sungai Penipah
S. Penipah
S. Bekedei
S. Penian
SOUTH CHINA SEA
K. MUKAH
MUKAH
Penakub
Batang Mukah
SCALE 1:125,000
Mile 0 1 2 3 4 5 Miles
Statute Miles


Location of Area Surveyed
N
SOUTH CHINA SEA
Btg. Balingian
Balingian
S. Matading B
S. penipah
Mukah
Oya
Igan
Btg. Oya
Btg. Mukah
Btg. Igan
Third Division
SIBU
Kanowit
Binatang
SCALE 1 : 1,000,000
0 5 10 20 30 40
Statute Miles

The coastal alluvium which is a strip of present-day sand beaches backed by abandoned former sand beaches form the distinctly smooth and stable coastline. Strandlines are extensive and occur as a band lying parallel or nearly parallel to the present beach and beneath the backing peat swamp. This band is broken in places by rivers and streams where marine alluvium has been replaced by either riverine or estuarine material. The small streams crossing this coastal belt from the peat areas behind tend to be in a rectilinear pattern, the stream water is fresh but peaty except near the mouths where salt water occurs. Streams may dry up temporarily in the dry season but most maintain a small, steady flow fed by the backing peat swamp. Soils in the areas are subjected to water table movements that fluctuate periodically.

Riverine alluvium is mainly found near the Btg. Mukah. Estuarine alluvium covers comparatively small areas mainly around the mouths of Btg. Mukah, Sg. Penian, and Sg. Penipah. The estuarine areas are subject to tidal water flooding. The water table lies close to the surface and fluctuates regularly. Continuous flooding by brackish water causes large quantities of salts to be deposited in the soil and tend to be retained in clay and organic soil. The macrotopography is flat but in detail the surface is commonly broken by cone-shaped mounds founded by burrowing mud-lobsters.

Peat swamps have developed in the badly drained inter-river areas overlying either marine alluvium, where it is more often shallow, or estuarine or lagoonal deposits possibly. Streams in the peat swamp are permanent but short and confined to the shallow peat fringes.

Completely gleyed hydromorphic soils may be produced in alluvial deposits due to the permanently high water tables, while the alternating dry and wet conditions cause partial oxidation and gleying seen as strongly-coloured mottles within the zone of fluctuation and characteristic of semi-hydromorphic soils.

The long-term rainfall data is available for Mukah from 28 non-consecutive years (1934-1969). The accumulated mean annual rainfall is 145.67 inches. The mean monthly rainfall from April to October, the driest part of the year is 7.72 inches. November to March, with a mean monthly rainfall of 18.71 inches is the wettest part of the year. The mean number of raindays per month in the dry season and wet season are 12.1 and 17.6 respectively.

The pattern of coastal deposition indicates that the environmental factors allowing the progressive accumulation of mineral, alluvial material must have been present for a considerable period of time in the past and contributed to the formation of a complex of sandy beach deposits and estuarine or riverine clays which, alternating in narrow tracts back from the present shoreline, results in the formation of present soil pattern in this area. All appear to be oriented more or less parallel to the present coastal line from the estuary of Btg. Mukah roughly northeastwards to Sg. Metading.

../3

The area is entirely mantled by either marine alluvium on the coast or riverine and estuarine alluvium around the streams. No residual soil is present in the area. Away from the coast mineral soils are overlain by a progressively deepening layer of peat. Peat formed by the freshwater swamp forest has accumulated to produce large basin peat swamps in which the peat is more than 40 inches in thickness. The underlying mineral alluvium, however, appears to continue the pattern of parallel rises and swales found nearer the coast and shows some microrelief, but this has been almost entirely mantled by peat and there is no apparent surface relief and significant landform features in the area. This is evidenced by the pattern of the irregular depth of peat and shallow mantle of peat spread seawards over the older beach deposits. It is probable that the peat surface has a slight downward gradient towards the coast, but it is too slight to be detected visually.

With the exception of the present beach and a narrow strip of land immediately behind it, all the soils are poorly-drained. During the wet season, water is removed so slowly even on the coast sandy soils that the watertable is commonly at or near the surface for a large part of the time. The external soil drainage is so slow that ponding normally occurs in depression sites and water table may fluctuate seasonally.

3.b. Soil Mapping Units

The soils are classified according to the current classification system (Soil Survey Staff, 1966, revised Scott, 1967, Appendix I). The soils occurring in the area are positioned within this system in Table 1. The majority of the soils can only be mapped in compound units of two or more families. In the following paragraphs the characteristics of each family and its agricultural significance are summarised.

3.b.1. Rajang-Pendam Association (900 acres)

Rajang Family is mapped in association with Pendam Family. This association occurs extensively near the river bank at the mouth of Btg. Mukah. Rajang Family soils also occur along the river bank of Sg. Penipah. The natural vegetation associated with these soils is nipah palm and mangroves.

