FIELD CLASSIFICATION of SARAWAK SOILS

(1 st. Approximation)

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By

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FIELD CLASSIFICATION OF THE SOILS OF SARAWAK

(1st Approximation)

I. INTRODUCTION

1. The Soils Division of the Department of Agriculture started its activities at the end of 1959. Before that time not much soil survey work had ever been undertaken in Sarawak and the available information on soils was scarce. It was concerned mainly with areas covered with "kerangas" forest, studied by T.W. Dames in 1956, together with several areas covered with extensive swamp forest, surveys of which were carried out by Sir Bruce White, Wolfe Barry Ltd. (1956).

2. In 1959 the survey section of the then called Soils Laboratory investigated several areas being approximately 42,000 acres in extent.

3. In 1960 with the arrival of three new soil surveyors the rate of surveying increased considerably and reached a total of 1800 sq. miles or 1,148,000 acres. In 1962 the Survey Section was able to increase this acreage to a total of 1,600,000 acres.

4. At present a total of 4360 sq. miles of Sarawak has been mapped, mainly on a reconnaissance basis, while in addition information is available over an area of approximately 5000 sq. miles studied by means of photopedological interpretation. The total area of known soil is therefore 9360 sq. miles or approximately 20% of Sarawak.

5. The rate of surveying in Sarawak is unusually high and this is caused by the following factors:-

   a) There is a need for a quick agricultural appraisal of large areas at present not inhabited.

   b) Areas for which feeder roads or other roads have been planned need to be investigated so as to avoid wastage of funds on the building of roads in inferior areas.

   c) Reconnaissance surveys in densely populated areas are needed to find out which areas are promising for intensified agriculture. The selecting of certain areas with prospects will avoid wasting time and funds otherwise spent in areas with less prospects.

6. In most other countries of the world, advanced or underdeveloped, the Soil Survey organisations have been given time to make a slow start, during which basic information could be collected and worked out. Hence a systematic grouping of soil became possible. The rate of surveying thereafter could accelerate depending on the value governments were attaching to the services of a soil survey organisation. This steady progress and this step by step developing of a survey system was typical for most European countries and in the tropics with old established soil survey organization.

7. Not so, however, in Sarawak where immediate and quick action was wanted. As a result a wealth of information on Sarawak soils has been collected but because of the great need for more and more surveys the small staff was neither able to record properly their investigations and to study certain soil phenomena, nor to make an attempt to bring order in the multitude of soil mapping units which have been in use in the past three years.

Certain soil groups have been given three different names because they were mapped independently by several surveyors in different parts of the country.

8. The following is therefore the first step being made to bring order to this chaotic situation.

The system worked out in this paper aims at classifying soils according to groups which we call Soil Associations. They are more or less convenient mapping units related to Topography and Parent Material mainly. From the experience gained in the last three years it appears that soils are strongly related to those two factors and the soil surveyors have not hesitated to make full use of this in soil mapping.

9. The choice of mapping units or associations is related to the reconnaissance nature of most of our work, and most of the defined units will therefore be used for reconnaissance mapping mainly.

10. In detailed surveying it will be possible to map soils within the association separately. It is therefore our aim to sort out in the near future the known soil series within the association and to define them. This work involves the classifying of approximately 1000 profiles brought into the Soils Laboratory in the last two years and the sorting out of the analytical data of approximately 5000 soil samples. Thereafter it will be possible to place a mapped soil in a certain soil group or soil series corresponding to the description of the soil and the average chemical features.

11. The working out of such a system is, however, very time consuming and because of the relatively short time since the Soils Division started to function and the fact that every day new soil series are discovered, the complete systematic grouping of Sarawak soils will require many more years work.

12. The present system aims at avoiding more chaos if soil surveying proceeds and it will enable the surveyors to map soils and to group them according to a classification system which can be enlarged and improved upon in time to come. It is estimated that this system will cover about 75% of Sarawak soils. The remaining 25% is made up of soils in the interior mainly and on the high plateaux of which but little information is available at present.

13. It is the intention that from now on in survey and other technical reports reference will be made to this classification system. The definitions and descriptions of the soil units will enable agriculturists, if they care to study this

classification, to place soils in these units and they should get used to the terminology and names of the Associations so that they know the implications if a soil is properly classified.

14. This system will be reviewed and amended from time to time to keep abreast with accumulating knowledge on soils in Sarawak until we have reached the stage at which we can compile an index system on Sarawak Soil series giving name, definition, characteristics, chemical properties and relative fertility.

15. In working out this system I had the valuable aid of Mr. D. Wall whose knowledge of the coastal areas was mainly responsible for sorting out the soils found in these areas.

16. A word of warning would not be out of place. It should be realised that the ultimate aim of our work cannot be reached in a couple of years and that what other countries have achieved in 50 years cannot be done overnight in Sarawak. This work, however, gives in a condensed form more or less the knowledge which we have acquired in the past years.

II. MAIN OUTLINE OF THE CLASSIFICATION SYSTEM

1. In order to work out a system which is scientifically and technically sound but which at the same time should be practical for use in the field the two main soil forming factors in Sarawak have been closely studied.

2. By using experience obtained from studying aerial photographs coupled with field observations all the topographical units or LANDSCAPE UNITS found in Sarawak and visible on aerial photographs (to make our system practicable) have been classified and defined.

3. Appendix A. gives in detail the classification of Landscape units used for our field classification of soils.

All landscape units received a code number and this will be used when interpreting aerial photographs.

The main groups in this classification are :

A group - Coastal landforms
B group - Riverine landforms
C group - Swamp and marshes
D group - Mountain and Hill forms

Each group is subdivided into smaller groups or units which can be detected on the aerial photographs and which have been found of importance for soil formation.

4. In certain instances it will be impossible to outline on the aerial photographs or small scale maps areas of one landscape unit or soil group and therefore we have made a group of composite landscape in which several units can be found which are closely related to each other. Those

/composite

composite landscape units enable the soil surveyor as well to group several soils together into one single broad group related to the composite landscape unit in which it is found. This has been proved of value in broad reconnaissance surveying where on a very small map large numbers of soil units have to be outlined clearly.

