Report No. 113

Report on a Semi-Detailed Soil Survey of the TANJONG JOL AREA

3rd Division

by
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HUNTING TECHNICAL SERVICES

NOTE

Acreages quoted in this report and the accompanying maps are considered accurate to within five per cent.

Report on a semi-detailed soil survey of the Tanjong Jol area, Third Division.

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INTRODUCTION

The Tanjong Jol area is located on Figure 1, Tanjong Jol itself being the headland which marks the junction of the Lassa estuary with the open sea. The survey area is bounded by the coast in the west and north, by the Batang Matu in northeast and has an abritrary boundary in the south and east. It is calculated that the area surveyed is approximately 4,100 acres.

Within the survey area some 1,786 acres of land have been approved since 1965 for coconut planting under the Coconut Planting Scheme. By mid-1967 some 275 acres of this land had been planted with coconuts. It was found, however, that these areas were subject to saltwater incursions and drainage improvement was requested together with protection against saltwater flooding. In 1967 the Department of Drainage and Irrigation investigated the area and put forward a scheme for minor drainage improvement, the estimated cost of which would be M$68,000.

It was decided that further coconut planting in this area should be halted until a drainage project was implemented. Before embarking on such a project a semi-detailed soil survey of the area was requested, in order to establish the area's potential for extended coconut plantings. The area had been the subject of a reconnaissance soil survey in 1962 (WALL & LIM, 1962) which showed that the area was in general potentially suitable for this crop but few rentises were laid down in this locality.

The semi-detailed soil survey, which is the subject of this report, was carried out in October and November, 1967, the work being largely undertaken by Agricultural Assistant Ismuni bin Omon. In the later stages of the survey he was assisted by A.A. Basmawi bin Mahli and A.A. Johdi bin Juko. The writer was with the party in its initial stages and joined it briefly later.

VEGETATION AND LAND USE

The bulk of the area is covered by freshwater swamp forest. Much extraction has taken place in the past and there appears to be little merchantable timber left. The forest is difficult to cut through and the prevalence of assam paya in particular added considerably to the expense of the soil survey. One large block in the southeast of the area (conforming more or less with the boundaries of the Sia Siong Yung block located on Map 3) has been cleared of forest completely and is now under thick secondary growth. Near the coast the swamp forest gives way to land which has largely been cleared for agriculture in the past and is now under coconut, wet padi and various stages of regrowth. In the west, however, a wide coastal belt is occupied by vegetation indicative of saline conditions, dominated by Nipa.

The main areas which have been cleared for agriculture are in the east and northeast, centred on Kuala Matu bazaar. Here much land is under coconut and wet padi, with smaller areas of rubber and fruit trees. A second isolated cleared area is in the southwest where some land near the coast has been drained for coconut planting.

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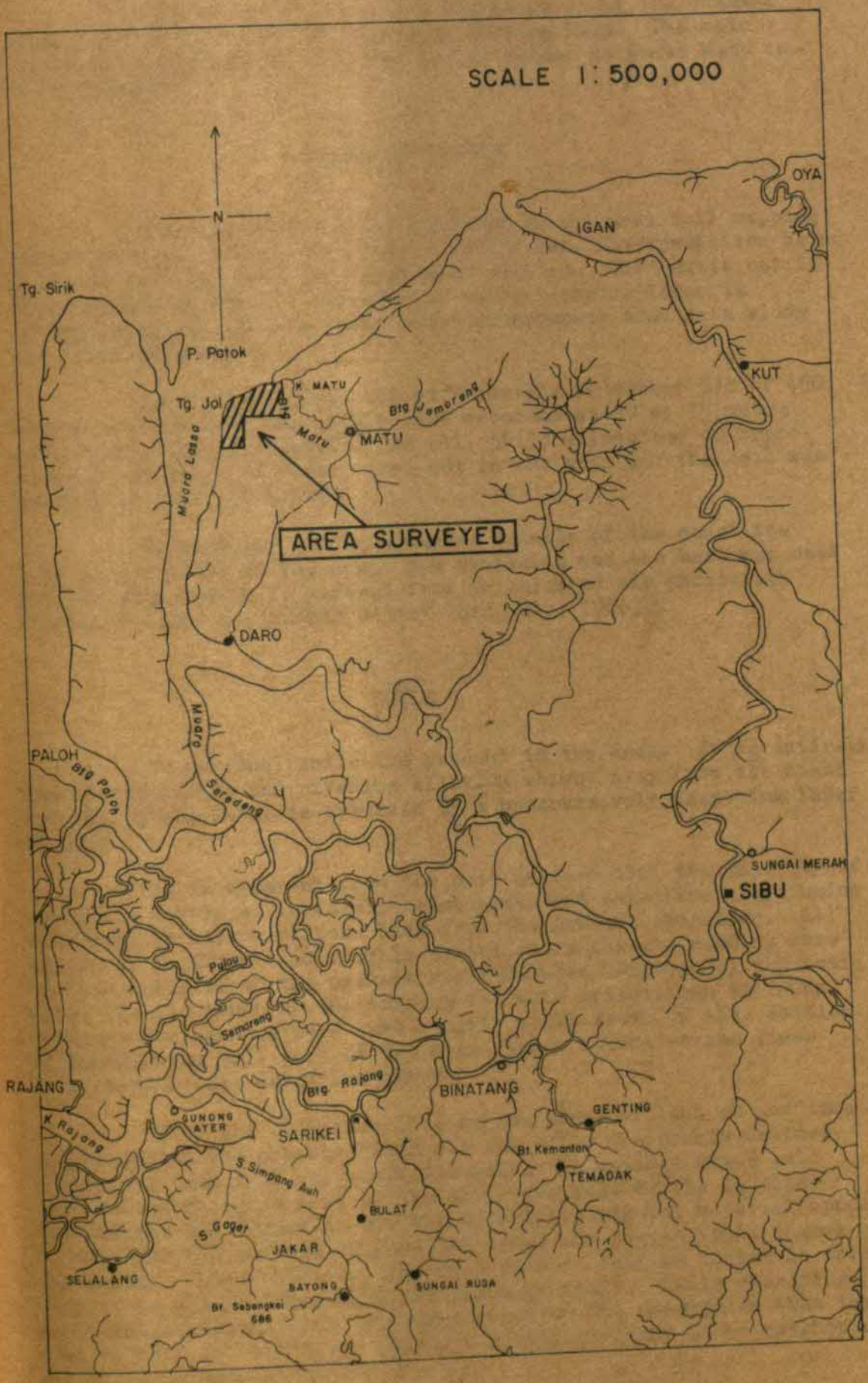

