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SCHEMATIC - RECONNAISSANCE SOIL SURVEY
OF THE
PAMOL — MERSING — ENDAU REGION
OF
NORTH JOHORE

by

HOWARD A. SMALLWOOD

Canadian Colombo Plan Soil Surveyor

MALAYAN SOIL SURVEY REPORT NO. 1/1967

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PART I

INTRODUCTION

The Schematic-Reconnaissance Soil Survey of the Pamol-Mersing-Endau Region in North Johore is one of a series of reports devoted to the description of the soils of West Malaysia as determined through the work of the Soil Science Division, Ministry of Agriculture & Co-operatives, Kuala Lumpur. The object of the survey was to obtain basic information about the soils of the region, their nature, distribution, and agricultural potentials. The report is accompanied by a soil map and a soil suitability map.

The soil map attached to this report shows the location and extent of the soil series, associations, or variants and of miscellaneous land types including areas of land considered too steep for agricultural use and land disturbed by the activities of man to the extent that it is considered unreclaimable. The soil suitability map indicates the distribution of five suitability classes, derived from the soil map, and based on the major or minor limitations to agricultural development presented by the soil mapping units. Both maps are drawn to a scale of two statute miles to an inch (1:125,720). The grid reference shown on the standard new series one inch to a mile (1:63,360), topographical maps published by the Survey Department has been included in the margin of these maps so as to facilitate cross-referencing and position finding.

This report follows the pattern set by two previous reports by the same author, covering the Kluang-Muar-Labis region and the Segamat-Gemas-Tangkak region. These regions adjoin, to the south west and west respectively, the area described in this report (Smallwood, 1965 and 1966). The report is essentially a progress report and the results may be subject to minor amendment when a final report dealing with all three areas which comprise the North Johore soil survey region has been completed. For this reason it has been made as brief and factual as possible and it does not include a technical soil classification or full descriptions of the soil profiles, which will be included in the final report. This survey concludes the Department of Agriculture Schematic Reconnaissance soil survey programme for the State of Johore.

Location and Size

The area surveyed is located in the north eastern portion of the State of Johore. It comprises the area lying north of the Kluang-Jemaluang road, east of the boundaries with the Kluang-Muar-Labis and Segamat-Gemas-Tangkak soil survey regions with the Pahang border and the coastline facing the South China Sea forming the northern and eastern borders respectively. The area is covered by New Series Topographical Map Sheet Nos. 109, 110, 117, 118, 119 and 124, on a scale of one inch to a mile

The area covers 690,403 acres, approximately one fifth of the State of Johore. Most of the area is under primary jungle, with 131, 844 acres of steepland considered too steep for agricultural use. The developed parts of the area are served by the large towns of Kluang, the medium sized towns of Mersing and Endau, and the smaller centres of Kahang and Jemaluang.

PART II

PHYSICAL FEATURES

A. Relief and Drainage

The broad relief and drainage patterns are shown on Figure 1. The northwestern portion of the region consists chiefly of land with high elevation and steep topography. A tract of hilly to undulating land of varying width lies in a northeasterly direction parallel to the coast of the South China Sea. Between these two areas there occurs the broad flood plain of the Endau River and its associated tributaries. This area is level to depressional in topography. To the south of the steepland mentioned above there occurs an area of gently undulating land which runs parallel to the Kluang-Kahang road. Smaller isolated locations of steepland occur throughout the entire region, and depressional areas occur in most of the major river and stream channels.

The surface drainage pattern is generally well developed; however, the main drainage channel, the Endau River, is rather sluggish and tends to meander throughout most of its entire length. The general direction of flow is towards the northeast into the South China Sea. The major rivers draining the region are the Sungai Endau, the Sungai Sembrong, the Sungai Kahang, the Sungai Selai, the Sungai Mersing, and the Sungai Jemaluang. Besides these major rivers there are numerous smaller streams which form a rather complex drainage pattern throughout the entire region.

B. Geology

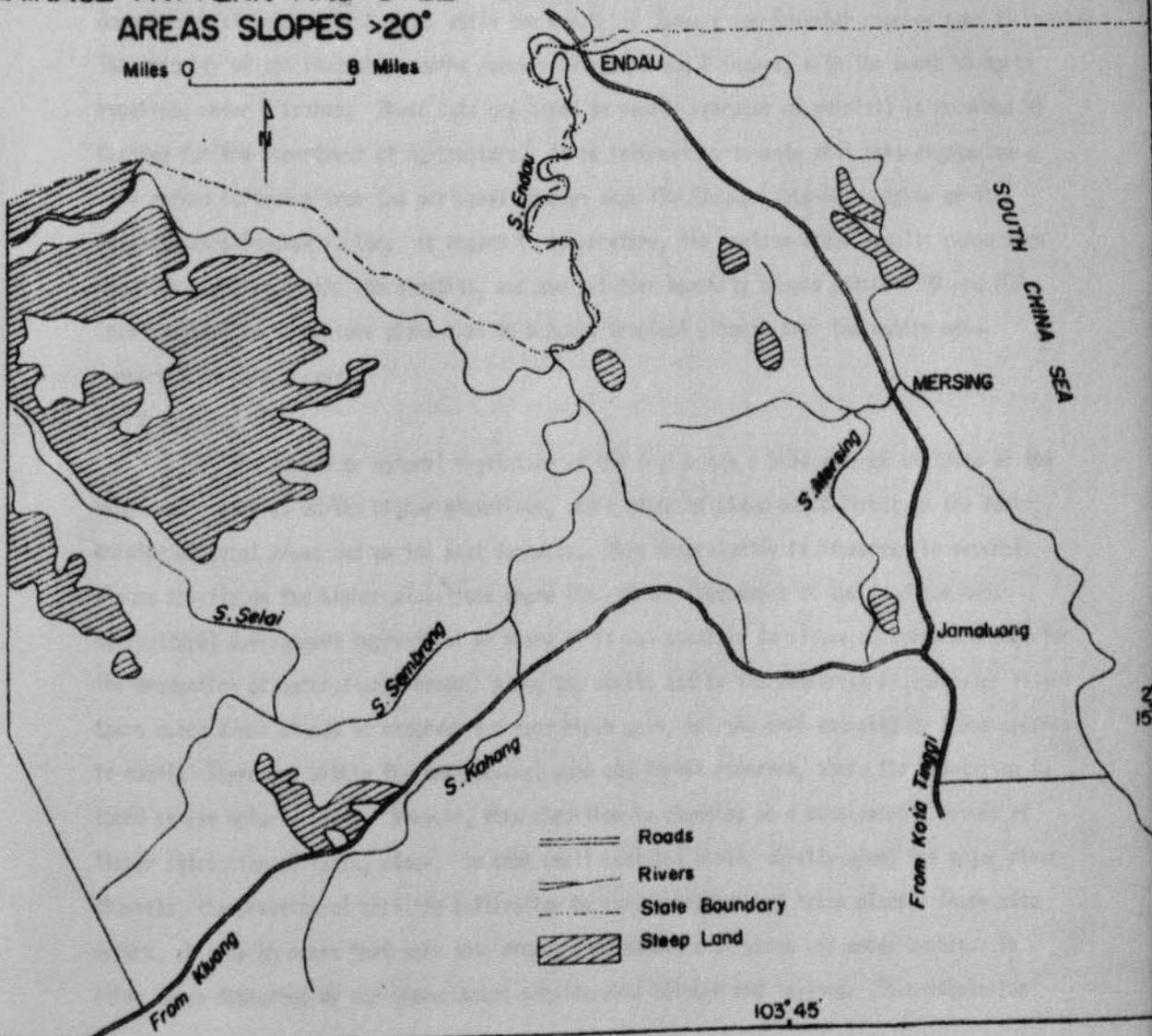
The geology of this region presents a rather complex picture. Generally speaking most of the steepland is composed chiefly of granite or sandstones, the hilly and undulating land chiefly of shales, and the level to depressional land, riverine or marine alluvium. Isolated small outcrops of rhyolite occur throughout the areas of shale. The alluvium appears to belong to several different age groups, ranging from older alluvium to recent alluvium. It is assumed, based on the formation of ancient beach ridges and other marine features, that the Endau River valley was once an inlet arm of the sea. All the rivers in this area are tidal. Although the area concerned is over thirty miles from the sea, the elevation is often under twenty feet above sea level.