5. The composite landscape units are:-

I. Recent coastal landscape.

II. Old coastal landscape.

III. Riverine landscape.

IV. Dissected peneplain formations (subdivided into low stage, intermediate stage and strongly dissected stage).

V. Mountain landscape.

VI. Limestone topography.

6. It must be understood that this classification system is by no means infallible. In instances it is founded on theories and assumptions because e.g. it has still not been proved that certain units belong to an old coastal landscape and they might well belong to old riverine landscape units. The landform, however, is there, while the names given to them are sometimes arbitrary. Again amendments will certainly be necessary if with progressing field work more proof is found.

7. As said, next to Topography, Geology is the second important soil forming factor in Sarawak. While in instances topography might overrule the influence of Parent Material (specifically in the coastal, riverine and swamp areas) in other places (mainly hills and mountains) the Parent Material has a dominant influence on soil development.

8. Therefore, as for the Landscape Units also the Geological formations found in Sarawak have been classified in a certain order to show their influence on soil formation.

It is fortunate that in Sarawak we have comparatively large scale reconnaissance geological maps which enable us to get a knowledge of the Geology of most areas in Sarawak. However, the information given on the Geological maps is not always of direct use to the soil surveyor because large areas, especially the ones covered with sedimentary rocks, are mapped more as geological time sequences than lithologically. Some interpretation is therefore necessary. With the experience of the last three years we are able to judge with some certainty which geological formation or feature is of importance for soil development in Sarawak and this forms the backbone of our classification of Geological units.

9. Appendix B shows in detail how the geological formations are classified. They are divided into 8 main groups, namely:

1. Igneous rock types.
2. Sedimentary rocks 1. sandstones 2. shales
3. Metamorphic rock types.
4. Limestone
5. Alluvia 1. Recent riverine 2. Recent marine 3. Old riverine 4. Old marine
6. Mixtures of alluvium and colluvium.
7. Colluvium.
8. Swamp deposits

The main groups are again subdivided into minor units according to a decimal code system. Certain groups are placed a bit arbitrarily but it is in instances difficult to class a unit because it could be placed in two groups. Code numbers are used for aerial photo interpretation and other purposes.

10. The classification of geological formations is by no means complete, but it reflects our present knowledge. It might well be the case that with more detailed surveying and studies, a finer subdivision would be necessary.

11. With the study of the landscape units from the aerial photographs and the information obtained from the Geological maps together with our present field knowledge we are able to prognose often with some certainty what soil groups will occur in about 75% of Sarawak. Through the process of elimination we are often left with a small number of possibilities which need to be checked in the field.

12. By using this system it is possible to map vast areas in a comparatively short time. The system is, however, only practicable on a reconnaissance scale. The fixing of exact boundaries of soil types within a group related to topography and geology needs to be done with a considerable amount of field work because such soil differences do not show up either on photographs or geological maps.

13. The systematic grouping of the landscape units against the geological formations offer us the key for our field soil classification which is outlined in detail in the following section.

III. MAIN CHARACTERISTICS OF THE FIELD SOIL CLASSIFICATION

1. For a discussion of the soil classification the schematic but detailed outline given in the accompanying table (see Appendix C) is referred to.

2. Following the system used for classifying the landscape units, the soil groups or Soil Associations as we have named them, are grouped in the same manner.

3. The following main groups of Soil Associations can be distinguished:

1. Coastal Associations.
2. Riverine Associations.
3. Swamp and Marsh Associations.
4. Mountain and Hill Associations.

Each group is subdivided into sub-group associations which are related either to sub-group landscape units, sub-group geological formation or according to different soils occurring on the same landscape unit or geological formation. This subdivision is done by using a decimal code system, the associations thereby receiving a code number which will be used as a reference number for a certain association.

4. That this system is not merely an artificial one, can readily be seen if we study the relationship which exists between the association groups and the Great World Soil Groups, or higher level soil classifications.

5. Soils of the Coastal Associations group fall in the ALLUVIAL SOILS mainly. This is also the case with the Riverine Group. All swamp and marsh associations fall in the ORGANIC SOILS with a few exceptions, while the RESIDUAL SOILS comprise the Mountain and Hill Associations.

The following table illustrates this better.

Coastal Associations Riverine Associations	- ALLUVIAL SOILS
Swamp and marsh associations	- ORGANIC SOILS
Mountain and Hill Associations	- RESIDUAL SOILS.

6. A similar table can be given to show the relation between the Associations and the World Great Soil Groups.

Coastal Associations	-	mainly REGOSOLS HUMUS PODSOLS GROUNDWATER PODSOL HALOMORPHIC SOILS few GLEY SOILS
Riverine Associations	-	mainly REGOSOLS GLEY SOILS few HUMUS PODSOLS AND INTERGRADES.
Swamp and Marsh Associations	-	mainly BOG SOILS HALF BOG SOILS GLEY SOILS HALOMORPHIC SOILS
Mountain and Hill Associations	-	mainly RED PODSOLIC SOILS YELLOW PODSOLIC SOILS

RED YELLOW PODSOLIC SOILS

INTERGRADES TO HUMUS PODSOLS.

7. This volume contains an ASSOCIATION INDEX in which each association is defined and described in as much detail as possible. It will be necessary, in a number of cases, to generalize, because the nature of the soils in each association is not yet fully understood and there is always the possibility that within a certain association not all soil units have yet been found or properly described. It will therefore be necessary to amend this index system if more knowledge is acquired.

8. Soils found within an association have been given a group number because most of the soils have not been sorted out yet and we have therefore abstained from designating series names at this stage. These numbers can at a later date be replaced by proper names if we know for certain that a soil group can be classified as one series. Similar soil groups can occur in several associations.

9. All soil groups are classified systematically in the SOIL GROUP INDEX. While the ASSOCIATION INDEX is in fact a practical aid for soil surveying, the SOIL GROUP INDEX is more an inventory of the soils so far discovered in Sarawak. This index will be subject to close study and checking in the field so that as our next step in building up our classification system proper soil descriptions can be given for each soil unit. It will provide us as well with a sound basis on which experiments aimed at assessing soil fertility levels can be carried out.

10. In instances it is possible to assess the relative fertility of soil groups by taking in account the age of the soil and its parent material. Although no morphological difference between certain soil units will be noticeable, a chemical difference will often exist if the soil has derived from either poor or rich parent material.

This is often the case with hydromorphic alluvial soils and weakly developed young alluvial soils. In such cases parent material has still a bearing on the fertility of the soil, while this influence will diminish when the soil is in an advanced stage of development.