Fig 1 : LOCATION

Isolated settlements are scattered along the coastal strip but the majority are temporary farming huts. The main permanent settlement in the area is the bazaar at Kuala Matu in the northeast.

METHOD OF SURVEY

There being no relief features in the area soil mapping relied on data from points along a rentis net, interpretation being aided in some areas by the vegetation pattern. The rentis net is superimposed on Map 1. Information between rentis lines is interpolated and is of a lower order of accuracy than data along the lines themselves.

Rentis lines were cut at intervals of either 375 or 450 metres and the soil was sampled and recorded at 50 or 75 metre intervals along each rentis. In all, 56.75 kilometres or approximately 35 miles of rentis were cut in the area and the soil was sampled at some 850 points.

No base map giving accurate details of the coastline (the main feature of the area) was available and the base map used for the soil survey is derived from an enlarged air photograph (Sortie 88. SK. 14, number 045 of 28th July, 1966).

SOILS

No residual soils are present in the area. It is entirely mantled by marine and riverine alluvium which, away from the coast and the Batang Matu, is overlain by a progressively deepening layer of peat.

It is apparent from the soil pattern that the majority of soils are developed in fossil beach sands and estuarine clays which alternate in narrow ribbons back from the present shoreline. All appear to be orientated roughly northeast-southwest, running more or less parallel to the present coast between Tanjong Jol and Kuala Matu. To the south of the tanjong the same orientation is found although the coast itself runs roughly north-south in this section. On approaching this part of the coast these relict strand lines merge into recent estuarine clays.

With the exception of a narrow strip of land on and immediately behind the present beach all the soils are poorly-drained. Proceeding back from the coast mineral soils rapidly grade into peats although, over most of the area, the peat mantle is thin. Peat depths are irregular but the underlying mineral material appears to continue the pattern of parallel rises and swales found nearer the coast. Where, however, the peat is more than 40 inches in thickness it is almost invariably underlain by clays. Peats overlying sand are generally thin, tending to confirm the assumption that the sand ribbons are old beach deposits rising slightly above neighbouring clayey estuarine tracts.

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The mineral material therefore shows some microrelief but this has been almost entirely blanketed by peat and there is no apparent surface relief in the area. It is probable that the peat surface has a slight downward gradient towards the coast, a feature typical of basin peats in other areas, but this gradient if present is too slight to be detected by eye.

The soils of the area are classified in four great soil groups, within which ten soil families are represented. The classification at the group and family level is shown in Table 1.

Great soil group	Soil Family
Gley soils	Bijat Sebandi Tatau Matu
Saline Gley soils	Pendam Jol
Peat soils	Mukah Igan Anderson
Recent Alluvial Soils	Kabong

Table 1 : Soil Classification

It will be noted that Jol Family is not referred to in the published classification of Sarawak soils (SOIL SURVEY STAFF,1966). As a result of work in this area and concurrent work in First Division a revision of both the Gley and Saline Gley great soil groups has been made. With the exception of Pendam, all soil families mentioned under these groups in Table 1 are affected. Details of the revisions which have been made are given in Appendix I to this report. Knowledge of these revisions is assumed in the following paragraphs.