An intermittent belt of coastal deposits occurs along the coast, behind which occurs some peat deposits of varying depths. The valleys of the Jemaluang and Mersing rivers appear to have

FIGURE 1

PAMOL-MERSING-ENDAU REGION
DRAINAGE PATTERN AND STEEP LAND
AREAS SLOPES >20°

Miles 0 8 Miles



-  Roads
-  Rivers
-  State Boundary
-  Steep Land

103° 45'

been infilled with colluvium from which some tin is being extracted. In the past a large iron mine was developed near the junction of the Endau and Sembrong rivers which is no longer in production.

C. Climate

In the classification of climates on a world wide basis by Koppen (quoted by Trewartha, 1954), Malaya is situated in an Af or Tropical Wet (Rainforest) climatic zone. This climate is distinctive in that its average daily temperature fluctuations are greater than the average seasonal temperature fluctuations, accompanied by abundant rainfall throughout the year. However, on a more detailed basis, rainfall maps and records reveal a significant variation in rainfall throughout the country. In this region the annual rainfall ranges between 110" - 130" (see Figure 2). With reference to the monthly distribution (see Figure 3), the month of December receives over 27 inches, while the months of January and November receive over 15 inches. The majority of the remaining months receive between 6 and 8 inches, with the month of April receiving under 5 inches. These data are based on yearly averages of rainfall as recorded at Mersing for the Department of Agriculture. It is interesting to note that this region has a more marked influence from the northeast monsoon than the Kluang-Labis-Muar region or the Segamat-Gemas-Tangkak region. In regard to temperature, the daytime highs usually range from the high eighties to the low nineties, and the relative humidity ranges between 70% and 80%. This combination of factors gives rise to a humid tropical climate over the entire area concerned in this survey.

D. Vegetation

The virgin or natural vegetation of the region has a predominance of trees of the Dipterocarp species on the higher elevations, and a stand of mixed swamp forest on the lower, moister alluvial areas and on the peat deposits. This natural state is preserved in several places chiefly on the higher elevations where the extreme ruggedness of the land has made agricultural development impractical or where it is not possible to secure adequate drainage for the production of agricultural crops. Along the coasts and in the estuaries of the major rivers there occur dense stands of mangrove and some nipah palm, but the area occupied by these species is small. There are within the area several game and forest reserves, where the vegetation is found in its natural state. However, this condition is changing as a considerable amount of timber extraction is taking place. In some small isolated areas, chiefly along the major river channels, the practice of shifting cultivation by the aborigines has taken place. There also occurs, chiefly on areas that were once mined, a mixed stand of scrub and woody bushes. In other areas disturbed by man there occurs considerable belukar and lallang. This vegetation

FIGURE 2

PAMOL-MERSING-ENDAU REGION RAINFALL MAP

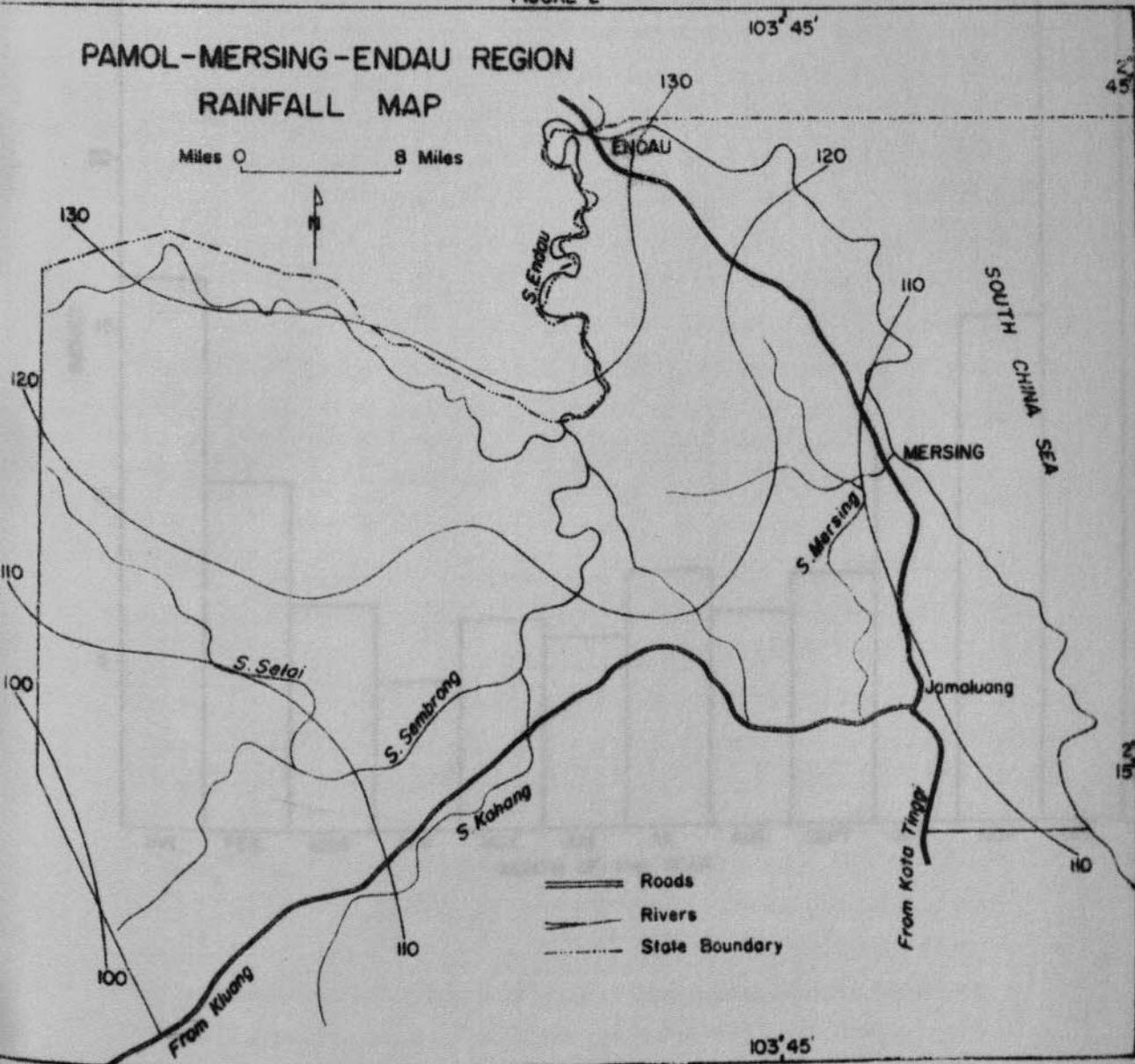
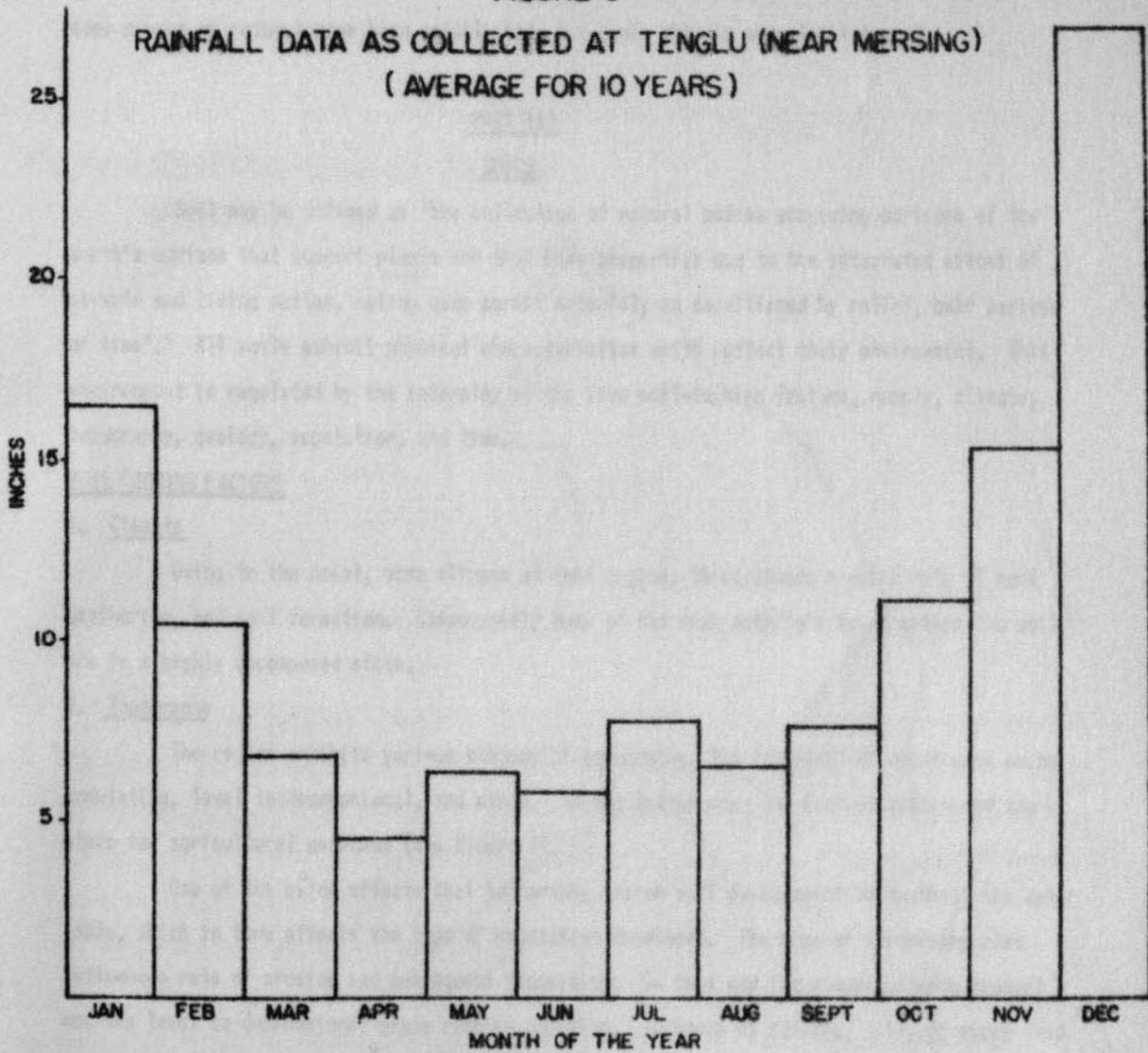