For such soils the suffix (r) or (m) will be used to indicate that the parent material of the soils was respectively rich (often basic igneous rocks) or medium (often acid igneous rocks and metamorphic rock types). In the case of limestone being the parent material the suffix (l) is used.

In this way we are able to indicate differences in fertility levels in otherwise similar soils.

11. In describing the Associations reference is made to the natural vegetation. Details of the natural vegetation types are given in the "Classification of vegetation types""prepared by J.A.R. Anderson of the Forest Department and which can be found in the back of this volume.

12. Finally, I would like to re-emphasize that this classification scheme is the first attempt to bring order into our soils work and to provide the Soils Division with a base on which further studies can be founded. It is definitely not the final answer and it is open to amendments, alterations and improvements. I express the hope that everybody working with soils in Sarawak will make use of this scheme. Agriculturists are especially invited to make a proper use of the classification in case advice is needed. The mere reference to a certain association or soil group encountered will enable the soil surveyors to give better advice on soil use. Helpful suggestions and sound criticism will be most welcome from all angles. It is anticipated that in 1963 an enlarged revision will be prepared.

(J.P. Andriesse)
Head of Soils Division.

SOIL-ASSOCIATION INDEX

1. In the association index each soil-association found in the Soil Classification outline (appendix C) is described in detail giving name, code number and the code numbers of the soil groups occurring within the association together with short description of the landscape, parent materials and vegetation.

2. While appendices A and B respectively, have served as a guide, for the nomenclature of the landscapes and the parent materials, in describing the natural vegetation the classification of vegetation types found in the back of this paper has been used. Only natural vegetation has been properly classified while secondary forest in relation to hill paddy farming has not been differentiated for the sole reason that changes occur every year and also because secondary forest in normal instances does not reflect the nature of the soil.

3. In describing the main soil groups of the association the most typical soil group within the association have been described first, but in a number of cases this was impossible. In Soil maps it will therefore be necessary to indicate which soil groups occur in a mapped association and of what proportion, if that is possible. It can happen e.g. that certain soil groups do not occur at all, while also the opposite is true namely that more soil groups will occur, not given in the description of the association in the context of this paper.

4. The same applies for the description of the minor soil groups within the association.

5. We have tried to indicate fertility levels of the associations. In most cases the fertility is dependent on the fertility level of the main series. Indications to fertility levels and related crop suitability is very arbitrary because of the absence of any experimental data and correlation between analytical results and crop-behaviour. The study of this aspect of our classification will be our next aim but it is anticipated that a considerable time will elapse before definite fertility levels and potential crop suitability can be given.

   To aid agriculturists in crop choice we have tried to give some indications but it must be stressed that those indications must be used with some reserve and that soil features of localised nature will often have a bearing on both fertility and crop suitability.

6. The fertility levels given apply only to Sarawak soils. In general a highly fertile level in Sarawak will be very moderate for world standards. While medium and low fertility levels will invariably be regarded as low to very low outside Sarawak.

7. The complex associations have not been described in this index because the possibility on the occurrences of soil types are so manifold that it is not feasible to give a characteristic description.

Association: TATAU

Code nr. 11

Description of the association.

Code nrs. soil groups in association
B.1
B.1(ca), B.7 and B.4

Typical landscape Recent beaches and sand bars. Flat to gently undulating. Usually between the shore-line (Oya Ass.) and peat (Anderson Ass.)

Parent materials Recent marine (quaternary) deposits, coarse to medium, non-calcareous mainly.

Natural vegetation or land use Similar to shallow peat vegetation - Asam paya, pelai, terentang, nibong. Rarely used for cultivation.

Description main soil series or soil groups

B.1 - Undifferentiated to slightly differentiated sands, W.T. above 24" normally. Non-calcareous.
Usually light grey to brown in colour. When light grey may be dark grey beneath W.T. and faint red-yellow mottles above.
Beginnings of peat accumulation often as topsoil.
Always too wet to dig pit below W.T.
Possibility of subdivisions into:

B.1.1 - Brown sands (peat humus staining or B_2 remnant? as at Tatau).

B.1.2 - Very pale brown, grey and light grey sands.

Description minor soil series or soil groups

B.1 (ca) - as B.1 but with shelly horizons in profile

B.4 (all subgroups) described under 12

B.7 - In this case drowned. Described under 14.

Tentative fertility level Without peaty topsoil and non-calcareous - poor. With peat and non-calcareous - potentially medium to good. Without peat and calc. - medium to good, i.e. sand by itself being mainly quartz is poor.

Tentative crop suitability Before drainage - sago, jelutong?
After drainage - annuals, coconuts (dwarf), bushfruit (papaya, citrus, etc.) - mainly shallow rooting crops

Association: IGAN | Code nr. 111

Description of the association.	Code nrs. soil groups in association
	B.1
	B.2.1 and B.2.2

Typical landscape

See 11, but including margins of peat swamps and infilled lagoons, flat to very gentle undulating.

Parent materials

See 11 plus freshwater organic swamp deposits.

Natural vegetation or land use

See 11

Description main soil series or soil groups

B.1. - described under 11.

B.2.1 and B.2.2 described below may become equal to or predominant over main series.

Description minor soil series or soil groups

B.2.1 - as B.1 (described under 11) but with up to 3 feet peat on sand.

B.2.2 - as B.2 (described under 11) but with up to 3 feet muck on sand.

Tentative fertility level

See 11

Tentative crop suitability

See 11.

Association: MUKAH

Code nr. 112

Description of the association.	Code nrs. soil groups in association
	B.1
	B.3.1 and B.3.2

Typical landscape

See 111

Parent materials

See 111 but including fine textured material

Natural vegetation or land use

As 11 and 111 but where shallow swamp on clay occurs it is often used for swamp padi, sago or rubber cultivation.

Description main soil series or soil groups

B.1 - described under 11

B.3.1 and B.3.2 as described below may become equal to or predominant over main series.

The clay beneath peat or muck may be riverine clay in which case there is a strong affinity with A.4(a)1 and A.4(a) 2 described under 222.

Description minor soil series or soil groups

B.3 - marine or possibly riverine clays covered with peat or muck.

B.3.1 - Up to 3 feet of peat on clay

B.3.2 - Up to 3 feet muck on clay.

Tentative fertility level

As 11 and 111 except clay beneath peat is more fertile than sand of 11 and 111.