Great soil group	Origin of parent material	Soil family	Texture	Surface peat	Mineral Soil (Sample descriptions)
Podzols	Alluvial sands	Buso	light-textured	Absent	Very dark gley(10YR3/1) loamy sand to pale brown (10YR6/3) or light grey (10YR 7/1) medium sand, overlying dark yellowish brown (10YR 3/4) soft humus pan. Moderately well to poorly-drained.
Gley soils	Riverine clays	Bijat	heavy-textured	Absent	Grey (5Y 5/1) to light grey (10YR 7/2) mottled clay. Poorly-drained.
		Sebandi		peat less than 10" thick	
	Marine sands	Tatau	light-textured	Absent	Grey(10YR 5/1) to very pale brown (10YR 7/3) medium to fine sands. Imp. to poorly-drained.
		Matu		peat less than 10" thick	Greyish brown(10YR 5/2) to light grey (10YR 7/1) sands. Poorly-drained.
Saline Gley soils	Estuarine clays	Rajang	heavy-textured	Absent	Dark grey (10YR 4/1) to grey (10YR 5/1) clay or silty clay, strongly saline, smell of sulphur. Poorly-drained.
		Pendam		Absent	Same as above but no smell of sulphur and weakly saline.
		Jol		peat less than 10" thick	
Peat soils	Shallow peat on mineral subsoil	Mukah	Mineral subsoil heavy-tex.	peat 10-40" thick	Grey(5Y5/1) to light grey (10YR7/2) mottled clay. Poorly-drained.
		Igan	Mineral subsoil light-tex.		Grey(10YR5/1) to pale brown(10YR6/3)medium to fine sand.Poorly-drained.
	Deep peat on mineral subsoil	Anderson 1	Mineral subsoil heavy- or light textured	peat 40-80" thick	Strongly gleyed sands or clays.
		Anderson 2		80-120" thick	
		Anderson 3		more than 120" thick	
Recent Alluvial soils	Marine sands	Kabong	light-textured	Absent	Very pale brown (10YR7/3) or pale brown to brownish yellow (10YR 6/8) well-drained to imperfectly drained. Medium to fine sand.

Table 1 : Classification of soils.

../5

(i) Rajang Family Soils

Rajang soils are characterised by a greyish, strongly saline, sticky clays with distinct sulphurous smell. The ground surface is broken by large mounds produced by burrowing mud-lobsters and locally containing moderate amounts of organic debris. Soil drainage is very slow externally and poor or very poor internally; permeability is thought to be low. The soils may lead to 'catclay' which is toxic to most plants on drying out. Rajang soils are affected by flooding of varying degrees of salinity and cannot be used for cultivation in their existing condition. To reclaim Rajang soils, it would be necessary to leach the excess salts from the soil and at the same time avoid forming 'catclay' or acid sulphate soils. Drainage and lowering of the water table is likely to oxidise the sulphide into sulphate, this would create extreme acidic conditions, with pH about 2.5. Reclamation of Rajang soils would be expensive and is probably uneconomic. In the area surveyed, these soils are of restricted extent and if drainage improvement of adjacent soils is planned, these soils can be incorporated in the improvement area. Rajang soils are not recommended for agriculture in our present state of knowledge regarding their problems.

(ii) Pendam Family Soils

Pendam soils are found associated with similar but younger soils of Rajang Family but are less saline and normally associated with nipah palm. Pendam soils comprise poorly-drained, grey to dark grey, sticky and plastic clays of estuarine origin which are weakly to moderately saline. Roots are concentrated mainly in A1 horizon but some fine roots are capable of penetrating the gleyed horizon. External drainage is very slow, while internal drainage is poor. Pendam soils are transitional in character between soils of the Rajang Family and the Bijat Family.

The Pendam soils are clayey, and by Sarawak standards are fertile, but flooding is an unavoidable risk. Where drainage improvement and salt leaching are possible the soils should be suitable for a wide variety of crops such as coconut, oil palm and citrus. Wet rice cultivation requires the least improvements to the soil and most strains of wet rice are slightly salt-tolerant.

3.b.2. Jol Association (50 acres)

Jol soils have the simil r characteristics of Pendam Family soils except that up to 10 inches of surface peat is present. The soil boundary on the map is largely based on the limits of the nipah palm in the vegetation cover. The soils are in complex association with Mukah Family soils and are believed to have the same agricultural value as Pendam soils.

../6

3.b.3. Bijat-Sebandi Association (450 acres)

The Bijat Family is mapped in association with the Sebandi Family. This association occurs near Btg. Mukah, and extends inland along the banks of Sg. Penipah. Bijat soils are poorly-drained gleyed clays developed in recent riverine clayey alluvium. External drainage is slow due to the low gradient while internal drainage is poor. Sebandi soils are similar to those of Bijat Family soils, except that a surface peat of less than 10 inches in thickness is present. These associations are non-saline and their use is limited mainly by the drainage condition. They are suitable for wet padi, fruit trees and vegetables once provided with drainage improvement and control.

3.b.4. Tatau-Matu Association (1,850 acres)

The Tatau-Matu association comprises soils developed in beach sands without significant surface peat deposits. This association forms a continuous band along the coastal line from Batang Mukah to Sg. Petangan and is virtually absent between Sg. Petangan and Sg. Penian. From Sg. Penian northeastwards it appears again. This association is also found in a long strip near Sg. Kalawap and Sg. Wak. Elsewhere their occurrence is more intermittent or patchily present.

The Tatau-Matu Association is dominantly a consociation of Tatau-Matu Family soils which are locally replaced by soils of the adjacent Kabong or Buso Family soils. On the present beach Tatau soils generally grade into well-drained pale brown to brownish yellow sands of the Kabong Family which, if present, occupies a band too narrow to be mapped and has been included in this association. Also included are some soils containing humus accumulation at some level in the profile which are transitional to Buso soils.

Tatau Family soils are poorly-drained, grey to very pale brown sands in colour. Profile characteristics vary; the subsoil colour may be yellowish-brown near the surface, grading to grey at depth, pale brown to greyish-brown throughout with scattered gley mottles, or light grey, unmottled. Where evidence of gleying cannot be seen, the soil is classified on the basis of its site and the level of the ground water which is normally within 20 inches of the surface. Tatau soils commonly bear a cover of low grasses and sedges immediately behind the present beach or a cover of swamp forest with scattered nibong.

The Tatau soils grade inland into more poorly-drained soils on which a peat or muck cover of less than 10 inches in thickness has developed, where the water table is permanently at or near the surface. These soils are classified in the Matu Family which comprises very poorly-drained, grey sands. Matu Family soils are transitional between Tatau soils and Igan soils. Matu soils occupy depression sites and Tatau soils undulations with slightly better drainage conditions. They commonly occur in complex association. It is suspected that during wet weather soils of Tatau-Matu Association become waterlogged readily, due to the slow external drainage, and that in dry weather they may be excessively drained and contain insufficient moisture for some crops.