FIGURE 3

RAINFALL DATA AS COLLECTED AT TENGLU (NEAR MERSING)
(AVERAGE FOR 10 YEARS)



is considered to be transient, and in due course the natural forest vegetation will re-establish itself.

Only a small percentage of this region has been developed. The major area which has been developed lies almost entirely in a narrow belt along the Kluang-Mersing-Endau road. These areas have been utilized for the growing of rubber and some oil palm. Dusun, padi cultivation, and market gardening are carried on in a very limited way throughout this area. Along the coast some groves of coconut have been established, but again this is on a limited scale.

PART 111

SOILS

Soil may be defined as "the collection of natural bodies occupying portions of the earth's surface that support plants and that have properties due to the integrated effect of climate and living matter, acting upon parent material, as conditioned by relief, over periods of time".* All soils exhibit physical characteristics which reflect their environment. This environment is regulated by the interplay of the five soil-forming factors, namely, climate, topography, geology, vegetation, and time.

SOIL FORMING FACTORS

1. Climate

Owing to the moist, warm climate of this region, there occurs a rapid rate of rock weathering, and soil formation. Consequently many of the rock materials found within the soil are in a highly decomposed state.

2. Topography

The region exhibits various classes of topography, the frequency of occurrence being undulating, level to depressional, and steep. In the latter case the land is considered too steep for agricultural purposes (see Figure 1).

One of the major effects that topography has on soil development is depth of the water table, which in turn affects the type of vegetation developed. The type of topography also influences rate of erosion and subsequent deposition. In this way the slopes undergo removal and the level to depressional areas receive addition. In areas of rolling, hilly, or steep land another effect of topography on soil formation, is the very gradual movement of the material, which, over long periods of time, tends to alter the slope and the general morphology of the soils.

*Soil Survey Manual, Soil Survey Staff, United States Department of Agriculture Handbook #18, Page 8.

In-general, the surveyed area has a favourable topography for agricultural development with the exception of part of the northwestern portion which is considered too steep, and some locations in the north central area which are depressional and would be difficult to drain. Both these areas would be best left under protective forests. The remainder of the area has a favourable topography, being mainly undulating to rolling. It is of interest to note that within the northwestern portion of this region there occurs a plateau like area surrounded by steep land. This land could have agricultural potential, although at present, it is quite inaccessible.

3. Geology

This region exhibits a distinctive geological pattern, as outlined in Part II, and it has been observed that the pattern of the soils is to a greater or lesser extent related to the geological pattern. Of all the prominent soil-forming factors outlined, it is felt that geology plays the major role in influencing the nature of the soils in this region. Most of the prominent land-forms appear to be the result of past intrusive igneous activity. The steepland areas are generally formed from granite and allied igneous rocks. In some exceptions the steepland is found on sandstone formations. Along the coast there occurs a long belt of carbonaceous shales intermixed with considerable vein quartz and phyllite, indicating that past metamorphic processes had taken place.

4. Vegetation

As little development has taken place, most of the area is covered by a multi-storey stand of Dipterocarp rain forest over the higher, undulating, better drained locations and a low mixed stand of swamp forest over the moister alluvial deposits or in the fresh water peat deposits. Besides these two prominent forest types there occur smaller areas of mangrove swamp vegetation in the region influenced by tidal effects and a mixed stand of drought-tolerant scrub and bushes on the sandy coastal beach ridges.

It has been noted that it is difficult to observe any noticeable change in the general composition of the Dipterocarp forest cover over an area where a known soil change occurs. Therefore it appears that vegetative patterns and monostands do not normally indicate the soil on which they are supported unless they belong to the fresh water swamp forest type or the mangrove swamp type, when a positive correlation between soil and vegetation can be made.

Although most of the area remains undeveloped, only certain areas on the steeper slopes and in the deeper swamps remain in a true virgin condition, as most of the forest reserves have been opened for timber extraction which is in active progress.

5. Time

Generally geological and other natural processes require long periods of time to bring about noticeable changes. Likewise soil formation, a natural process, requires considerable time to complete or reach its maximum development.

As previously mentioned, there occurs a constant rejuvenation of soil parent material and sufficient time is required for the rejuvenated materials to develop to soils. It is in this respect that time can be considered a passive soil forming factor.

In summing up, it should be noted that all soil forming factors are inter-related and each can modify the influence of another.

SOIL CLASSIFICATION

The basic unit in field classification used in this survey is the soil series. A soil series includes all those soils of similar profiles, formed on similar or the same parent material, having the same category of drainage and moisture regimes, and usually formed under similar vegetation.

Most commonly, one soil series is associated with another soil series, usually in a complex landscape pattern. This has led to the establishment of the soil association, where two soil series are mapped as a single unit. Although this unit may incorporate small inclusions of many series, only under extremely complex patterns should a mapping association have more than two members. The soil series within the association are named in such an order as to indicate the predominance of one series over the other in the association, and in this way two associations with identical member series may be established. Thus, for example, Batu Anam-Malacca Association denotes an association wherein the Batu Anam Series is the more prominent member; whereas the Malacca-Batu Anam Association denotes an association wherein the Malacca Series is the more prominent member of the association.