Tentative crop suitability

As 11 and 111, plus - padi, oil, palm, coconut, other perennials after suitable improvement.

Association: OYA

Code nr. 12

Description of the association.	Code nrs. soil groups in association
	B.4
	B.1, B.4.1, B.4(ca) and B.7

Typical landscape

Recent beaches and sand bars. Flat to undulating.

Parent materials

See 11

Natural vegetation or land use Rhu laut, penaga laut, baru laut.

Often cleared for cultivation. Then reverts to poor scrubby 'heath land' used as cattle grazing.

Description main soil series or soil groups

B.4 - Undifferentiated to slightly differentiated very pale brown to yellow sands.

W.T. more than 24 inches deep normally.

Below W.T. soil is olive grey to dark grey (containing abundant minute organic fragments)

Excessive drainage to W.T.

Occasionally, one or more of minor groups described below except B.1 may be predominant.

Description minor soil series or soil groups

B.1 as described under 11 with all subgroups.

B.4.1 as B.4 described above but with faint to strong red-yellow/strong brown mottling in subsoil.

/or

B.4 (ca) as B.4 described above but calcareous. (shells)

B.7 described under 14 (eroded coast)

Tentative fertility level

Medium under natural vegetation, very low once cleared.

Tentative crop suitability

Not suitable for cultivation unless much fertiliser added regularly - then for vegetables, coconuts, water melon.

Association: EDIN

Code nr. 121

Description of the association.	Code nrs. soil groups in association
	B.1 and B.4
	B.2.1 and B.2.2, B.3.1 and B.3.2

Typical landscape

Gently undulating: sand spit - lagoon landscape near river mouths mainly.

Parent materials

See 11 and 12

Natural vegetation or land use

See 11 plus 12

Description main soil series or soil groups

B.1 as described under 11

B.4 as described under 12.

In places B.2.1, B.2.2 and B.3.1 with B.3.2 given as minor series below may t equal or predominant over the main series.

Description minor soil series or soil groups

B.2.1 - as described under 111 peat on sand
B.2.2 - as described under 111 muck on sand
B.3.1 - as described under 112 peat on clay
B.3.2 - as described under 112 muck on clay

Tentative fertility level

Peats and mucks as for 11 and 112. Sand bars as for 12.

Tentative crop suitability

As for 11 and 112, and 12

Association: KABONG

Code nr. 122

Description of the association.	Code nrs. soil groups in association
	B.5 and B1 and with B4
	B.5 and B.4.1 with B.4 (ca)

Typical landscape

Sand bars and still accumulating lagoons

Parent materials

As 11 plus salt water deposits in lagoons.

Natural vegetation or land use

As 11 or 12 on sand bars, mangrove and nipah in lagoons

Description main soil series or soil groups

B.1 - as described under 11

B.4 - as described under 12

B.5 - as described below may be equal to or predominant over the main series.

Description minor soil series or soil groups

B.4.1 - as described under 12

B.4(ca)- " " " 12

B.5 - saline peats and mucks, 0 - 3 feet deep on mixed saline clays and sands (Not differentiated yet) - Strong affinity with M.5 (see 33).

Tentative fertility level

As 121.

Saline soils, potentially fertile

Tentative crop suitability

As 121. Saline soils not usable with present knowledge of agriculture.

Association: SEMATAN

Code nr. 13

Description of the association.

Code nrs. soil groups in association

B.6

Typical landscape

Recent to old beach landscape. Flat to undulating.

Parent materials

As 11, possibly originated from micaceous fluviatile deposits.

Natural vegetation or land use

As 11 and 12

Description main soil series or soil groups

B.6 - deep, ferruginous sands, slightly podsolised in top.

Subsoil may have soft to hard iron concretions.

Imperfectly drained in lower horizons.

Description minor soil series or soil groups

Not investigated yet.

Tentative fertility level

Medium to poor.

Tentative crop suitability

Without fertilizing coconut. With incorporation of organic matter suitable for vegetables.

Association: MIRI

Code nr. 14

Description of the association.	Code nrs. soil groups in association
	B.7a and B.7.b
	B.8

Typical landscape

Flat to very gently undulating coastal terraces, present sea level.

Parent materials

Quaternary marine alluvium, mainly quartz sand.

Natural vegetation or land use

'Kerangas' - rhu bukit, sempilor, bindang, Kawi, keruing sindor, Rarely cultivated.

Description main soil series or soil groups

B.7 - podsolic sands.

B.7.(a) - True humus podsol with weakly developed B1/2 horizons.

B.7.(b) - True humus podsol with strongly developed B1/2 horizons.

The B horizon may be found below augering depth of 4 feet.

Excessive drainage to B_2, then waterlogged. When occurring at present sea level the podsol may be 'drowned' by encroaching peat swamp.

B.7.(a) and B.7.(b) have strong affinities with respectively A.8 and A.6 or R.10 c and b.

Description minor soil series or soil groups

B.8 - described under 15.

Tentative fertility level

Low to medium under natural vegetation. Very low after removal of vegetation.

Tentative crop suitability

Unsuitable for agriculture.

Association: TANAH PUTEH	Code nr. 15
	Code nrs. soil groups in association
Description of the association.	B.8, B.9
	B.7a and B.7b, B.3.1 and B.3.2

Typical landscapes

Flat to very gently undulating. Coastal terraces, probably some old river terraces.

Parent materials

Quaternary marine and possibly riverine alluvium. mainly fine textured, occasionally coarse.

Natural vegetation or land use

Graduations between poor lowland Dipterocarp and 'kerangas', very rarely cultivated.

Description main soil series or soil groups

B.8 - Deep white to pale yellow clays and silty clays. May be faint red-yellow mottles in subsoil. White colour probably due to old marine influence, (i.e. relic gleying). In deeper subsoil blue grey marine clay layers may be seen.

Drainage poor to medium.

B.8 (a) - as B.8 but with quartz grit layer (possibly old disintegrated pebble layer).

B.9 - as B.8 but with yellow topsoil.

Description minor soil series or soil groups

B.7a - as described under 14

B.7b - as described under 14

B.3.1 and B.3.2 as described under 112 - in peat and muck filled hollows.

Tentative fertility level

Low to very low.

Tentative crop suitability

Unsuitable for agriculture mainly.