../7

With appropriate, regular manuring and improved drainage they can probably be used for cultivation. The top soil of the association is the richest part of the profile, the fertility of the soils, however, are inferior to the other gley soils basically because of the high ratio of sterile quartz to the exchange complex. Because of the poor organic status of the subsoil the applications of fertilizers will be essential for optimum yields and applications should be on the basis of little and often, rather than infrequently as heavy doses. If they can be lightly drained, however, they can be planted with vegetables, maize and shallow-rooted crops such as chilli, groundnut, water-melons, banana and pineapple. These soils are commonly used for coconut in their present state but are only recommended for this crop if the drainage condition can be regulated and improved in order that the water table can be maintained at 2-3 feet when the palm is young and lowered progressively to 5-8 feet as the palm grows.

Kabong soils are recently deposited beach sands found along the present coast. This soil is quartzose, highly permeable and structureless. The Kabong soil profile is normally a pale brown to yellowish brown medium sands, and are mainly distinguished from soils of the Tatau Family by the absence of a high ground water table and lack of gley features within at least 24 inches of the surface. The paler Kabong soils are generally found on the present beaches and small outliers of these soils which occur inland from the beach are generally more yellow in colour and associated with low rises. It will be difficult to efficiently fertilize because of the extremely low exchange capacity but organic matter can be used to improve the exchange status. At present, they can be recommended for coconut. With adequate fertilizers, however, it may be possible to grow a greater variety of crops.

3,b.5. <u>Buso Association</u> (3,350 acres)

The Buso Family has a predominantly coastal distribution and occupies old strandlines, associated are small areas of recent alluvial, gley, peat, and saline gley soils. This association occurs in the area adjacent to the Tatau-Matu Association forming a wider belt parallel to the coast. From Sg. Jabongan along the coast to Sg. Penian, Tatau-Matu soils are replaced by soils of Buso Family. At Sg. Penian and Sg. Penipah Buso soils have developed farther inland, and is found in complex association with Tatau-Matu soils. The Buso profile is normally a pale brown to light grey sand overlying a dark brown sand, the dark brown horizon resting in turn on yellow to pale olive sands. The soils are loose and structureless, but the dark brown sands show weak cementation by humus in B-horizon which is called a soft humus pan. External drainage of Buso soil is very slow; internally the soil is excessively to very poorly drained; water table varied at the depth of 16 inches to 38 inches from the surface at the time of survey and commonly coincided with that of the B-horizon.

../8

The Podzol soil group is nutritionally the least fertile in the Sarawak and Buso soils belong to this great soil group. In addition, their drainage properties are unfavourable for crop growth as in most places they readily become waterlogged after rain because of the flat topography and the perched water table within the profile caused by humus pan in the subsoil, but excessively drained during the dry period. Because of the extremes of internal drainage, added fertilizers leach easily in the Buso soils due to their extremely low cation exchange capacity. Clayey soil or organic matter, however, can be added to improve the exchange status. If chemical fertilizers are used, they should be added frequently in small doses. This, together with the lowering of the ground water table where necessary, may be possible to cultivate vegetables and fruit trees.

It may be noted that Buso soils in this part of the coast are weakly developed, barely qualify in characteristics for classification as Podzols, and in many cases are transitioned to Tatau soils. The agricultural potential may be somewhat greater than is at present assumed. In order, however, not to encourage development which is later found to be beyond the capacity of the soil, Buso soils in this area are not presently recommended for cropping where alternative soils are available.

3.b.6. Igan Association (4,100 acres)

Igan Family soils comprise surface peat or muck exceeding 10 inches but less than 40 inches in thickness overlying pale brown to grey sands. The sandy substratum of Igan soils belong to old beach deposits.

Igan soils are very extensive in these areas forming a fairly broad belt between Buso Association and the Anderson Association. It bears a cover of peat swamp forest and secondary growth as well. The water table is always at or close to the surface.

The fertility of the sands is believed to be low and similar to that of Tatau Family, and only the peat is capable of storing added nutrients. The better drained shallow peat of Igan soils can be used to grow vegetables and fruit trees. Igan soils are only marginally suitable for coconut palms and drainage improvement to lower the water level by 3-4 feet is required to allow for shrinkage of the surface peat. Und: ined Igan soils, however, are known to support sago palm satisfactorily.

3.b.7. Mukah Association (250 acres)

Mukah Family soils comprise heavily gleyed sticky clays overlain by 10-40 inches of peat or muck and with permanently high water table. Mukah Family soils are less extensive, being largely confined to area near the mouth of Batang Mukah. Its clay minerals are higher in nutrients than Igan Family quartz sands and have a higher capacity to absorb and retain exchangeable nutrients. They also have higher agricultural potential after drainage improvement. Lightly drained Mukah soils are suitable for wet rice. Roots are generally confined to the upper-

../9

most 18 inches and cannot tap the mineral reserves of the underlying clays more than 20 inches depth. Fertilizer is required to increase the yields. More intensively drained shallow peat of Mukah soil are suitable for coconuts, oil palms and vegetables. Mukah soils, however, are susceptible to deep flooding.

3.b.8. Anderson Association (8,850 acres)

Soils of the Anderson Family consist of deep, waterlogged, raw woody peat or muck. All peats deeper than 40 inches are classed in the Anderson Family, Anderson 1 being 40-80 inches of peat, Anderson 2 comprising 80-120 inches of peat and Anderson 3 covering all peats deeper than 120 inches. The texture of the underlying mineral material is not considered in classifying these deep peats. The approximate pattern of sand deposits under the peat mantle has been shown on the soil map. The Anderson Family soils are under the cover of peat swamp forest with a considerable proportion of 'Asam Paya' plants in many localities. There is a general tendency for the peats to become deeper inland.