The term, "soil variant", which has been used in this survey, denotes a soil with characteristics sufficiently distinct to warrant establishing a new series but, because of its limited extent it is considered impracticable to establish a new series for the present. However, some soil series which were once considered soil variants, in earlier reports, have now been elevated to a series' status. Similarly, other profiles which were once considered soil variants will be renamed as more field information becomes available.

The term, soil family, is also used in this survey, and may be defined as a group of

soil series based on broadly similar parent materials.* This is not a mapping unit, but rather a term designed to group series into units of classification, and is used only in the descriptive legend of the soil map.

In the interest of clarity and simplicity the soil series described in this report will be grouped as members of a soil family. Soil associations will not be discussed in the report, but will appear on the soil map as two kinds, those being associations of members of the same family and associations of members of different families.

SOIL SUITABILITY.

The method of classification for soil suitability which is adopted here is identical to a more comprehensive Malayan-wide soil suitability classification.** This classification is designed to group all soils encountered in Malaya under five suitability classes. The method of deriving the class to which a particular soil series or soil association will belong is based on a condemnation-appraisal approach. The limitations to agricultural development are assessed, and the particular series or association is placed under the one class of the five suitability classes which best accommodates it with its limiting characteristics.

Categorized below are the limitations to agricultural development which have been found to occur in the soils of this region.

Very Serious Limitations

1. Slopes steeper than 20°
2. Massive, thick laterite at or very near the surface.
3. Land disturbed by mining operations or excavations.

Serious Limitations

1. Acute nutrient deficiency, both major and trace elements.
2. Very poor or poor drainage conditions.
3. Moderately steep slopes ($12^{\circ} - 20^{\circ}$).
4. Massive, thick laterite within two feet of the surface.
5. Two feet or more of acid peat.
6. Strong compaction.

*It has been felt, from a morphological and management point of view, that, in future reports, soil families shall include soils which exhibit like profile properties, but do not necessarily have similar or the same parent materials, and shall be used as a mapping unit. However, in this report, the system of grouping soil families having similar or the same parent materials shall continue, so that a continuity may be maintained.

**Soil Survey Manual for Malayan Conditions, Appendix 13.

Serious Limitations

7. Sand texture throughout.
8. Acid sulphate condition.
9. Saline conditions.

Minor Limitations

1. Susceptibility to flooding, both fresh and saline.
2. Weak structures within the top four feet.
3. Imperfect to moderate drainage conditions.
4. Weak or moderate compaction.
5. Acid peat less than 2 feet thick.

The particular design of this type of soil suitability classification allows a certain degree of flexibility whereby the soils of any one series or association may belong to more than one suitability class. This allows the soils to be classified bearing in mind their full range of characteristics; e.g. soils of the Rengam Series are placed in Class 1 when they occur on nearly level to rolling topography and in Class 3 when they occur on steeper topography (slopes over 12°).

As for the crop suitability of each particular series, this is discussed briefly in the series descriptions which follow the suitability classification.

Class 1.

Class 1 soils have no limitations. These soils have textures ranging from sandy clay loams to clays. They have well developed structures and friable to firm consistence, which permit unimpeded root ramification and proper drainage. They occur on nearly level to rolling topography. In this region, some of the soils included in this class belong to the Jerangau, Rengam, Munchong, and Serdang Series.

Class 2

Soils of Class 2 have a few minor limitations. In this region, some of the soils of this class belong to the Briah, Kulai, Serdang (red variant), and Rengam (red variant) series.

Class 3

Class 3 contains the widest range of soils. These soils are characterized by having at least one serious limitation. Among them are sedentary soils and soils developed on marine and riverine alluvium, besides colluvium, organic clays and mucks, and shallow peats up to two feet in thickness. Besides these miscellaneous land types, Class 3 includes soils belonging to the Rengam (with slopes over 12°), Kulai (with slopes greater than 12°), Malacca, Tavy, Durian, Batu Anam, Holyrood, Pohoi, Apek, and Batang Merbau Series.

Class 4.

In Class 4 the soils have more than one serious limitation. In this region, included in this class are soils of the Holyrood (grey variant), Malacca (nodular laterite), Marang, Rudua, and Rompin Series and peats greater than two feet in depth.

Class 5.

Class 5 soils have at least one very serious limitation. In this region they include soils belonging to the Malacca (massive laterite), Rusila, and Kranji Series. Included also in this class are areas covered by steep land, disturbed land, and very deep peats.

In summing up these five classes it is of interest to note that when two soils are mapped in association, one series of the association will often fall under a class different from the other. Hence it is at the discretion of the soil surveyor to choose which class best accommodates the association, e.g. under average conditions Malacca occurs under Class 3 along with Batu Anam. However, Malacca may occur also under Class 5, and may still be in close association with Batu Anam. In this particular case one must choose the class which best suits the most dominant series in the association, taking into consideration its major and minor limitations.

SOIL SERIES

A. Sedentary Soils

Rengam Family

Rengam Series. (RGM). This commonly encountered series is characterized by a well-structured, free-draining, deep profile, derived from a parent material of highly weathered granite. One of its chief distinguishing features is its distinctive sandy clay texture, the sand fraction usually being comprised of fairly coarse, angular quartz grains, which give this soil a rather coarse texture. The size of the quartz grains appears to be related to the grain size of the original granite from which it is derived. The surface soil, under virgin jungle, is a greyish brown (2.5Y5/2) sandy loam to sandy clay, normally one to two inches in depth. The subsoil is generally yellow (10YR 7/8) to brownish yellow (10YR 6/6 to 6/8) sandy clay to sandy clay loam with a friable, moderate to strong, fine, subangular blocky structure, usually four feet in thickness, showing considerable uniformity throughout. Below this appears a reddish tinge whose intensity increases with increasing depth, often accompanied by a general coarsening in texture.

Some profiles exhibiting all the characteristics of Rengam, except that this red colour extends almost to the surface, were encountered. These profiles have been designated as a Rengam (red variant) (RGM/1), and are usually mapped along with the regular series, as it appears that they form a complex landscape pattern with the normal series. Because of this colour variation

this variant has been included under a different soil family, namely the Kampong Kolam Family.

The Rengam Series is one of the more productive soils mapped in this survey, and is usually found on undulating to rolling terrain near or adjacent to areas of steep land. It can be extensively developed for the cultivation of most agricultural crops, such as rubber, oil palms, or dusun, as its structure allows deep root penetration and, owing to its high clay content, it has good moisture and nutrient retention. This soil is considered to be a Class 1 soil.

Kulai Family

Kulai Series. (KLI). This series is characterized by a distinctive light olive (2.5Y5/4) sandy clay loam surface soil grading into an olive yellow (2.5Y6/6 to 6/6) clay subsoil. This soil is derived from rhyolite extrusions, and often appears to be derived from an intermixing of sedimentary and igneous rocks. The soil is moderately deep, weakly to moderately structured, with a firm consistence. It is found generally on moderately steep to steep topography. It supports an average stand of jungle and, when developed, produced an average crop of rubber. The most limiting factor of this soil would be its rather steep topography which would render it subject to severe erosion hazards.

Only limited areas of this series have been discovered in this region. Under average conditions it is considered to be a Class 2 soil.

Tampin Series. (TPN). This pale-coloured, coarse grained soil is easily distinguished by its pale yellow (2.5Y7/4) colour and its extremely coarse, gravelly texture. It is derived from highly siliceous granite and is always found in close association with Rengam Series, usually on hilly to undulating terrain, at higher elevations. Often the surface has outcroppings of large granite boulders which would cause this series to be rather shallow and would render it rather difficult to cultivate. This series has an extremely compact, gravelly subsoil which appears to inhibit root penetration but does not cause impeded drainage due to its gravelly texture. This soil is not of widespread occurrence and occurs in appreciable amounts only on a large plateau-like formation formed chiefly from granite and allied rocks where it occurs in very close association with the normal Rengam Series. It appears to be a juvenile, shallow, pale-coloured expression of the Rengam Series.