With the exception of Pendam and Jol Families, which are mapped in association, family units are employed on the soil map. The soil families are described in the following sections, in the order given in Table 1 and in the key to Map 1.

SOIL FAMILIES

Bijat Family

Bijat Family soils comprise nonsaline poorly-drained alluvial clays in which drainage conditions are not sufficiently bad for surface peat to have accumulated. Such soils are confined to the neighbourhood of Kuala Matu bazaar. It is probable that the parent material is derived both from estuarine clays and from material deposited by the Batang Matu and that both Bijat and Daro Series are represented in this area, (see Appendix I).

Bijat profiles are normally light grey, greyish brown or, rarely, dark grey clays with scattered yellowish brown mottles. The surface 4-8 inches are commonly a very dark brown clay loam. The profile is wet through most of the year and at most sites is strongly gleyed throughout the subsoil. At the present time almost all the land mantled by Bijat soils is in cultivation for wet padi or for rubber.

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It is estimated that the Bijat Family covers approximately 70 acres.

Sebandi Family

The Sebandi Family is closely related to the Bijat Family but occupies areas where drainage conditions are sufficiently poor for a thin (less than 10 inches) surface layer of peat to be present. Watertables are at or near the surface throughout the year and the clayey mineral profile is strongly gleyed. Sebandi soils are found in positions transitional between Bijat soils and Peat soils in the northeast of the area. They also occupy a narrow strip in the west where they are transitional between the Pendam - Jol association and Peat soils. The boundary between Sebandi and Jol Families has been inferred from the vegetation and is taken to follow the boundary between Nipa forest and freshwater swamp forest.

In many localities in the north Sebandi soils are used for wet padi and, to a lesser extent, for coconuts. In the west some areas have been cleared for these crops but in other areas they remain under cut-over forest.

Sebandi Family soils cover approximately 200 acres.

Tatau Family

Tatau Family soils comprise, in this area, marine sands which are strongly gleyed in the subsoil due to their lowlying situation. In the north of the area they form a continuous belt immediately behind the present beach. Elsewhere their occurrence is more intermittent.

Profile characteristics vary. The subsoil colour may be yellowish brown near the surface, grading to grey or bluish 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 groundwater, well-drained soils being placed in the Kabong Family which is discussed below.

These soils commonly bear a cover of swamp forest with scattered nibong but in many areas have been cleared for coconut or, near Kuala Matu bazaar, for rubber. They occupy some 340 acres.

Matu Family

Where the water table is permanently at or near the surface Tatau Family soils commonly grade into soils of the Matu Family. Matu soils are developed in marine sands which are completely gleyed and normally grey in colour. At the soil surface the mineral profile is overlain by a thin layer of peat or muck, up to 10 inches thick. Matu soils are thus the coarse-textured equivalent of Sebandi soils (and bear the same relation to Tatau soils as Sebandi soils do to those of the Bijat Family).

Matu soils are normally found adjacent to Tatau soils and, like the latter, are only common in the north of the area. In many localities they remain under swamp forest but they have been cleared for rice or coconuts in some areas and near Kuala Matu bazaar are partly planted with rubber.

Matu soils are somewhat less extensive than Tatau soils and cover an estimated 230 acres.

Pendam Family

From Tanjong Jol southwards the soils near the coast itself are dominantly developed in estuarine clays and bear a cover of Nipa which indicates than they are at least weakly saline. Smaller areas of such soils occur in the northeast of the area. No salinity tests have been undertaken but on the basis of the vegetation they are considered most appropriately classified in the Pendam Family. It is quite possible that in some localities, particularly in that land immediately on the coast in the southwest of the area, these soils are sufficiently saline to be considered as Rajang Family soils. (The Rajang and Pendam Families are only distinguished on the basis of groundwater conductivity levels). But, if this is so, it is expected that Rajang soils occupy only a narrow coastal strip and need not be considered separately from Pendam soils.

The Pendam profile is normally a dark grey to very dark greyish brown sticky clay. There are commonly many rotting root fragments in the profile, the latter showing no consistent horizon differentiation apart from rare depositional texture contrasts. These clays are mined by med lobsters and the surface mounds which they throw up are a characteristic of the family.

Near Kuala Matu bazaar Pendam soils have been cleared for coconut but elsewhere they are largely untouched.

It is calculated that, with soils of the Jol Family (Pendam and Jol soils are not mapped separately), Pendam soils cover some 460 acres.

Jol Family

Soils which have the characteristics of Pendam Family soils but have, in addition, a thin surface peat horizon up to 10 inches in thickness have been separated as Jol Family. In this area they have been mapped together with Pendam Family and remarks with regard to the latter (given above) also apply to the former. Towards the interior Jol soils commonly occupy a transitional belt between Pendam soils and soils of the Sebandi Family. With the exception of salinity Jol and Sebandi soils are very similar. The boundary between them on the map is largely based on the limits of the Nipa palm in the vegetation cover.