Anderson Family peats are less fertile than most shallow peats. Burning these deep peats periodically may be a practicable aid to improve the low fertility. The suitability of these soils for cultivation depends largely on the practicability of drainage improvement. This is likely to be possible on Anderson 1 soils. Experimental work regarding the use of deep peats with shallow drainage is at present in progress and may extend the possibilities of use for these widespread soils.

4. VEGETATION AND LAND USE

Along the coast, most of the land is under low regrowth which is not more than 4 feet high, grasses such as Chrysopogon aciculatus, Echinochlor colona, and Eragrostis unioloides; are dominant in this area, sedges such as Fimbristylis accuminata, F. pauciflora and F. miliacea are abundant. Melastoma malabathricum are the common shrubs found scattered around the area. Near the coast part of the land with low regrowth has been used for coconut and cattle grazing but the grass is of such poor quality and so unpalatable that some undernourished cattle which roam along the beach are fed with sago trunk. Wet padi cultivation is mainly carried out on the Mukah soils near Btg. Mukah. In the estuarine area which is subjected to tidal flooding, the dominant vegetation is nipah palm and mangroves. Along the bank of Sg. Penian and of Sg. Penipah nipah swamp also occurs; these areas are indicative of saline conditions and of little agricultural importance at present. Most of the riverine soils are occupied by sago palms mixed with regrowth of varied ages and spread over the peat soils. Sago palms seem to grow well on the shallow peat under natural conditions. Forest has been cleared for agriculture mainly either around or along the major streams; some land which has been cleared for agriculture in the past, presumably for padi, is now under secondary growth of tall grasses and sedges of varied age. Ferns are abundant in recently abandoned padi land and areas newly cleared by fire. A few small gardens make use of levee sites for growing vegetables. Buso soils used for growing tapioca and shallow peat used for maize are said to give good yields.

../10

The bulk of the area is covered by freshwater swamp forest. Much timber extraction has taken place in the past around the Sg. Penipah. A logging camp situated by the bank of Sg. Penipah has been built recently and a logging railway extends from there into the forest interior.

5. DEVELOPMENT POTENTIAL

The classification of development potential can be defined as the potential for speedy and economic development and is not the agricultural potential as such; it refers only to the alluvial and peat soils found along the coast or in association with major rivers, freshwater swamps or interior valleys. Soils on hill land are not considered.

Five classes are used and shown on the potential maps. Class DIIA mainly covers soil families such as Bijat, Sebandi, Mukah (10-20" peat over clay), Pendam and Jol; Class DIIB mainly covers Tatau-Matu and Igan (10-20" peat over sand); Class DIIIA mainly covers Mukah (20-40" peat over clay) and Anderson 1 (40-60" peat overlying clay); Class DIIIB mainly covers Igan (20-40" peat over sand) and Anderson 1 (40-60" peat overlying sand); Class DIV covers Anderson 1 (60-80" peat), Anderson 2 and 3; Class DIV covers Rajang only. The classification has been defined in detail elsewhere (Scott, 1967, Appendix II).

6. CONCLUSIONS

Land in this area in general is lowlying. Poor drainage condition is therefore the main limiting factor to cultivation particularly in the peat swamp area away from the coast.

Any large drainage scheme is most likely to be a method of efficient improvement, but certain consideration has to be given in the provision of drains, as such drains may be blocked by long shore drifting sand unless outlets to the coast could be made through natural streams. Drains may provide the inflow of water into the cultivated land, thus making the present drainage condition worse. It is essential to conduct detailed levelling/the tidal water flooding of the area where drainage improvement is needed.

The coastal strips of Tatau-Matu and Buso Association can be used after minor drainage improvement. Shallow phases of Igan and Mukah Family as well as deep peat in small area can be made quite productive with drainage improvement. Anderson and Rajang Family require major drainage improvement, such land in which large-scale improvement for agriculture would be extremely expensive, and is impracticable at present, unless a regional drainage improvement scheme can be provided or small area can be incorporated in the adjacent improvement scheme. The particular problems of potential acid sulphate soils formed from Rajang soils must also be overcome.

../11

The peat is of low fertility as well as very acid and the underlying sand is poorer in storing nutrients than clay. Fertilizer dressing is most likely to be necessary for continued yields in this area particularly on the sandy soils of the Tatau-Matu and Buso Associations, because of the extremely low cation exchange capacity and the strongly leached conditions. Sandy soils, however, are likely to benefit from organic manures which can increase the absorption capacity and improve the exchange status.

It is recommended that soil of Tatau-Matu Association can be used for coconut growing and possibly extend to Buso soils; soil of Bijat-Sebandi and Mukah Associations are suitable for wet padi and the Igan soils for sago palm.

In planning development, however, it should be noted that the drainage requirements for coconut and wet padi are incompatible and it is unlikely that efficient drainage and irrigation for these crops can be effected in closely adjacent areas. In the present case, the emphasis is intended to be on coconut, for which the Bijat-Sebandi (and possibly Mukah) Association can be used once adequate drainage is provided.