As this area is under natural vegetation, it is not known how this series would respond as an agricultural soil; however, its coarse texture and shallow, compact nature would be its chief limiting factors. Upon development this series could be considered a Class 3 soil.

Kampong Kolam Family

Jerangau Series. (JRA). This series is characterized by a well-structured, deep soil, somewhat like the Rengam Series in appearance, but with a redder hue and a much finer sand

fraction. This soil is derived from acid igneous rocks of the granodiorite or hornblende granite type, and is found in this region only in close association with the Rengam Series. The surface soil is usually a dark brown (7.5YR 4/2 to 3/2) sandy clay loam, two inches in thickness under jungle conditions. The subsoil is generally strong brown (7.5YR 5/8) fine sandy clay loam to clay loam, with a well developed fine subangular blocky structure. The soil is usually at least four feet in depth, with the texture coarsening with increasing depth. The profile exhibits good drainage and, owing to its great depth, allows good root penetration. This series on occasion, like Rengam, exhibits a redder colour than usual, and could then be considered a red variant of the normal Jerangau.

Included also in this family is the Rengam (red variant) (RGM/1), which has been described previously.

Only a limited area of Jerangau has been mapped in this survey. However, it is believed that a more detailed survey would reveal more of its presence in association with Rengam. This series is considered to be a Class 1 soil.

Malacca Family

Malacca Series. (MCA). This series is characterized chiefly by the presence of a large quantity of massive or nodular laterite which generally occurs within one or two feet from the surface or which may occur very near the surface, with the result that after cultivation lateritic boulders and a loose mantle of nodular laterite concretions are strewn over the surface of the soil. Bauxite-like concretions commonly occur throughout the laterite horizon, and often some vein quartz is present. The commonest texture above this laterite horizon is that of sandy clay to clay loam. Intermixed with and directly below the laterite horizon there occurs a yellowish brown (10YR 5/6) to strong brown (7.5YR 5/8) clay subsoil which grades into a variegated or mottled horizon of extremely firm clay, which in turn gradually merges into a pallid zone of highly weathered shales and mudstones.

This series, because of its lateritic tendencies, is considered only marginal for agricultural purposes. However, it has found considerable use as road surfacing aggregates, and extensive quarries have been developed for this purpose. In some areas the laterite and the associated minerals have been mined for their iron content.

The majority of the Malacca Series in this region is found in close association with Pohoi, Durian or Tavy Series. Under normal conditions this series is considered a Class 3 to Class 5 soil, depending on the depth of topsoil over the laterite and upon the nature of the laterite itself, whether massive or nodular.

Tavy Family

Tavy Series. (TVY). This clay loam soil can best be distinguished by its character-

At present very little of this series has been developed in this region, it is felt however that it has average capabilities of producing most agricultural crops. On the hilly terrain erosion is a hazard. Under normal conditions this series is a Class 3 soil.

Batang Merbau Series. (BMU). This deep soil can be distinguished most easily by its strong brown (7.5YR 5/6) to brownish yellow (10YR 6/6) colour and fine sandy clay loam texture. This soil series has developed from schist rocks and phyllites, and may become quite shallow on the steeper slopes. The profile shows weak structure and is often quite sandy and uniform in colour throughout its entire depth. This series is commonly found on undulating to rolling topography, and is often found in association with Durian which resembles it somewhat but is much heavier in texture and firmer in consistence than the Batang Merbau Series. Its tendency to become shallow on the steeper slopes would be its chief limiting factor. Under favourable topography this series could be considered a Class 2 to Class 3 soil. In this region this series is found only in association with Durian, Pohoi, and Malacca Series.

Munchong Family

Munchong Series. (MUN). This deep, strong brown (7.5 YR 5/6) silty clay soil is similar to the Serdang Series but can be distinguished by its somewhat heavier texture, better structure, and deeper colour. It is considered one of the better shale-derived soils mapped in this survey. It is usually found in close association with the Serdang Series, and may soils exhibit characteristics of both or are transitional in nature. In this region this series is mapped only in association, generally with Serdang, and in a three-member association with Serdang and Bungor Series. It is usually found on sloping topography, and under virgin conditions supports an average stand of jungle. When brought under cultivation it is a favourable agricultural soil suitable for the growing of most tree crops. Under normal conditions this series is considered to be a Class 1 soil.

Pohoi Family

Pohoi Series. (PHI). This soil can be most easily distinguished by its light yellowish brown (2.5Y6/4) colour and its sandy clay loam texture. It occurs chiefly on undulating terrain in association with other shale-derived soils; however, it is distinct in that its parent material is carbonaceous shale, and it forms only where these shale deposits emerge to the surface. It is of widespread occurrence along the East Coast, forming a discontinuous belt parallel to the coast. Considerable vein quartz may be present in the profile, but it is seldom lateritic. It appears to support an average stand of jungle, but when brought under cultivation appears only marginal, requiring good management practice and strict erosion control. Under normal conditions this series is considered a Class 3 soil.

Batu Anam Family

Batu Anam Series. (BTM). This soil is characterized by a yellowish (2.5Y 5/4) to grey (2.5Y 7/2) colour, an extremely firm consistence, and a heavy texture, combined with considerable variegation and mottling at depths of three feet or greater, and often a thin lens of nodular laterite concretions occurs at about twenty inches depth. It is derived from iron-poor shales and mudstones, and is usually found on gently sloping to undulating terrain. It is not of widespread occurrence in this survey and is found only in association with Durian and Marang. This soil is considered a rather poor soil owing to its inherent low fertility and its strong tendency, when dry, to become very compact and hard. With the addition of fertilizers and with proper management it produces an average yield of rubber. For crops other than rubber this soil is considered marginal and requires a high degree of management in order to produce favourably. Under normal conditions this series is considered a Class 3 soil.

Marang Series. (MRG). This sandy, pale-coloured, shallow soil can be most easily recognized by its distinctive light grey (2.5Y 7/2) colour, its sandy texture, and its occurrence on undulating to rolling terrain along the East Coast region of Northern Johore. It is of widespread occurrence and is usually found in close association with Apek or Pohoi Series, with which it forms a rather complex pattern. It is found exclusively along the East Coast region, and appears to have developed on very pale-coloured shales and vein quartz. Often this soil occupies very small areas, being sometimes less than an acre in size, thus making mapping as a single series difficult. Therefore most of this soil has been mapped on an association basis. This series appears to be of very low fertility when developed and is quite prone to erosion due to its sandy nature. Under natural conditions it supports a below average stand of jungle, and some areas where this soil has been developed have been abandoned, probably due to its low fertility. Under normal conditions this series is considered to be a Class 4 soil.

Serdang Family

Serdang Series. (SDG). This yellowish brown (1CYR 5/8) to brownish yellow (10YR 6/8), uniformly coloured, deep, freely draining sandy loam soil is characterized by a very friable consistence. Derived from sandstones, quartzites, and conglomerates, it is found usually on moderately steep to gentle slopes of sandstone ridge formations. It is of widespread occurrence and is often found in association with Munchong and Bungor Series. In some of the steeper areas it is found in association with profiles which are similar but possess a distinctive red (10R 4/6 to 2.5YR 4/6) colour, which have been designated as a Serdang (red-variant).

This soil, owing to its topography and its extremely friable consistence, has been found to erode very quickly if left exposed for any length of time. Being easy to cultivate it is widely used as an agricultural soil. Under normal conditions this series is considered to be a Class 1 soil.

B. Alluvial Soils

Telemong Family

Telemong Series. (TMG). This free-draining, sandy loam alluvial soil is characterized by a deep, uniform yellowish brown (10YR 5/4) profile, and is to be found along the higher banks or levees of the major rivers or streams of the region. It is derived from recent alluvial deposits of the present streams and as such is confined to a narrow belt along these streams. It is of widespread occurrence and is to be found in considerable extent along the upper reaches of the Endau and the Selai rivers, and does occur to a very small extent along many of the major rivers of the region.