Association: RIDGEWAY (composite Miri/Tanah Putih)

Code nr.16(14/15)

Description of the association.	Code nrs. soil groups in association
	As for 14 and 15
	As for 14 and 15

Typical Landscape

Old terraces (coastal and possibly marine)

Parent materials

Quaternary alluvium, coarse to fine

Natural vegetation or land use

Kerangas to poor Lowland Dipterocarp.

Description main soil series or soil groups

Heterogeneous but mainly B.7a and b as described under 14 and B.8 and B.8(a) as described under 15.

Ridgeway is quite similar to Tanah Putih but the podsolization is in general more pronounced giving rise to more B.7a and B.7.b

While in Miri association podsols are predominant and in Tanah Putih because of the more clayey nature of the soils humus podsols are in the minority, in Ridgeway both soil groups occur in roughly equal proportions.

A better classification of these three associations is definitely needed at a later date.

Description minor soil series or soil groups

See 14 and 15.

Tentative fertility level

Low to very low

Tentative crop suitability

Unsuitable for agriculture.

Association: UNDUP

Code nr. 21

Description of the association.	Code nrs. soil groups in association
	A.1

Typical landscape

High levees above normal water level. Usually small strips along the middle and upper stretches of the main river courses.

Parent materials

Heterogeneous recent riverine alluvium.

Natural vegetation or land use

If Primary - Riparian forest characterised by Belian, Engkabang, Keruing, Peran and Merbau. Also fruit trees like Durian are often to be found on these soils

Description main soil series or soil groups

A1. - Weakly developed yellow brown sandy to clayey deposits.
Sometimes faint mottling in subsoil indicating stagnant water in heavier textured layers.
The texture in the profile often ranges from sandy layers to clay loam layers.

In general well drained soils.

A1 is subdivided into A1.1 - sandy soils
A1.2 - clayey soils
A1.3 - alternative layers of sand and clay.

Description minor soil series or soil groups

Tentative fertility level

The fertility depends on the sources of the alluvium. It can be rich in the case of Basic Igneous and Acid Igneous rocks. When sandstones and shales are involved the soils are always lower in fertility.

Tentative crop suitability

Suitable for a wide range of crops. Especially fruit trees are doing well on these soils. Recommended for vegetables and also rubber.

Association: SEMILAJAU

Code nr. 211

Description of the association.

Code nrs. soil groups in association

A.1.1. -

A.1.2 and A.1.3

Typical landscape

See 21.

Parent materials

See 21 but mainly sands.

Natural vegetation or land use

See 21

Description main soil series or soil groups

A.1.1 as A.1 (described under 21) mainly sandy layers (sand to sandy clay loam).

Description minor soil series or soil groups

A.1.2 - as A.1 but mainly clayey layers (clay loams to clay).

A.1.3 - as A.1 but alternating sandy and clayey layers.

Both described under 21.

Tentative fertility level

Depending on source of alluvium. The clay soils are better than the sandy ones. See 21.

Tentative crop suitability

Restricted use because of rapid drainage.

Association : MALANG

Code nr. 212

Description of the association.	Code nrs. soil groups in association
	A.2
	A.1

Typical landscape

High levees above normal water level. Flat topped with gentle slopes towards basins.

Parent materials

Heterogeneous, depending on source of material. Mainly clays.

Natural vegetation or land use

Not typically found yet under Primary forest. Used for rubber and fruit trees.

Description main soil series or soil groups

A.2 - Deep, moderately well drained clay loams to clays. Yellow brown to strong brown in the top overlying yellow brown subsoils with intense red mottling throughout.

The A.2 is somewhat older than the A.1 or the material is more iron rich. Typically found at 24th mile Kuching-Serian road.

Description minor soil series or soil groups

A.1 described under 21. Occurring immediately on the river banks.

Tentative fertility level

Depending on source of alluvium.

Tentative crop suitability

All deep rooting crops as fruit trees, rubber.

Vegetables and other marketing crops.

Oil palm.

Association: KAYAN

Code nr. 213

Description of the association	Code nrs. soil groups in association
	A1.3
	A.1.1 and A.1.2

Typical landscape

See 21

Parent materials

See 21

Natural vegetation or land use

See 21. Often bamboo if under secondary forest.

Description main soil series or soil groups

A.1.3 as A.1 (described under 21) but with sandy and clayey layers. Often weak grey mottling in more clayey layers.

Description minor soil series or soil groups

A.1.1 and A.1.2 (described under 21).

Tentative fertility level

Depending on source of alluvium. Often of low fertility if soils are too sandy.

Tentative crop suitability

Fruit trees, especially citrus and rubber. Vegetables and coffee after incorporation of organic matter.

Association : ENTEBAR

Code nr. 214

Code nrs. soil groups in association

A.3

Description of the association.

Typical landscape

Low, inconspicuous levees, above normal water level but liable to yearly flooding.

Parent materials

Mainly mudstones of red colour.

Natural vegetation or land use

If Primary - Riparian forest. Fruit trees. Often used for rubber.

Description main soil series or soil groups

A.3 - deep, dark brown to dusky red friable clays which become blocky on drying.

Faint grey mottling may occur in subsoils.

Moderately well drained.

Most typically found along Sungei Dor, 2nd Division (Simanggang District).

Description minor soil series or soil groups

Some sandy soils of the same colour. Probably admixture of sands from other sources.

Tentative fertility level

Low fertility, but physically good.

Tentative crop suitability

Fruit trees and rubber.

Association: STRAP

Code nr. 22

Description of the association.	Code nrs. soil groups in association
	A.4 - A.4.a - A.4.b - A4(a)1,2 - A4(b)1,2
	A.1

Typical landscape

Very low levees with gentle slopes slightly above normal water level in river. High water table and flooded during wet season. Mainly occurring at lower stretches of river courses. Locally called "empran". Also filled up ox-bows.

Parent materials

Heterogenous riverine deposits ranging from sands to clays. Organic deposits occur as minor parent materials.

Natural vegetation or land use

Ranging from true Riparian forest to Peat swamp forest. Mainly used for wet paddy land.

Description main soil series or soil groups

A range of soils with hydromorphic features as gleying and redox layers. Can be covered with a topsoil of organic deposits up to three feet of depth.

A.4 - Dark reddish brown to grey brown or grey sands to clays overlying red, brown or yellow mottled grey subsoils which are merging into dirty white to bluish grey gley - horizons.

Sandy soils often have strong brown mottles, while clay soils show distinct reddish mottles.