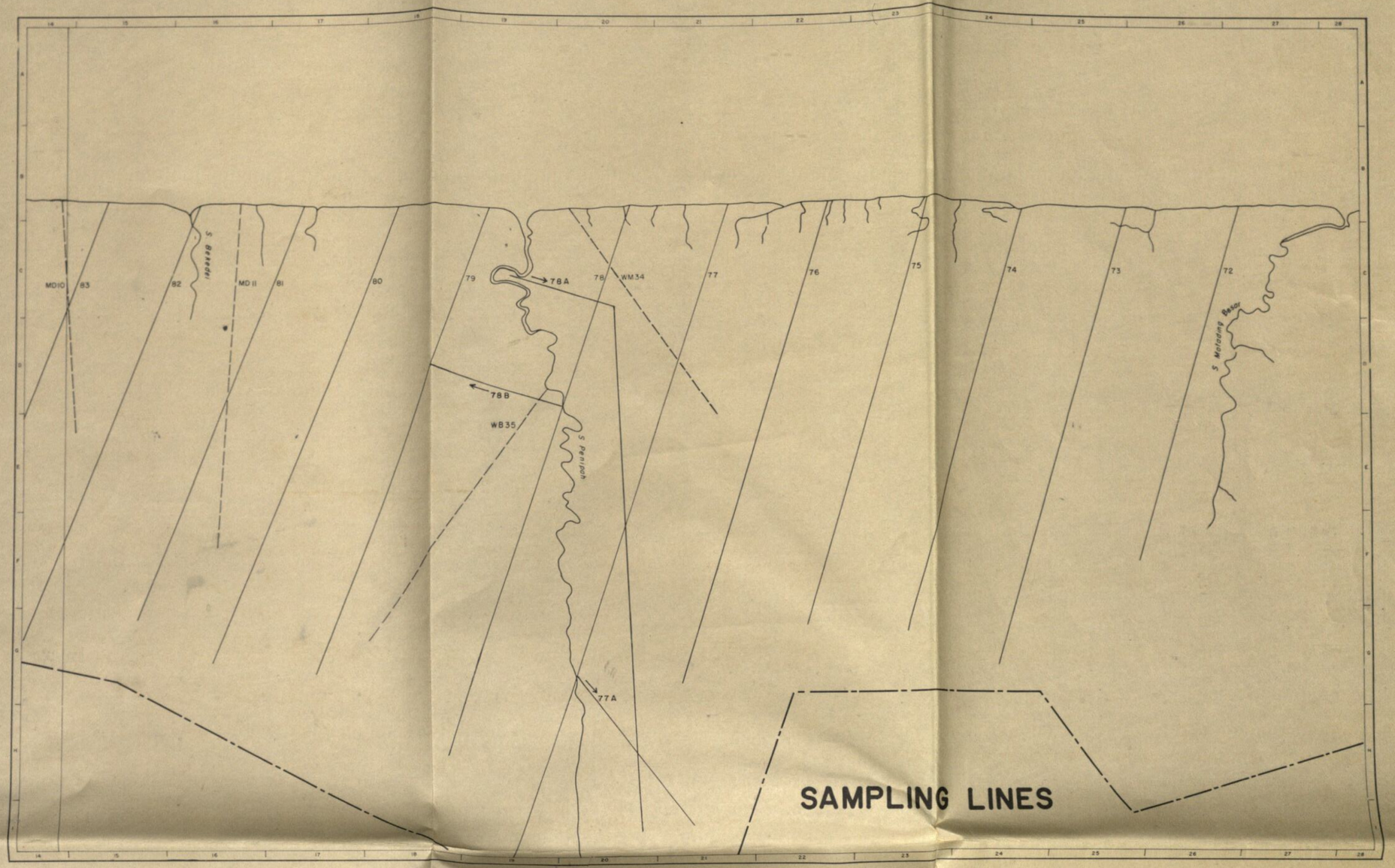
It is estimated that approximately 2,500 acres (mainly the Tatau-Matu and Bijat-Sebandi Associations) can be considered suitable for coconut with little drainage improvement and that with moderate drainage improvement the acreage can be extended to a total of approximately 4,700 acres, including the shallower phases of the Igan and Mukah soils and some other soils of more minor extent. Extension of planting beyond this figure would entail major drainage improvement which is unlikely to be practicable. It must be noted that this calculation does not take into account the acreage already under crop, which must be allowed for in estimating the potential for further development.

REFERENCES

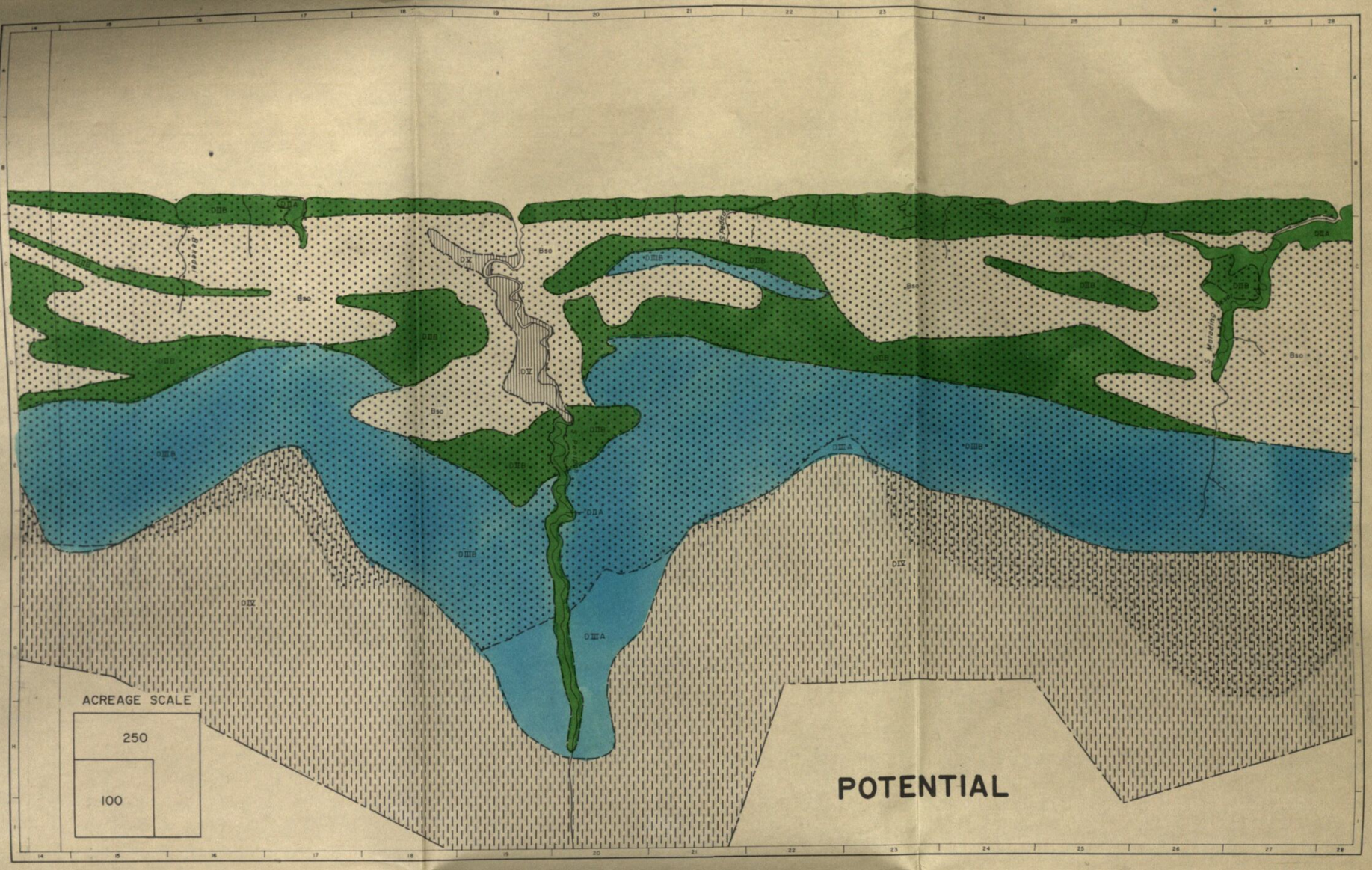
Scott, I.M.	1967	Report on a semi-detailed soil survey of the Tanjong Jol Area, Third Division. Report No. 113 in this series.
Scott, I.M.	1970	Report on a detailed-reconnaissance soil survey of the Metading-Balingian Sarupai Area, Third Division. Report No. 141 in this series.
Soil Survey Staff	1966	A classification of Sarawak Soils. Technical Paper No. 2. Department of Agriculture.