Due to its location along the navigable rivers where considerable settlement has taken place, this series finds use as a site for building and gardens, and has thus been intensively developed owing to its ease of cultivation. It is always found in association with riverine alluvium and is considered a Class 2 soil.

Telaga Series (TLA). This free-draining recent alluvial soil is somewhat like the Telemong Series in appearance but tends to have a somewhat siltier texture. It usually exhibits a yellowish brown (10YR 5/8) colour. It occurs along those rivers which tend to flood during the annual monsoon periods, and is to be found chiefly along the meander belt of the Endau River, in close association with Telemong Series and riverine alluvium. Very little of this series has undergone development, with the exception of that which is partially developed by the aborigines, usually as a state of shifting agricultural, where it appears to have a good nutrient status for the growth of most garden crops such as sweet potatoes, tapioca and peanuts. Under normal conditions this series is considered a Class 2 soil.

Briah Family

Briah Series. (BRH). This alluvial soil is characterized by a brown to dark brown silty clay topsoil from two to seven inches in depth. Below this there occurs a light brown or light grey (10YR 6/1 to 7/1) silty clay loam subsoil which has some partially decayed organic (plant) remains and distinct brownish colouring along old root channels and a distinct mottled zone. This series is sometimes characterized by the presence of two superimposed parent materials, the upper one being of riverine alluvium and the lower one being of marine alluvium which is very acid in reaction. A sulphurous odour is a characteristic of this soil especially if the water-table is within two feet of the surface.

Poor drainage is the principal limiting factor and must be corrected if this soil is to be used for agriculture. When proper drainage is secured this soil will produce an average stand of rubber and other crops, but it is important that the level of the water table be kept to a depth of three feet, the effective rooting depth for most tree crops.

In this region the Briah Series has been mapped only in association with organic clays and mucks and riverine alluvium. Most of the area thus mapped has been developed, and drainage has been improved by a series of main ditches and lateral drains and, with a strict control of the water table, it appears to produce well. Under good drainage and normal conditions this series is considered to be a Class 2 soil.

Kranji Family

Kranji Series. (KNJ). This recent marine alluvial soil is developed exclusively along the coastal swamp margins of the sea and along the estuaries of the major rivers and streams. It is found in the sheltered bays of the East Coast, and is subject to daily flooding with saline waters owing to the rise and fall of the tides. This feature causes a water-logged and saline condition to prevail, thus preventing the extensive use of this series as an agricultural soil or the possibilities of improving its drainage, as it is approximately at sea level. The surface soil is usually brown (10YR 5/3) to dark brown (10YR 3/3) silty clay of varying depth. The subsoil is usually greenish grey (5GG/1) grading into dark bluish grey (5B 4/1) silty clay to sandy clay usually with a sticky consistence and a distinct sulphurous odour. Below this mineral horizon one may encounter muck with considerable amounts of partially decayed roots and other organic remains. Often one encounters a lens of marine shells in various stages of decomposition, usually easily distinguishable. The surface soil is often disturbed by the digging and "chimney" building by certain species of marine crabs.

In the virgin condition this series supports mangrove swamp and nipah palm swamp vegetation. Where drainage has been possible some limited areas have been developed for the growing of coconuts. The production of mangrove wood for charcoal purposes and nipah palm for thatching or "attap" purposes is probably the most suitable use for this series. It may be possible to utilize this series on a small scale for the development of fish ponds, but it would have limitations for this type of industry due to its saline condition which renders it of very limited suitability for development. Under the above-mentioned conditions this series is considered a Class 5 soil.

Rudua Family

Rudua Series. (ROU). This dark grey (10YR 4/1) to grey (10YR 5/1) freely drained marine sandy soil is characterized chiefly by its occurrence on former beach deposits along the East Coast of the region and its distinctive podzol characteristics. The surface soil is usually

a thin layer of loose structureless loamy sand, dark grey (10YR 4/1) in colour, which grades into a light brownish grey (10YR 6/2) to light grey (10YR 6/1) loose fine sand. Below this horizon one usually encounters a somewhat compact, cemented, humic iron horizon of a dark brown (10YR 3/3) colour, which occurs at about four to five feet of depth or at the water table. This series is exclusive in that it forms only on former beach ridges and has been located only on the East Coast of the area surveyed. Under previous, natural conditions, this soil probably supported a poor stand of jungle; however, as most of the soil has been developed and often abandoned, it now normally supports a secondary bush and savanna type of vegetation or coarse drought-tolerant grasses. Under good management it could probably produce cashew nuts and tobacco. It is often found in close association with the Rusila and Rompin Series, but can be easily identified by its colour and the distinctive podzol features of its profile. Having an extremely low reserve of nutrients and being too freely drained, this series could be considered a Class 4 soil.

Rompin Series. (RMP). This sandy marine alluvial soil is most easily recognized by its distinctive reddish yellow (7.5YR 6/6) colour, its very fine sandy texture, and its occurrence on ancient beach ridges along the East Coast. It has slight podzolic tendencies but these are not as pronounced as in the Rudua Series. This series is not of widespread occurrence, and can easily be mapped as a single series due to its distinctive features and its occurrence along the former beach ridges. In some places there occurs in this series a lens or substrate of partially decomposed marine shells at varying depths and is considered to be a phase of the normal series. Where this feature occurs there appears to be a marked decrease in the vigour of the growth of coconuts, which be attributed to the presence of this shell substrate.

Very little is known of the nutrient status of this series; however, it would appear to be very slightly better than the average sandy marine alluvial soil found on the East Coast. It appears to have a better nutrient status than the Rudua Series, which occurs under similar circumstances, and supports an average stand of coconuts if managed well. This series is considered a Class 4 soil.

Jambu Family

Jambu Series. (JBU). This sandy marine alluvial soil is found exclusively on ancient to subrecent former beach ridges at various locations throughout Northern Johore. It is located chiefly on a series of remnants of beach ridges running parallel to and a few miles inland from the East Coast. It has also been found in the interior of the area, on the flood plains of the Endau River and its related tributaries, where it is presumed that in subrecent geological times this region was an inlet arm of the sea.

This series can be distinguished most easily by its white (10YR 7/1) to grey (10YR 5/1) colour and its loose consistence. One encounters in this series, as in the Rudua Series, a humic-iron podzol horizon, which is not as pronounced as in the Rudua Series and occurs at greater depths, but has the same general characteristics. The surface soil is dark grey (10YR 4/1) fine sand of varying depth, often covered by a loose mantle of white bleached sand. This grades into a light grey (10YR 6/1) to grey (10YR 5/1) loamy sand subsoil of varying depth. Below this there is a horizon which is somewhat enriched with iron, weakly cemented giving it a firm consistence and a pronounced dark brown (7.5YR 4/2) colour. The boundary between the loamy sand subsoil and the iron-rich horizon is continuous and sharp, but is extremely wavy as one horizon protrudes into the other with a pronounced "tonguing" effect. This wavy boundary is believed to be caused by slight differences in permeability of the soil along former root channels at this depth.

Being excessively drained and leached, this series possesses very little natural fertility, but as it occurs only sporadically in small isolated areas, it does not present itself as being a major problem soil. Under good management this series could probably be developed for the production of cashew nuts, and with the addition of fertilizers, could probably produce tobacco profitably. Under normal conditions this series is considered a Class 5 soil.

Rusila Family

Rusila Series. (RSL). This alluvial soil results from the infilling of the depressional areas between the successive beach ridges along the East Coast of the region where it develops in a very wet to water-logged environment. Being derived from the adjacent ridges, it is of variable texture, usually sandy, and, due to the stagnant nature of the impounded waters, a very sulphurous condition prevails. Under such conditions the decomposing vegetation assumes a black (10YR 2/1) colour which appears to stain the surface soil to a considerable depth. Usually beneath this horizon one encounters a grey (10YR 6/1) gleyed sand or clay. As this series is partially or wholly submerged in water for the greater portion of the year, very little is known of its morphology or composition; however, the limited attempts to develop this soil have usually met with failure, and those areas currently under the cultivation of wet padi produce very low yields.