Mukah and Igan Families

Where surface peat exceeds 10 inches in thickness the soils are considered as Peat soils and the depth of the peat is considered the most important characteristic in classifying at a family level. In the case of shallow peats, however, the nature of underlying mineral horizons is also taken into account. Mukah and Igan soils comprise peats which are 10 to 40 inches in thickness. In Mukah profiles the peat is underlain by strongly gleyed sticky clays while Igan soils have marine sands below the peat.

Soils of the Mukah Family are very extensive in this area, particularly to the south of Kuala Matu bazaar. They also cover large portions of the southern part of the area. Igan Family soils are less extensive, being largely confined to areas where the peat overlies old sandy beach deposits. These are mainly found near the coast in the north of the area.

Neither soil type is cultivated to any great extent and in most localities these families remain under swamp forest. In the east of the area, however, to the south of Kuala Matu bazaar, Mukah soils have been extensively cleared both for wet rice and for coconut.

Mukah Family soils cover approximately 970 acres and Igan Family soils approximately 350 acres.

Anderson Family

All peats deeper than 40 inches are classed in the Anderson Family. Within this family depth phases are distinguished, 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. (Anderson 3 does not occur in this area). Within the Anderson 1 mapping unit an additional depth boundary at 60 inches of peat is included on the soil map.

The peats are raw, woody and acid. They are underlain by clays at almost every point sampled. They are only cleared in a very few areas (with the exception of a block, presumably intended for coconut, in the southeast, in which the forest has been completely felled some time ago and is now replaced by thick regrowth). The bulk of the Anderson Family remains under poor swamp forest with a considerable proportion of asam paya in many localities.

There is a general tendency for the peats to become deeper towards the southeast away from the coast, but probes show that this is complicated by the microrelief of the underlying mineral material. The clays on which the peats have built up appear to form gentle undulations in which are shallow enclosed basins. Furthermore, slightly higher ridges are formed by fossil beach lines, one of which strikes northeast-southwest through the centre of the area and isolates one tract of relatively deep peat completely from the main area of Anderson soils. As Map 1 indicates the peat depth pattern is not simple.

It is calculated that Anderson 1 soils cover some 1,300 acres in this area of which 860 acres are peats 40-60 inches deep and 440 acres peats 60-80 inches deep. Anderson 2 soils cover only 30 acres and, at the points sampled, do not exceed 95 inches in depth.

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Kabong Family

Kabong soils are recently deposited beach sands found along the present coast and are distinguished from soils of the Tatau Family by better drainage and lack of gley features in the profile. Small outliers of these soils which occur somewhat inland from the coast are generally associated with low rises or areas in which drains have been provided in connection with coconut planting.

The Kabong profile is normally a yellowish brown to greyish brown coarse or medium sand. Within at least 20 inches of the surface, and commonly throughout the profile, indications of gleying are absent. Where the matrix colour is grey Kabong profiles are mainly distinguished from profiles of Tatau soils by the absence of a high groundwater table. Where not under low secondary growth Kabong soils are generally planted with coconut.

Kabong soils cover approximately 130 acres in this area.

SOIL SUITABILITY FOR COCONUTS

The present soil survey was carried out in connection with proposed drainage schemes involving some 1,115 acres of land, this land comprising two blocks, one near Kuala Matu and another south of Tanjong Jol. Much land between these blocks has also been approved under the Coconut Planting Scheme, however, and any drainage works may ultimately affect these areas as well. The soil survey therefore covered the entire Tanjong Jol area and included all portions of land now approved under the Coconut Planting Scheme. Before considering the localities which are of immediate interest to development planners it is convenient to discuss the area as a whole.

Coconuts will grow on a variety of soils, ranging from some residual Red-Yellow Podsolic soils on hill land to riverine alluvial clays and coastal sands. The most important characteristic necessary is good drainage as coconuts growing in waterlogged conditions generally have a short bearing life but it is essential that the roots can reach a constant supply of water. The optimum depth of the permanent watertable is arguable and, in any case, will vary with the age of the palm and the development of the root system, but is of the order of 2-3 feet for the young palm and 5-8 feet for the mature palm. For the purposes of defining suitability ratings a depth limit of 40 inches is used, as this is a limit employed in many divisions of the Sarawak soil classification (SOIL SURVEY STAFF, 1966). Provided that the surface 40 inches is freely draining and fresh groundwater is present below this depth the soil is considered suitable for coconut palms regardless of the texture. Both sands and clays are acceptable, provided that they are well-drained. Fertiliser requirements will, of course, vary.

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It may be remarked that many stands of coconuts are at present growing in Sarawak on soils much inferior to those described above and that the standards quoted are rather high, ignoring much land which is at present, or with less drainage provision than that prescribed would become, at least marginally suitable for this crop. This is intentional. The soil survey was initiated to assess the justification for spending M$68,000 on a drainage project in the area. The problem is not similar to, for example, one where emergency resettlement of a large community is required and, within reason, any soils are better than none. In the present case it would only mislead if soil conditions which were not well within the range required by the crop for optimum growth were discussed as being suitable for planting.