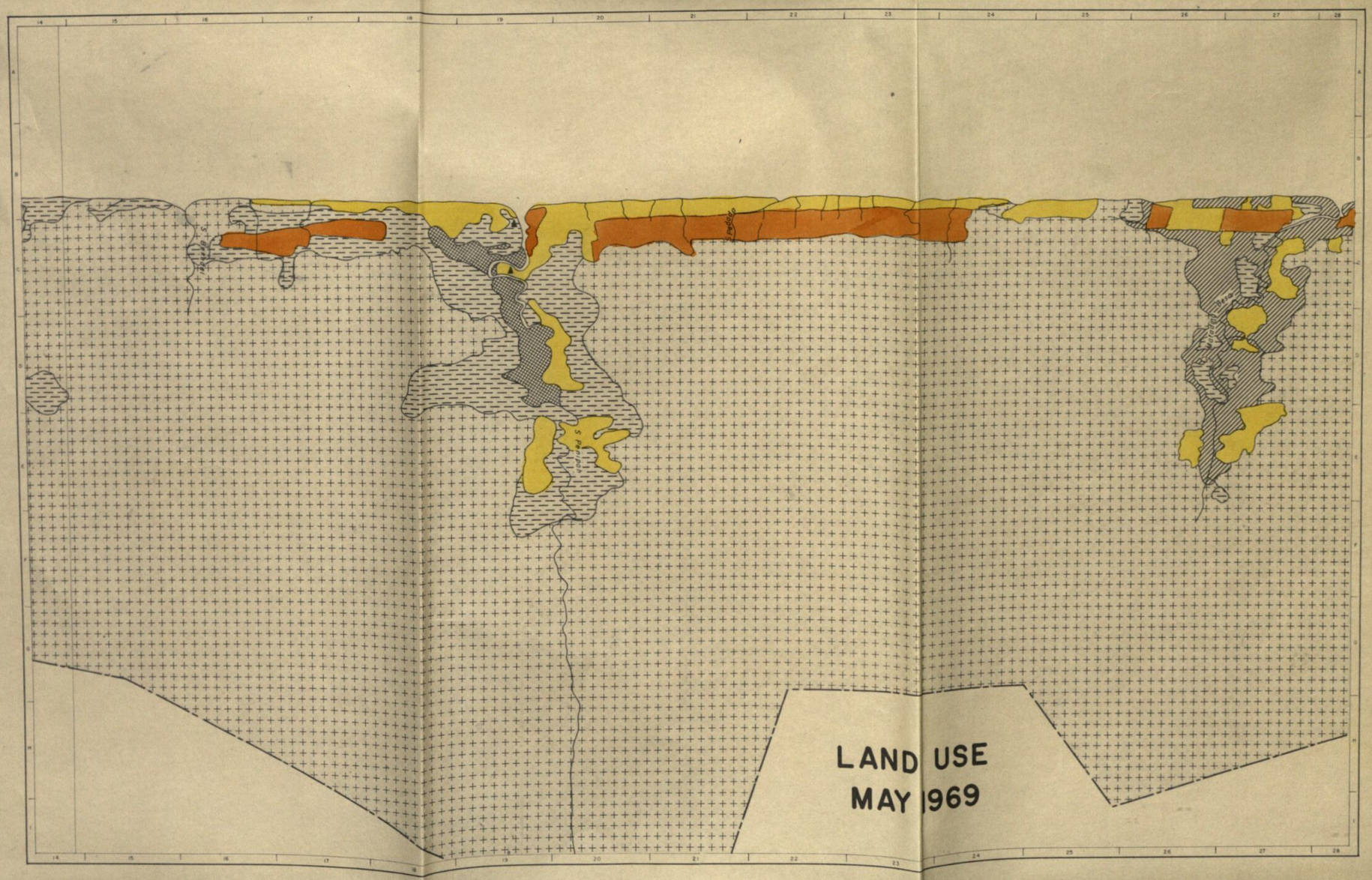
***

(East)