This series is usually found in association with the Rudua Series, the latter occupying the better drained locations. Under average conditions the Rusila Series is considered to be a Class 5 soil.

Holyrood Family

Holyrood Series. (HYD). This subrecent alluvial soil is best characterized

by its freely draining, pale yellow (2.5Y 7/4) to yellow (10YR 7/6 to 7/8) sandy loam to loamy sand topsoil and its subsoil of weak structure and friable to loose consistence which often, with increasing depth, becomes structureless and almost white in colour. This series is found on terrace remnants and is often found adjacent to areas of steepland of granite origin or in river flood plains, and often appears to be closely associated with colluvial deposits and fans, occurring in an extremely complex landscape pattern. Usually in this location this series assumes a distinct greyish (10YR 5/1 to 6/1) colour and has been considered a grey variant (HYD/1) of the normal series, and is always mapped in association with the normal series. This series is of widespread occurrence throughout the region, its chief locations being an area north of Kluang in the Sembrong River valley and to the north of Kahang in the Kahang River Valley. In this region this series is mapped in association with Ulu Tiram Series, being an association of Sub-recent and Older Alluvial deposits. It is also mapped in association with Local Alluvium and Colluvium.

This series exhibits a low level of natural fertility and, because of its freely draining nature, presents a problem in the retention of nutrients and moisture. Extensive areas have been developed, but generally rubber does rather poorly, requiring good management practices in order to produce favourably. Under normal conditions this series is considered to be a Class 4 soil.

Harimau Family

Harimau Series. (HMU). This brownish yellow (10YR 6/8) fine sandy clay loam soil is somewhat like a Rengam Series in appearance but is derived from a parent material of Older Alluvium and exhibits some major differences from the Rengam Series in its topographical setting and its consistence and structure in the lower horizons of the profile. The Harimau Series appears to be confined chiefly to gently undulating topography and usually occupies the lower slope position of an area of granite-derived soils, often making its separation difficult due to the profile similarities with the Rengam Series. However, in deep cuttings one often encounters a thin lens of rounded pebbles, clearly marking its alluvial origin and within the profile one usually finds a friable surface horizon with a marked increase in compactness with increasing depth, and evidence of poor structure throughout. This series is often found in association with the Holyrood Series, occupying the more undulating sites and the Holyrood Series occurring on the more gently sloping to level locations. There occurs such a formation in the Kahang district, where a considerable area of this association has developed.

As this soil is derived from "old alluvial" deposits, it inherits a marked deficiency in some nutrients which must be replaced by fertilizers if this soil is to produce

favourably. Under normal conditions this series is considered to be a Class 3 soil.

Ulu Tiram Series. (UTM). This soil series is derived from coarse-textured Older Alluvial deposits and resembles in the upper horizons those soils formed in situ from granite. However, the chief distinguishing characteristics of this series is the coarse textured subsoil which grades into a layer of rounded, water-worn pebbles or boulders usually at considerable depth. The subsoil is pale yellow (2.5Y 7/4) in colour, becomes very compact with increasing depth and contains many coarse subangular quartz grains, which grade into a lens of water-worn cobbles and pebbles, chiefly of quartzitic composition. This series is only of sporadic occurrence in this region found only in close association with Holyrood Series, occupying the higher, more undulating positions, while the Holyrood occupies the more nearly level to gently sloping reaches of the terrain.

This soil, being derived from "older alluvial" deposits, tends to inherit marked deficiencies in some of the major and minor nutrients which must be replaced by applications of fertilizers if this soil is to produce favourably. Under normal conditions this series is considered to be a Class 3 soil.

C. Miscellaneous Land Units

Riverine Alluvium. (RVA). This land unit is characterized by its presence in the flood plain or meander belt of some of the larger rivers of the region. It has variable profile characteristics but is formed from former river deposits of an undifferentiated nature, ranging from coarse sands to clay. It is usually found on a nearly level landform, occurring on a very weakly dissected upper terrace, showing some micro relief and occurring always above the more recent deposits found near the river's present location. Often ox-bows and cut-off channels occur, showing definite signs of stream migration and past river activity. It appears to be recent to subrecent in age, as often there is some profile development. This land unit reflects the texture and colour of the sedentary soils of the surrounding areas and has a variable composition indicating that the materials of which it is composed have been derived from a variety of sources. At times this alluvial land unit is found to superimpose other recognizable profiles.

This land unit is of fairly widespread occurrence and has undergone considerable development as it is fairly productive. It would, however, be prone to flooding during times of high rainfall, but appears to have developed enough micro relief in order to be moderately well drained in most locations. It is difficult to assign a class to this unit; however, it would be comparable to most Class 3 soils.

Local Alluvium. (LAA). This land unit reflects all those materials moved by water from small or local drainage basins and deposited along the margins and terraces

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of the small streams that drain these basins. As a rule these alluvial deposits have no distinct horizon development and are of variable texture, and may be found along old stream channels where there are no streams at present.

These alluvial deposits are usually of marginal to submarginal productivity, and those areas which are developed are supporting a below average stand of oil palm, and rubber, but relatively good padi. Some limited use has been made of this unit for market gardening. As with most alluvial soils drainage is often a problem, and artificial drainage must be supplied if this unit is to produce favourably. In this region this land unit is of widespread occurrence and often occurs in association with other series where it always occupies the lower or more depressional sites. This land unit is considered equal to a Class 3 or Class 4 soil.

Colluvium, (COL). This land unit includes all those materials moved primarily by the influence of gravity, assisted in some measure by water, from areas of steep land and deposited in a rather unsorted condition, exhibiting a wide range in textures and having little or no profile development. It is of widespread occurrence but, due to its mode of deposition, is confined to a narrow belt surrounding most areas of steep land and located in some steep sided valleys. Often colluvium deposits have been mined for their tin content, and many of the colluvial deposits occur as Disturbed Land after mining operations have ceased. Due to its restricted location it does not rank as a major land unit and as such cannot be considered a potential agricultural unit. Its nutrient status would appear low, as often it is in association with Holyrood Series in a complex landscape pattern, the colluvium occurring adjacent to the steep land mass. This unit, under normal conditions, is considered a Class 4 soil.

Organic Clays and Mucks, (OCM). Where the soil encountered is predominantly clay (mineral matter), there is also a fair percentage of organic matter, in the range of 20% - 35%, the soil is considered as "organic clay". If peat has undergone sufficient decomposition to make plant remains unrecognizable, it could be considered as "muck". Muck has a higher mineral content than peat, in the range of 35% - 65%. This higher mineral content and more advanced state of decomposition is due to some changes in the environment, such as improved drainage or cultivation, or to the deposition of matter from flood waters. Often it is difficult to distinguish between organic clays and mucks, as the two are transitional in nature. In this region both types have been mapped as one association. They are of wide-spread occurrence, usually occupying the narrower, deeper valleys of the region which are in a water-logged condition most of the year, and sometime occur adjacent to the alluvial plains.

These soils, because of their environment, are almost always poorly drained in the natural state, and the chief means of improvement is by increased drainage. With adequate drainage the organic clays and mucks produce an average crop of rubber and oil palm and are fairly suitable for coconut production. However, good lateral root support is lacking, with the result that many trees are leaning, and shrinkage causes an exposure of the roots. Often this land type is found in association with Bria Series. Under normal conditions it could be considered as a Class 3 or Class 4 soil.

Peat. (PET). Peat is formed when organic matter accumulates more quickly than it decomposes. In most cases the organic matter is sufficiently fresh and intact to permit the identification of plant remains and tissues. In this region the peat deposits have been found usually in association with mucks and organic clays, usually in a very complex landscape pattern, always occupying the lower depressional areas which are water-logged throughout the year. Most of the peat deposits are from four to six feet in depth, and greater depths have been encountered. Improved drainage is the chief means of reclamation and, when drained, peat will support pineapples and other shallow rooted crops. It is important that too rapid or excessive drainage is not practised as peat is prone to irreversible drying and shrinkage, with the result that lateral support becomes a problem and many roots become exposed. The depth of peat, its acidity, and its possibility of drainage are chief determinants of the class to which it will belong. In this region most peat deposits are considered to be Class 4 or Class 5.