Of the soils present in this area only Kabong Family is suitable for coconut without drainage improvement but there are considerable tracts of land which would be suitable for this crop with relatively minor drainage improvement, these comprising areas mantled by Bijat, Sebandi, Tatau and Matu soils. Rather deeper drainage would be necessary on Mukah and Igan soils. Such soils with a 20 inch peat cover, for example, would need drainage to a depth of roughly 5 feet. The deeper peat soils of the Anderson Family can obviously only be considered for this crop if fairly large-scale drainage works can be undertaken and only long-term benefits can be expected from such improvements. Some Anderson soils are so deep that drainage is not a practical consideration. Where the limit is taken depends on a number of factors: in particular, the amount of money available for investment in improvements, the size of the area and the soil pattern. Where small outliers of deep peat are present in an area which is dominantly an association of shallow peat and mineral soils they have, in any case, to be included in any drainage scheme plan. The standards taken will thus vary and must be decided for each area and each drainage project. As a general rule, however, a limit of 60 inches of peat appears realistic. Where large areas of peat soils deeper than 60 inches are present, reclamation can only be considered through a major drainage scheme involving a considerable investment of funds and even where such a scheme is considered justified it will be some years before permanent crops can be planted on such land.

Table 2 indicates how much land is available in the area for coconut planting following particular degrees of drainage.

Land requiring no drainage improvement	approximately 150 acres
Land requiring watertable lowered by not more than 4 feet	approximately 1,300 acres
Land requiring watertable lowered by some 4-8 feet (and the bulk of the overlying peat removed by oxidation and compaction)	approximately 2,180 acres
Land requiring more than 8 feet of drainage and peat removal	approximately 470 acres

Table 2 : Drainage improvement required for coconut planting in survey area.

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Table 2 refers to the area as a whole. Of the 4,100 acres surveyed, however, drainage improvement is only considered for some 1,115 acres, these comprising two blocks which are subject to saltwater flooding at the present time. The proposed drainage improvement schemes are located on Map 3. It may be noted that this is derived (together with the Coconut Planting Scheme blocks also shown on the map) largely from a sketch (No.67/17) supplied by the Drainage and Irrigation Department. Cadastral sheets supplied by Lands and Survey Department were also consulted and the C.P.S. block boundaries revised in some details to agree with them. However, due to the variety of scales employed and the lack of physical features in the area with which to tie in information it was found very difficult to marry the data from different sources; it is fairly certain that these boundaries are somewhat misplaced on Map 3. D. & I. Sketch No.67/17 has been used because it is the only source which combines the C.P.S. and drainage improvement scheme boundaries. It will also be noted that the location of Drainage Improvement Scheme No.1 is moved east of that shown on Drainage and Irrigation Department Drawing 67/79/1-1 which has been widely circulated. The writer was informed that this scheme was to be moved farther east in order to include some portions of land approved for C.P.S. which were outside the original boundary. The scheme has been relocated on the map to agree with these plans.

Table 3 shows the drainage requirement for coconut within the areas covered by the proposed drainage improvement schemes. These figures can only be roughly correct as they are based on the doubtful assumption that the schemes are precisely located on Map 3.

	Approximate acreages		
	Scheme No.1	Scheme No.2	Scheme No. 1 Future extension
Land requiring no drainage improvement	3	nil	nil
Land requiring watertable lowered by not more than 4 feet	131	16	8
Land requiring watertable lowered by some 4-8 feet (and the bulk of the overlying peat removed by oxidation and compaction)	222	136	442
Land requiring more than 8 feet of drainage and peat removal	nil	nil	157

Table 3 : Drainage improvement required for coconut planting in proposed drainage scheme areas.

(Acreage calculations from Map 3 gave a figure of 1,044 acres for the combined drainage scheme areas, an error of 6 percent from the 1,115 acres which has been quoted regarding this project. Official acreages for the three individual units are not known. Figures in Table 3 have been adjusted to give a total of 1,115 acres).

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From Table 1 it can be seen that satisfactory improvement of both scheme areas for coconut planting will involve lowering the groundwater table by some 8 feet, although many portions of both schemes require drainage to shallower depths. Neither scheme includes peats deeper than 60 inches (i.e. requiring drainage to a depth of more than 8 feet) and it can therefore be considered practicable to improve all the land in these two blocks. However, it will be noted that the future extension which is anticipated for Scheme No.1 does include land in which deeper peats are found.

Two further points may be made which apply generally to drainage improvement in this area. Firstly, lowering the groundwater levels in the poorly-drained soils may well affect the level of the watertable in the coastal sands, thus limiting the suitability of the latter for coconut planting. Secondly, unless preventive measures are taken, drains dug into the areas at present under coconuts or approved for C.P.S. may, instead of drawing water off the area, attract more water from the interior freshwater swamps which back them up.