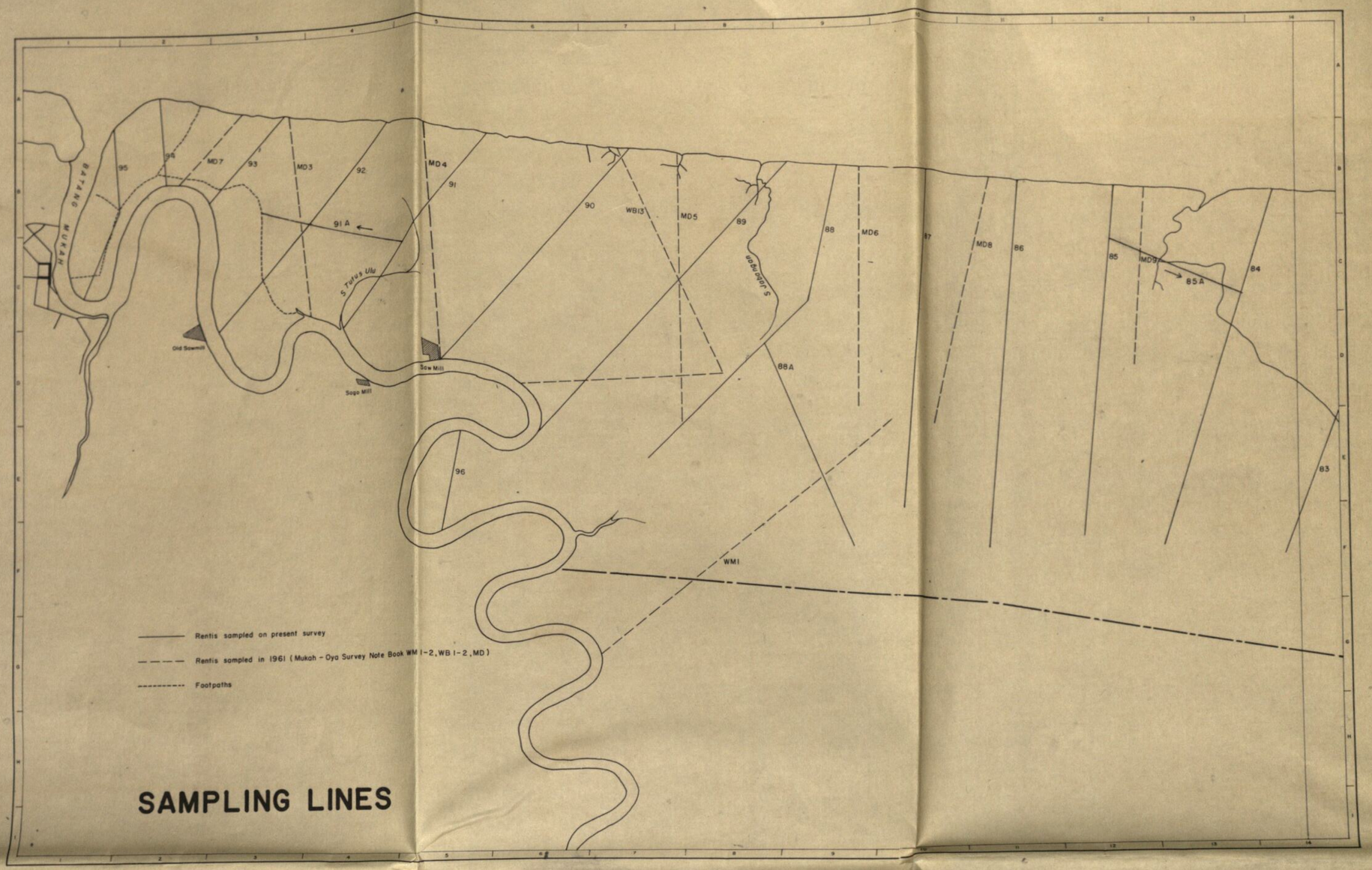

MD10
83
82
S Berendt
MD11
81
80
79
78A
78
WM34
77
76
75
74
73
72
S Melodeny Beach
78B
WB35
S Peniaph
77A
SAMPLING LINES