Steepland. (STP). Steepland is that land which, because of its steepness is unsuitable for agricultural uses. Steepland is recognized where most slopes are steeper than 20° . In this region this slope boundary often occurs at the 250 foot contour; however, the elevation of the land is not to be confused with its steepness as there are areas which are above the 250 foot contour which exhibit only an undulating topography. The boundaries of the steepland are usually interpreted directly from the topographical maps and, where access is possible, are checked in the field.

Most of the soils developed on steepland are shallow, juvenile profiles derived chiefly from granite, quartzite, or sandstones parent materials. In this region most of the steepland is found within forest reserves, game reserves, and water catchment areas which, under a policy of sound land use, represent probably the best possible use at present, as clearing would lead to erosion and flood hazards. Steepland is considered a Class 5 soil.

Disturbed Land. (DLD). This land has come to its present state chiefly by the activities of man. Most of the disturbed land in this region is encountered in and

around the larger towns, where there have been extensive excavations for borrow pits and levelling and terracing for new housing projects. In some of the more remote areas where iron rich deposits are encountered or where extensive quarrying for road surfacing materials has been carried out, the adjacent areas are covered by the washings and tailing from mines and the overburden from the quarries. Seldom do these disturbances cover a considerable acreage in this region. This land unit is considered a Class 5 soil.

PART IV

SURVEY METHODS

Methods of Investigation

Work in this region was a continuation of field work carried out in the Segamat-Tangkak-Gemas Region. It commenced in early March, 1966, at which time an air reconnaissance was made by Royal Malaysian Air Force "Alouette" helicopter over the entire region in order to gain an insight into the various forms of topography and to see the possible means of access by newly developed roads or navigable rivers. In early June, 1966, regular field work commenced and continued until early February, 1967, with some interruption owing to the Northeast Monsoon and with some time set aside for correlation trips and conferences. All of the field work was carried out from the new soil survey office located on the Central Agricultural Station, Ayer Hitam, Johore.

As this region is the least developed of all of the three phases of the survey of Northern Johore, access in most instances was difficult. However, the Endau River proved to be the most valuable as an access route into the interior of the region as it is navigable for the greater part of its length, and several newly developed timber extraction roads provided a means of access into the southerly portions of the region. The eastern portion was well serviced by the road linking Jemaluang to Endau, besides several timber extraction roads into the Gunong Arong Forest Reserve, which provided adequate access in this area.

Approximately four hundred miles of roads, tracks, and foot paths were covered in this survey. In areas where no paths or timber lorry tracks existed, specially cut "rentis²" were made. Over one hundred miles of rentis² were cut in this survey, the soil being examined every quarter-mile. Labour from near Ayer Hitam was recruited for the cutting of these rentis², a maximum of three teams comprised of six men each being used during the height of the field season.

Methods of Mapping

Two distinct methods of mapping are used in this survey. The first method

is to draw the approximate location of the soil boundaries on the field map while in the field. This is usually done when access and visibility are favourable. As most of the vegetation consists of tree crops, belukar, or jungle, this is not often possible, and the second method is used; that of drawing the soil boundaries in the office from information gathered in the field. In this method the boundaries are interpreted from the topographical map with reference to contour lines and vegetative boundaries, and from the position and identification of the soil profile callings as marked on the field map or as recorded from the rentis. In the field notes are made on traverse field sheets which are a permanent record of observations and are filed for future reference. The position of the soil examination site is marked on the field map and its six-figure grid reference identification, and features are recorded on the traverse field sheet. These traverse field sheets are referred to when the soil boundaries are being drawn in the office.

Types of Maps

The maps which were used most in the field were on a scale of 2½ inches to one mile (1:25344). In areas for which these maps were not as yet published, the one-inch-to-one-mile (1:63360) maps were used. This map was used primarily in planning and recording rentis lines, and was useful for gaining a general view of an extensive area. On occasion estate maps were used, but this was seldom the case as these maps are at various scales and are sometimes difficult to obtain. The Forest Department, Mersing, also supplied maps of newly developed roads and rentis networks which were found most useful while working in forest reserve areas.

PART V

CONCLUSION

The purpose of carrying out the soil survey in Northern Johore was to map the soil pattern within both the developed and undeveloped regions and to assess the agricultural potentials of the soils so that recommendations could be made for sound land use.

At the present time only a small percentage of the Pamol-Mersing-Endau region of North Johore is developed, and several factors appear to be responsible for this lack of development. Firstly, a good deal of the land within this region was originally designated as forest and game reserves, and no development was permitted legally within these boundaries. Although a good percentage of the land was thus confined, an extensive area still remained open for development, which began in a narrow belt chiefly along the main Kluang-Mersing-Endau road. It proceeded very slowly, however, owing to

the advent of World War II and the ensuing Emergency, and consequently the overall cultivated acreage remained more or less stable for a period of over twenty years. With a return to peace in the last ten years, development resumed although it did not reach the same tempo as in the other parts of the State of Johore. Poor access was partly responsible but it is plausible that the rural population, the majority of whom reside along the Eastern seaboard appear to be more interested in the pursuit of a maritime livelihood than one based on an agricultural economy. It is felt that this lack of interest by this sector of the rural population accounts for the overall lack of settlement of this region. Thus, there exists within the human milieu in this region a social or cultural barrier to development, which should be given the cognisance in land settlement planning.

Besides the above mentioned reasons, the soil survey has revealed that the Pamol-Mersing-Endau region does not have the potentials for development that the other areas of the State of Johore possess. Firstly, a large portion of the region surveyed has soils which although topographically suitable are often prone to flooding and being sandy are low in inherent nutrient status. In contrast to these low lying soils there are other areas having land too steep for agricultural development.

The land not included in the above mentioned categories consists of a rather monotonous "eroded surface" often deeply incised and having steeper topography than is usually normal for its elevation. The majority of this area appears to have developed on sandstone and shale deposits of a complex nature, resulting in a rather complex soil pattern. Within this "eroded surface" area, chiefly in the south central and the south-west sector of this region, there are sizeable areas of suitable soil, derived most from igneous or sandstone parent materials. The exact extent of these soils is not known at present but it is thought that they would have good potential for agricultural development. Reference should be made to the soil suitability map with regard to the general extensiveness of these soils. It is felt that no effort should be spared to bring these soils under cultivation, as their present use as a forest reserve is not in keeping with a policy of sound land use.

Present forest and game reserve boundaries should be revised, bearing in mind the soil pattern and topography on which they occur, and soils with high agricultural potentials should be released for development. The timber industry must not be entirely deprived of land for rejuvenation purposes, but the areas of less suitable soils that should be set aside for this purpose. All soils have a certain degree of agricultural capability, but some are more valuable than others for agricultural production. In order that all soils should be utilized to their optimum capacity, one must select the crop that is most suitable for each soil, assuming the climatic and economic factors are not limiting.

REFERENCES

- Geological Survey Staff, 1948: Geological Map of Malaya.
- Leamy, M.L. and Panton, W.P., 1966: Soil Survey Manual For Malayan Conditions, Division of Agriculture Bulletin No. 119.
- United States Department of Agriculture Handbook No. 18.
- Trewartha, G., 1954: An Introduction to Climate, McGraw-Hill Series in Geography, Toronto, Canada.

GLOSSARY OF MALAY TERMS

- Belukar - jungle regrowth or secondary jungle.
- Dusun - orchard of mixed fruits.
- Lallang - a coarse tropical grass.
- Rentis - a track or trace cut through the jungle usually in a straight line. *The plural form of this term in Romanized Malay is rentis2.*
- Sungai - river.