RECOMMENDATIONS

The present problem is whether or not to spend M$68,000 on drainage improvements in the area. The works which are anticipated largely comprise the provision of two gates, regrading and enlarging an existing drain in Scheme area No.2 and excavation of a new drain in Scheme area No.1. Drainage and Irrigation Department point out that as bunding is not included in the plan 'flooding during high spring tide for a limited period will have to be tolerated in the area, as certain sections in the area are below high spring tide levels'.

Details regarding depth of drains are not given in the D. & I. Paper quoted but it seems clear that such drainage works will not improve the soils to the point where they can be recommended for coconut planting. The question of soil suitability is, however, rather academic in this context as by mid-1967 it was reported that 275 acres were already under coconuts in the area. Through poor drainage and intermittent salt-water flooding portions of these plantings are in danger of failing. The Divisional Development Officer has stated that this project should not be considered a salvage operation but rather one to open up more agricultural land. The improvements for which estimates have been prepared seem, however, to be more appropriate to the former aim than the latter (although it is gathered that the drainage works can be extended at a later date if required without revising the original drainage plan). Whether it is worth while spending the sum quoted in order to save these plantings is a socialogical question which the writer does not propose to answer but it would appear to be highly uneconomic.

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It is recommended that the present plans for limited improvement be discarded and a full-scale drainage scheme for the area as a whole be considered from the start. There are large tracts of land in the area covered by the soil map which with drainage would be suitable for coconut planting but improvements would entail, among other things, provision of a perimeter bund on the seaward side of the area and other works on the inland side to prevent water from the main swamps to the southeast of the area entering the lands being improved. The deepest peats occur in the south of the Sia Siong Yung block but rather deep peats also cover a large tract of the George bin Darahman block. These areas should be excluded from the scheme. If a drainage scheme is implemented at all the Pendam-Jol soils west of the Tatah bin Mor block and partially included in the Awang Laga block should be incorporated. In addition to drainage these soils require correction of high salt levels.

The drainage requirements of the area and potential for developing the land surveyed is shown in Map 2. This map should be read in conjunction with Appendix II. A suggested boundary to the scheme, which excludes the areas requiring major drainage improvement shown on Map 2, is overlain in red on Map 3. The area enclosed totals some 2,900 acres.

REFERENCES

ANDRIESSE, J.P.	In preparation	Report on a Semi-Detailed Soil Survey of the Stinggang-Stungkor area, First Division. Sarawak Soil Survey Report No.109 Kuching.
SOIL SURVEY STAFF	1966	A classification of Sarawak soils. Research Branch, Department of Agriculture, Sarawak, Technical Paper No.2. Kuching.
WALL, J.R.D. & LIM, C.P.	1962	Report on a Reconnaissance Soil Survey of the Igan-Grigat Area, Third Division. Sarawak Soil Survey Report No.43/6. Kuching.

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APPENDIX I

REVISIONS TO THE CLASSIFICATION OF SARAWAK SOILS

In classifying the soils of the Tanjong Jol area certain profiles were noted the characteristics of which were not covered by the family definitions given in the current classification of Sarawak soils (SOIL SURVEY STAFF, 1966). These profiles were confined to soils in the great soil groups of Gley soils and Saline Gley soils. Work in First Division carried out concurrently with the Tanjong Jol survey (ANDRIESSE, in preparation) also encountered problems in classifying soils in the great soil group of Gley soils where it proved very difficult to establish whether the profile was developed in material of residual or alluvial origin.

The Soil Survey staff have therefore revised the family classification of the Gley soils and Saline Gley soils and, in the case of the former, reduced some family separations to series level distinctions. The revisions will be discussed in detail in a future supplement of the Classification of Sarawak Soils. They are briefly set out below.

GLEY SOILS

Changes in the classification of families

1. A first distinction is now made between light-textured Gley soils and fine-textured Gley soils. It is commonly difficult to distinguish between residual, recent alluvial and old alluvial soils where they are light-textured; there is commonly little difference in profile characteristics between them; and such contrasts which are found are commonly unrelated to the origin of the parent material. Gong and Tatau Families are therefore combined.

2. Within the heavy-textured Gley soils no distinction is now made between soils derived from recent riverine parent material and those developed in recent marine alluvium. Where both types of parent material occur in an area the boundary between them is commonly difficult to establish.

Classification of series

While the origin of the parent material is difficult to establish in some areas no such difficulty arises in others. Distinctions on this basis which have been dropped from the family level classification have therefore been retained in defining some series. Where origin of the parent material is known soils are mapped at the series level. Where it is in doubt a family mapping unit is employed.

The present classification of Gley soils below the group level is given in the following Table. This replaces Table 7 in the published classification (SOIL SURVEY STAFF, 1966).

Texture	Origin of parent material	Peaty O horizon less than 10 inches thick	Family	Selected series
Light-textured	Not differentiated	absent	TATAU	Tatau, Plan Gong, Bokah
		present	MATU	Luis, Matu
Heavy-textured	Residual or old alluvial	absent	SEMADOH	Semadoh, Embang
		present	GERAWAT	Gerawat
	Recent alluvial	absent	BIJAT	Bijat, Daro
		present	SEBANDI	Sebandi

Gley Soils - Family Classification

(The definitions of light and heavy texture grades remain unchanged).