A.4 is subdivided into (a) clay soils
(b) sandy soils

A.4(a)1 - as A.4a but covered with up to 3 ft. of peat
A.4(a)2 - as A.4a but covered with up to 3 ft. of muck
A.4(b)1 - as A.4b but covered with up to 3 ft. of peat
A.4(b)2 - as A.4b but covered with up to 3 ft. of muck.

Description minor soil series or soil groups

Small strips of A.1 (described under 21) might occur on somewhat higher grounds.

Tentative fertility level

Depending on parent material. Often of medium to high fertility for Sarawak standards. If Parent material is sandstone, soils are invariably poor.

Tentative crop suitability

Use is restricted because of flooding and wet soil conditions. Mainly suitable for wet paddy. If drained possibly other crops. If flooding is serious sago might be an alternative crop.

Association: BYAT

Code nr. 221

Description of the association.	Code nrs. soil groups in association
	A.4 (a)
	A.1

Typical landscape

See 22

Parent materials

See 22, clay deposits mainly.

Natural vegetation or land use

See 22.

Description main soil series or soil groups

A.4 (a) - as A.4 (described under 22) but clay only.

Description minor soil series or soil groups

Some soils along the borders of the rivers might occur (A.1 described under 21) drier.

Tentative fertility level

Depending on parent material. Often fertile to medium fertile.

-

Tentative crop suitability

Limitations are flooding and drainage. Very suitable for wet paddy. Sago is an alternative crop if flooding is too bad. If drained, coconut, citrus, coffee.

Association: NYABOR

Code nr. 222

Description of the association.	Code nrs. soil groups in association
	A.4 (a) - A.4(a)1 - A.4(a)2
	A 1

Typical landscape

See 22

Parent materials

See 22 mainly clays and organic deposits.

Natural vegetation or land use

Description main soil series or soil groups

Very similar to 221 but included are peat and muck up to three feet deep overlying the clay deposits.

A.4 (a) as A.4 (described under 22) but only clays.
A.4(a)1 - as A.4a (described under 22) but peat over clays.
A.4(a)2 - as A.4a (described under 22) but muck over clay.

Description minor soil series or soil groups

Some drier soils described as A.1 (see 21) may occur.

Tentative fertility level

Dependent on parent material. Can be fertile to medium fertile.

Tentative crop suitability

Mainly wet paddy; after draining possibly coconut, coffee, citrus.

If flooding too bad, sago.

Association: (not yet extensively found)

Code nr. 223

Description of the association.	Code nrs. soil groups in association
	A.4 (b)
	A.1

Typical landscape

See 22

Parent materials

See 22 (sandy deposits only).

Natural vegetation or land use

See 22

Description main soil series or soil groups

A.4 (b) - as A.4 (described under 22) but sandy soils only.

Description minor soil series or soil groups

Some drier soils of A1 nature (described under 21)

Tentative fertility level

In general low (parent material often derived from poor sandstones).

Tentative crop suitability

Mainly wet paddy. If drained market gardening, coconut, citrus.

Flooding is limitation.

Association: SALITUT

Code nr. 224

Description of the association	Code nrs. soil groups in association
	A4(b) - A4(b)1 - A4.(b)2
	A.1

Typical landscape

See 22 - sands only with organic deposits

Parent materials

See 22

Natural vegetation or land use

See 22

Description main soil series or soil groups

A.4(b) - as A.4 (described under 22) but only sands.

A.4(b)1 - as A.4.b (described under 22) but peats on sands only.

A.4(b)2 - as A.4.b (described under 22) but mucks on sands only.

Description minor soil series or soil groups

Some drier soils of A.1 nature (described under 21) may occur.

Tentative fertility level

Dependent on parent material. In general low.

Tentative crop suitability

Mainly wet paddy. If drained, citrus, coffee and coconut. If flooding too bad, sago might be alternative crop.

Association: SADONG (Composite Undup/Strap)

Codenr. 23 (21/22)

Description of the association	Code nrs. soil groups in association
	Heterogeneous

Typical landscape

Low to very low levees not mapped separately because of small scale mapping or complex pattern of landscape units.

Parent materials

Heterogeneous riverine deposits and organic swamp deposits.

Natural vegetation or land use

Combination of 21 and 22

Description main soil series or soil groups

Mainly:

soils of the A.1 group (described under 21)

soils of the A.4 group (described under 22).

Description minor soil series or soil groups

A.4.1 and A.4.2 as described under 22.

A.3 as described under 214.

Tentative fertility level

Dependent on parent material. Fertile to poor.

Tentative crop suitability

Dependent on locality. Combination of 21 and 22.

Association: BUSO

Code nr. 24

Description of the association.	Code nrs. soil groups in association
	A.5 - A.6 - A.7 - A.8
	A.9

Typical landscape

Old river terraces - more or less flat areas (often partly eroded) well above present flood level of main river courses. Most typical along Sarawak Kiri river (1st Division)

Parent materials

Old riverine deposits (pebbles to loams)

Natural vegetation or land use

Typical Kerangas forest (Lowland heath forest) or very poor Lowland Dipterocarp forest. Partly in use for rubber or under secondary vegetation.

Description main soil series or soil groups

Heterogeneous soils, all with podsolic features.

A.5 - Yellow to very pale yellow (sometimes white) topsoils on darker yellow or white with yellow mottled subsoils. Texture of subsoils often heavier than topsoils. Quartz pebble layers frequently present in profiles. (pebbles often partly disintegrated).

A.5(a) - Overlying other older alluvial deposits (often pebble layer coincides with lower boundary of deposits).

A.5(b) - Overlying residual soils or rocks (often pebble layer indicates lower boundary of the old alluvium).

A.6 - White topsoils with pronounced bleached A.2 horizon on well developed humus pan.
Pebble layers might be present.

(a) Overlying alluvium

(b) Overlying residual soils

A.7 - Truncated podsols (strongly developed humus pan found on top).

A.8 - White topsoils with pronounced bleached A.2 horizon on weakly developed B.1 (humus pan).

(a) Overlying alluvium
(b) Overlying residual soils

Description minor soil series or soil groups

A.9 - Yellow coloured soils sands to loams often with interlayers of pebbles of medium age. They are intergrades between regosols and podsolised soils.
(pebbles well preserved)

Several residual soils exposed in places where alluvium has been eroded.

Tentative fertility level

Very low fertility.

Only A.9 might be of low fertility.