Tfa/Mfu
S Peniaph
A1
A2
A3
Bjt/Sbd
SOILS


ACREAGE SCALE
250
100
POTENTIAL


LAND USE
MAY 1969

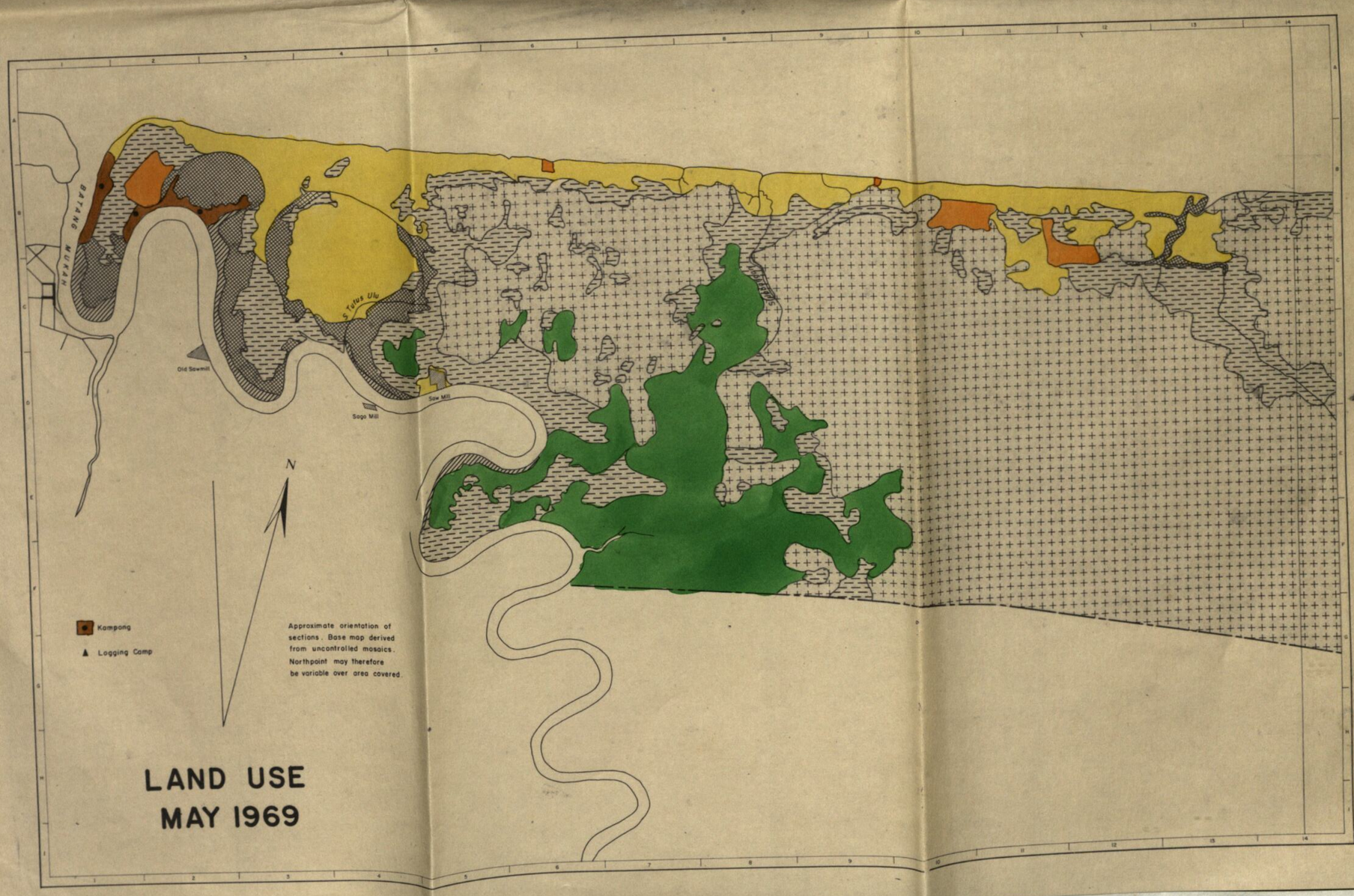
MUKAH – PENIPAH AREA (West)



SAMPLING LINES

SOILS

POTENTIAL



LAND USE
MAY 1969

MUKAH – PENIPAH AREA

KEYS

SOILS

MAPPING UNIT	SOIL FAMILIES	MAIN SOIL CHARACTERISTICS	ACREAGE
Tta / Mtu	Mainly Tatau and Matu. Some Kabong on present beach. Locally in complex association with Buso.	Imperfectly to poorly drained greyish brown to pale brown sands developed in marine alluvium. Well-drained to impertectly drained sands restricted to present beach and old beach ridges. Thin surface peat common in depression sites.	1,850
Bso	Mainly Buso with some Tatau and Matu. Locally in complex association with Igan; also Mukah in some depression sites.	Moderately well-drained to poorly-drained grey to pale brown sands with dark brown soft humus pan developed in old beach alluvial sands.	3,350
Rjn / Pnd	Mainly Rajang and Pendam.	Weakly to strongly saline poorly-drained grey clay soils developed in estuarine alluvium.	900
Jol	Mainly Jol with some Mukah	Weakly saline poorly-drained grey clay soils with thin surface peat developed in estuarine alluvium	50
Bjt / Sbd	Mainly Bijat and Sebandi with some Mukah.	Poorly-drained mottled grey clay developed in riverine alluvium. Thin surface peat horizons common.	450
Mkh	Mainly Mukah with some Jol and Sebandi.	Shallow peat soils generally 10 – 40 inches thick, normally underlain by clays, poorly drained.	250
Ign	*Mainly Igan with some Anderson 1. Locally* in complex association with Mukah.	Shallow peat soils, generally 10 – 40 inches *thick, normally underlain by sands, poorly* drained.	4,100
A1	Dominantly Anderson 1 soils	40 – 80 inches peat	4,000
A2	Dominantly Anderson 2 soils	80 – 120 inches peat	1,450
A3	Dominantly Anderson 3 soils	120 inches plus peat	3,400

Peat soils more than 40 inches thick underlain by either sand (stippled on the map) or clay.

POTENTIAL

MAPPING UNIT	RATING	DRAINAGE REQUIREMENT AND AGRICULTURAL POTENTIAL
Bso	—	Infertile soil, not recommended for development without heavy fertilizer applications. Where this is practicable, suitability as class DIIB.
DIIA	Class DII	Suitable at present for wet padi, minor drainage improvement required for coconuts.
DIIB		Not recommended for wet padi, minor drainage improvement required for coconuts.
DIIIA	*Class DIII*	Minor drainage improvement required for wet padi, moderate drainage improvement required for coconut.
DIIIB		Moderate drainage improvement required for coconuts, not recommended for wet padi.
DIV	Class DIV	Major drainage improvement required for coconuts with moderate drainage improvement suitable in part for wet padi (except stippled area).
DV	Class DV	Drainage and salinity problems are so great that large scale improvements would be extremely expensive; not recommended for development at present.

LAND USE, MAY 1969

MAPPING UNIT	LAND USE OR VEGETATION
	Sago
	Coconut
	Recently cleared land; padi land, low regrowth and new clearances for crops.
	Secondary growth; presumably mainly old padi land; includes regrowth of varied age.
	Peat swamp forest.
	Nipah forest.
	Mangrove forest, mangrove and nipah complexes and other vegetation associated with saline areas.

Scale 1 : 30,000

Mile 1 3/4 1/2 1/4 0 1 2 3 4 5 Miles

Metres 500 0 1/2 1 2 3 4 5 6 7 8 Kilometres

Soil Survey Drawing No. 239 a,b,c,d, Survey Area No. 156 January 1972 Compiled by Tan In Kok Drawn by Sebli Mohd. Ap.