SALINE GLEY SOILS

Soils have been mapped in association with Pendam Family soils in which the vegetation indicative of saline conditions is found but which have thin surface peat horizons. There is no provision for such profiles in the Saline Gley soils but to maintain consistency with divisions within the Gley soils the presence of thin peaty O horizons must be considered a criterium for separation at the Family level. A Jol Family has therefore been established. It is considered that the presence of peat is in itself an indication of weak rather than strong salinity and no provision for a 'peaty equivalent' of Rajang Family is therefore necessary.

A 'peaty equivalent' of Nonok Family has not been mapped to date but no doubt occurs. Provision is made for such soils in the Table below.

By inference from this Table any soils within the Saline Gley soils group which have more than 10 inches of surface peat are included in the Limbang Family. Such was not the original intention but this problem is left until Limbang soils have been mapped and studied in a greater number of localities. At present there are few data on soils in this family. It is also questionable whether these soils should be in this group at all. They would probably be better considered as Saline Peat soils.

The following Table replaces Table 8 in the published classification (SOIL SURVEY STAFF, 1966).

Parent material	Peaty O horizon less than 10 inches thick	Texture of mineral soil	Salinity	Family
Mineral	Present	Light	Weakly saline	?
	Absent			NONOK
	Absent		Strongly saline	BELAT
	Present	Heavy	Weakly saline	JOL
	Absent			PENDAM
	Absent		Strongly saline	RAJANG
Organic				LIMBANG

Saline Gley Soils - Family Classification

(The definitions of light and heavy texture grades are as those used for Gley soils).

In mapping Saline Gley soils considerable assistance is given by the vegetation pattern, the presence of mangrove and Nipa indicating saline conditions. Hitherto the presence of nibong has also be used. It is now considered that nibong without associated Nipa or mangrove indicates at best very weakly saline conditions and where the division between Saline Gley and Gley soils on the map must rely entirely on vegetation patterns it is considered more appropriate to map such areas as Gley rather than Saline Gley soils.

APPENDIX II

DRAINAGE REQUIREMENT AND DEVELOPMENT POTENTIAL CLASSIFICATION FOR FLOODPLAIN AND COASTAL AREAS

At the present time considerable emphasis is being placed on the development of wet rice, coconut and oil palm on land where agricultural development is limited by poor drainage conditions. A drainage scheme is commonly proposed for such areas and it is becoming standard practice to request soil survey information at a semi-detailed level before investing in drainage works. A need has therefore arisen for a system of rating such land in terms appropriate to these development problems, so that different scheme proposals can be readily compared and the relative benefits of drainage works in different areas assessed.

A Drainage Requirement and Development Potential Classification has therefore been compiled, in which the soil families occurring in such areas are rated from the viewpoint of the ease with which they can be brought into productive cultivation. The Classification is employed for the first time in the Tanjong Jol area, the soil data being interpreted in terms of the Classification in Map 2.

This system has different aims from other soil and land classification systems which have been used in soil survey reports and in some respects is founded on different basic assumptions. In particular, to keep the system relevant to the type of problem for which it is designed, only a limited range of soil and land conditions are considered and the agricultural goals against which the land is rated are confined to those which conform to present development policies for such areas. To avoid confusion with other types of land rating some explanation of this system is required.

The Classification 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. Well-drained alluvial soils are included (although drainage works are not required on them) because they are commonly found in association with poorly-drained soils and any scheme for agricultural improvement of the latter is likely to concern the former as well.

In defining the Classes and rating the soils within them it is assumed that a general development scheme is envisaged rather than the ad hoc improvement of smallholder units. If sufficient effort is applied, deep peat soils, for example, can be made quite productive in small areas with little drainage improvement. On large areas, however, such a form of development would be impracticable. Due to the expense of draining these soils and the length of time necessary before any large-scale development of them can be effected, they are given a low rating in this system.

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At the Class level the extent of the drainage requirement is rated. Within the Classes, subclasses are distinguished on the "development potential" once appropriate improvements are carried out.

The development potential can be defined as the potential for speedy and economic development and is not the agricultural potential as such. Thus a droughty infertile sandy soil suitable for a limited range of crops is given a higher rating than a poorly-drained clay which, with the application of minor drainage works would be suitable for a wide range of crops. The more limited agricultural potential of the former is offset by the relative ease with which it can be brought into cultivation. From the viewpoint of the development planner both soils are of interest. Conversely, strongly saline clays exist which, on the basis of chemical analyses, appear to have a higher inherent fertility, and therefore agricultural potential, than most if not all other soils considered in this Classification. The problems of bringing them into agricultural use are, however, so great that they are considered to have a very low potential for development except in particular conditions and their potential is not classified.