Tentative crop suitability

At present regarded as unsuitable for agriculture.

A.9 possibly for rubber or citrus.

Association: UNDUP/BUSO (Composite association)

Code nr. 25

Description of the association.

Code nrs. soil groups in association

See 21 and 24

Typical landscape

Old terraces bordering younger ones in riverine landscapes

Parent materials

Old and recent alluvium (sands to loams)

Natural vegetation or land use

See 21 and 24

Description main soil series or soil groups

Heterogeneous.

Any described soil group of 21 and 24 can occur.

Description minor soil series or soil groups

Any described soil group of 21 and 24.

Tentative fertility level

Dependent on parent material. Mainly poor to very poor.

Tentative crop suitability

Mainly unsuitable for agriculture. Only soils classified under 21 can be used (see 21).

Association: REMUN

Code nr. 26

Description of the association.

Code nrs. soil groups in association

A.10

Typical landscape

High lying cones, developed at debouching points of quick flowing mountain streams.

Parent materials

Dependent on locality. (mainly alluvium and colluvium of coarse texture).

Natural vegetation or land use

Often Riparian forest. Many fruit trees as Durian, Rambutan, etc.

Often in use for the building of longhouses.

Description main soil series or soil groups

A.10 - Dark brown to reddish brown gravelly loams, often with boulders and pebbles embedded in profile.

Sandy layers may occur together with more clayey deposits.

Shallow and deep soils both occur. They can overly either parent material or residual soils of different parent material.

Description minor soil series or soil groups

Tentative fertility level

If derived from Basic igneous rocks fertile.

Tentative crop suitability

Suitable for all fruit trees and tree crops.

Association: ANDERSON

Code nr. 31

Description of the association.	Code nrs. soil groups in association
	M.1 - M.2
	M.3 - M.4

Typical landscape

Extensive basin freshwater swamps between rivers or backing coastal ridges. Flat or dome shaped.

Parent materials

Freshwater organic swamp deposits - mainly woody, sometimes with some mineral matter.

Natural vegetation or land use

Peat swamp forest - Mixed swamp forest, Alan forest - Alan bunga forest - Padang Paya forest.

Description main soil series or soil groups

M.1 - Woody peat deposits (more than 65% loss on ignition) from 3'to 60 feet plus.

M.2 - Mucks (mineral matter more than 35%) from 3' to 60 feet plus.

Peat and muck can be either on clay or sand.

M.1a - on clays.

M.1b - on sands

M.2a - on clay

M.2b - on sand

Description minor soil series or soil groups

M.3 - Muck overlying woody peat (muck top 0-3 ft deep).

M.4 - woody peat with muck interlayers deeper than 3 feet.

M.3a - on clays

M.3b - on sands

M.4a - on clays

M.4b - on sands

Tentative fertility level

Variable depending on quality of peat and depth. In general of low fertility.

Tentative crop suitability

If peat shallower than 10 feet drainage might be possible thereafter citrus, coconut and pineapple may be planted. Undrained peat will support sago.

Association: ANDERSON (1, 2 and 3) | Code nr.311,312 and 313

Description of the association.	Code nrs. soil groups in association
	depth phases of M.1 - M.2
	depth phases of M.3 - M.4

Typical landscape

See 31

Parent materials

See 31

Natural vegetation or land use

See 31

Description main soil series or soil groups

Anderson 1, 2 and 3 are depth phases of the Anderson association.

Soil groups are the same as for Anderson (see 31)

Anderson 1 - all soils peat or muck 3 - 6 feet deep.

Anderson 2 - all soils peat or muck 6 - 10 feet deep.

Anderson 3 - all soils peat or muck more than 10 feet deep.

Description minor soil series or soil groups

As Anderson (see 31) Anderson 1 - all soils 3 - 6 feet peat or muck.

" 2 - all soils 6 - 10 feet peat or muck

" 3 - all soils more than 10 feet peat or muck.

Tentative fertility level

Variable. Dependent on depth and quality of peat.

Tentative crop suitability

Anderson 1 and 2 can be drained (depending on locality) and are then suitable for coconut, citrus (possibly), and pineapple. Anderson 3 might support sago.

Association: SIRIK

Code nr. 32

Description of the association	Code nrs. soil groups in association
	M.1(s) - M.2(s)
	M.3(s) - M.4(s)

Typical landscape

Coastal swamp under saltwater influence (rare in Sarawak).

Parent materials

Organic swamp deposits (either originated from fresh-water swamp now submerged by seawater or originated from saltwater swamp).

Natural vegetation or land use

Mangrove-Nipah vegetation mainly.

Description main soil series or soil groups

The same soil groups occur as in Anderson (described under 31) but they are all under saltwater influence, the symbols will receive the suffix (s) for saltwater.

M.1 (s) - as M.1 (see 31) but saltwater influence
M.2(s) - as M.2 " " " "
M.1a(s) - as M.1a " " " "
M.1b(s) - as M.1b " " " "
M.2a.(s) - as M2a " " " "
M.2b.(s) - as M.2b " " " "

Description minor soil series or soil groups

M.3 (s) and M.4(s) for description see 31 (M.3 and M.4)
M.3a(s) " "
M.3b(s) " "
M.4a(s) " "
M.4b(s) " "

Tentative fertility level

Uncertain (not enough information).

Tentative crop suitability

At present regarded as unsuitable because of saltwater influence.

Association: SIRIK (1, 2 and 3) | Code nr. 321,322,333

Description of the association | Code nrs. soil groups in association | depth phases of M1(s) - M.2(s) | depth phases of M3(s) - M.4(s)

Typical landscape

See 32

Parent materials

See 32

Natural vegetation or land use

See 32

Description main soil series or soil groups

Sirik 1, 2 and 3 are depth phases of Sirik -association

Sirik 1 comprises all soils of Sirik (see 32) but peat or muck 3 - 6 feet deep.

Sirik 2 " " " " " (see 32) but peat or muck 6 - 10 feet deep.

Sirik 3 " " " " " (see 32) but peat or muck deeper than 10 feet.

Description minor soil series or soil groups

As Sirik (see 32) Sirik 1 - all soils 3 - 6 feet peat or muck.

Sirik 2 - all soils 6 - 10 feet peat or muck.

Sirik 3 - all soils more than 10 feet peat or muck.

Tentative fertility level

Uncertain.