As stated above, in rating the soils their suitability has been estimated only for wet padi, coconut and oil palm. The large-scale development of these crops is encouraged by the Department, as their environmental requirements can be met in Sarawak and they are known to be economically feasible. Certain floodplain and coastal soils are known to be suitable for other crops (cocoa, coffee, for example) but the feasibility and economic benefits of large-scale plantings of these crops are, to a large extent, unknown. Such crops are therefore not considered in rating the families.

The Classification relies heavily on the amount of knowledge available on the requirements and benefits of large-scale crop planting in Sarawak and is strongly influenced by present development policies in connection with floodplain areas. Only within these limits can the Classification be considered an objective one. A permanent absolute rating is not intended. It may be repeated that the Classification is drawn up to help those who are involved in development planning for such areas to assess the problems confronting them and to apply the policies current at the present time. It is not intended for use in other contexts.

Five Classes are used. Class D.I mainly covers dry land soils, D.II and D.III land is of interest to planners where drainage improvement can be provided. Class D.IV land should generally be ignored in planning and Class D.V covers particular problem soils. (The prefix 'D' is used to avoid confusion with other classifications in circulation).

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CLASS D.I : NO DRAINAGE IMPROVEMENT REQUIRED

CLASS D.IA

Definition: Land on which a wide range of crops can be grown with little improvement. Minor fertility problems. Possible minor drainage problems. Possible intermittent flooding hazard.

Soil families: MALANG. SEDUAU.

Recommended use: Coconut or oil palm (but where other areas are available for these crops such land is best reserved for fruit trees, vegetables, etc.)

CLASS D.IB

Definition: Land on which a limited range of crops can be grown at present. No drainage problems. Moderate fertility problems. All problems easily rectified.

Soil families: KABONG. SEMATAN.

Recommended use: Coconut.

CLASS D.II : MINOR DRAINAGE IMPROVEMENT REQUIRED

CLASS D.IIA

Definition: Land on which wet padi can be grown at present. If drainage improved a wider range of crops is possible. Minor fertility problems. Only minor drainage improvement necessary but for large-scale development Government assistance required in most areas.

Soil families: BIJAT. SEBANDI. MUKAH (10-20 inches peat). PENDAM. JOL.

Recommended use following improvement: Coconut or oil palm.

CLASS D.IIB

Definition: As for Class D.IIB but fertility problems moderate to great.

Soil families: TATAU. MATU. NONOK. KAYAN. IGAN (10-20 inches peat).

Recommended use after improvement: Coconut.

CLASS D.III : MODERATE DRAINAGE IMPROVEMENT REQUIRED

CLASS D.IIIA

Definition: Land not recommended for agriculture without prior improvement of drainage conditions. Where areas are large drainage problems can only be rectified through a major drainage scheme (although where small areas of this Class occur in an area of dominantly Class D.II land the entire area can appropriately be considered as the latter for the purpose of planning improvements.) Minor fertility problems. Suitable for a range of crops following improvement.

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Soil families: MUKAH (20-40 inches peat). ANDERSON 1 (40-60 inches peat; where underlain by clay).

Recommended use after improvement: Coconut or oil palm. (But where wet rice is required small areas of this land in an area dominantly of Class D.IIB can be treated as Class D.IIB land).

CLASS D.IIIB

Definition: As for Class D.IIIA but fertility problems moderate to great.

Soil families: IGAN (20-40 inches peat). ANDERSON 1 (40-60 inches peat; where underlain by sand).

Recommended use after improvement: Coconut.

CLASS D.IV : MAJOR DRAINAGE IMPROVEMENT REQUIRED

Definition: Land in which the drainage problems are so great that no agricultural use can be considered unless a regional drainage scheme can be undertaken (and in many areas such a scheme is known to be impracticable). Where small areas of this Class occur in an area of dominantly Class III land the entire area can be considered as the latter for the purpose of planning development. Only long-term benefits can be expected from this portion of the area, however.

Soil families: ANDERSON 1 (60-80 inches peat). ANDERSON 2. ANDERSON 3.

Recommended use after improvement: Where peat is underlain by clay, as for Class D.IIIA. Where peat is underlain by sand as for Class D.IIIB.

CLASS D.V. : DRAINAGE REQUIREMENT UNCLASSIFIED

Definition: Land in which drainage and salinity problems are so great that large-scale improvements would be extremely expensive. It is considered, however, that the agricultural returns from such land are likely to be sufficiently high to justify the cost of such improvements. Such land cannot at present be considered for development where the acreage is large unless a regional drainage improvement scheme can be provided. However, where the acreage is small and adjoins large areas of Class D.IIB land it should be rated as Class D.II land also and included in any drainage improvement scheme planned for the adjacent area.

Soil families: RAJANG.

Recommended use after improvement: There is insufficient data for recommendations to be made, but this land is likely to be appropriate for coconut, oil palm or wet rice after drainage and leaching of salts.