Tentative crop suitability

Unsuitable for agriculture because of saltwater influence.

Association: REJANG

Code nr. 33

Description of the association	Code nrs. soil groups in association
	M.5 (a)
	M.5 (b)

Typical landscape

Saline lagoons and old meanders, saline delta swamps and saline coastal flats. In general flat terrain submerged by seawater or under tidal influence.

Parent materials

Marine deposits - mainly clays and silts.

Natural vegetation or land use

Mainly Mangrove and Nipah

Description main soil series or soil groups

M.5 Greyish brown (rusty mottled) topsoil on bluish grey to dark grey gleyed subsoil. Shells might occur in these soils. Sometimes a thin organic layer is found on top, while in the sublayers sometimes remnants of old mangrove and Nipah swamps can be traced.

M.5 (a) - clays

(The soils often show a yellow discolouration upon drying showing sulphuric acids present in the soil).

Description minor soil series or soil groups

M.5(b) - more sandy soil

Tentative fertility level

Rich in plant nutrients.

Tentative crop suitability

Only suitable for agriculture after reclamation and amelioration.

Association: PANTU

Code nr. 34

Description of the association	Code nrs. soil groups in association
	A.4 - A.4.1 - A.4.2
	A.1

Typical landscape

Medium to small size valleys between gently undulating hilly terrain to more steep hilly country.

Parent materials

A mixture of alluvium and colluvium, heterogeneous in mixture and dependent on the country rock.

Natural vegetation or land use

Primary forest - peat swamp forest mainly. At present mainly in use for wet paddy and under secondary forest.

Description main soil series or soil groups

This association is quite similar to STRAP - association described under 22, the difference being in landscape and the parent material.

Because of the hydromorphic nature of the soils in both associations the same soil groups are found. It might be possible to find differences between soils on a lower classification level.

A.4 - described under 22

A.4.1 - described under 22

A.4.2 - described under 22

As with association 22 both sandy and clayey soils can occur.

Description minor soil series or soil groups

Small strips of A.1 (described under 21) may occur near banks of small streams.

Tentative fertility level

Very muck dependent on parent material. Often fertile when occurring near basic igneous rocks and in conjunction with Serian association.

Tentative crop suitability

Suitable for wet paddy. Drainage and flooding are limitations for other crops.

Association: PLAN

Code nr. 341

Description of the association	Code nrs. soil groups in association
	A.4(b)
	A.4.1(b) - A.4.2(b) and A.1

Typical landscape

See 34

Parent materials

See 34 (mainly sandy soils)

Natural vegetation or land use

See 34

Description main soil series or soil groups

A.4 (b) as A.4 (described under 22) but sandy soils only.

Description minor soil series or soil groups

A.4.1 (b) - as A.4.1 (described under 22) but peats on sandy subsoils.

A.4.2 (b) - as A.4.2 (described under 22) but mucks on sandy subsoils.

Tentative fertility level

See 34.

Tentative crop suitability

See 34.

Association: SAMARAHAN

Code nr. 342

Description of the association	Code nrs. soil groups in association
	A.4(a)
	A.4.1(a) - A.4.2(a) - A1.

Typical landscape

See 34.

Parent materials

See 34 - mainly clay deposits.

Natural vegetation or land use

See 34.

Description main soil series or soil groups

A.4 (a) - as A.4 (described under 22) but clays only.

Description minor soil series or soil groups

A.4.1 (a) - as A.4.1 described under 22 but with peat topsoils on clay subsoils.

A.4.2 (a) - as A.4.2 described under 22 but with muck topsoils on clay subsoils.

A1 - dexcribed under 2.

Tentative fertility level

See 34.

Tentative crop suitability

See 34.

Association: PAYA MEGOK

Code nr. 35

Description of the association	Code nrs. soil groups in association
	A.4 - M.6
	A.2

Typical landscape

Flat valleys underlain by limestone. High watertable. Limestone might occur at surface. Most typical in Serian and Bau districts (1st Division.)

Parent materials

Heterogeneous. Often derived from Basic igneous rocks, limestone, shales and sandstone (mixed). Some old peat deposits.

Natural vegetation or land use

Mainly in use for wet paddy cultivation. Secondary vegetation - scrub and grasses.

Description main soil series or soil groups

This association has soils which are morphologically very similar to A.4 (described under 22).

In instances however an old peat layer may occur in the subsoil giving evidence of a former peat swamp. These soils are classified as M.6

M.6 - greyish brown topsoils overlying reddish and grey mottled sublayers which merge into an olive mottled bluish gley horizon. In this gley horizon layers high in organic carbon (peaty layers) may occur.

Both A.4 and M.6 can be either sandy or clayey but the latter occurs more frequently.

M.6(a) - clay type.
M.6(b) - sandy type.

Description minor soil series or soil groups

A.2 described under 212.

This soil has a lower watertable than A.4 and M.6 and occurs at higher localities in the valleys or immediately bordering a river flowing through the valley.

Tentative fertility level

Often highly fertile for Sarawak standards. pH can be as high as 6.

Tentative crop suitability

Suitable for wet paddy, but flooding is the main risk. If drained very suitable for off-season cropping vegetables, tobacco, groundnut and other annuals.

Association: (not yet found extensively) Code nr. 351

Description of the association	Code nrs. soil groups in association
	A.4(b)
	M.6(b)

Typical landscape

See 35

Parent materials

See 35 (but mainly sandy soils)

Natural vegetation or land use

See 35.

Description main soil series or soil groups

A.4(b) see under 22 (sandy soils)

M.6(b) see under 35 (sandy soils)

This association is similar to Paya Megok but for the texture of the soils.

Description minor soil series or soil groups

Tentative fertility level

See 35.

Tentative crop suitability

See 35.

Association: TAIE

Code nr. 352

Description of the association.	Code nrs. soil groups in association
	A.4 (a) - M.6(a)
	A.2

Typical landscape

See 35.

Parent materials

See 35 - but mainly clay.

Natural vegetation or land use

See 35.

Description main soil series or soil groups

Prototype of Paya Megok association.

A.4 (a) as A.4 (described under 22) clay soils.
M.6 (a) as M.6 (described under 35) clay soils.

Description minor soil series or soil groups

A.2 described under 212

See further 35.

Tentative fertility level

As for 35

Tentative crop suitability

As for 35.

Association: MUNDAI

Code nr. 353

Description of the association.	Code nrs. soil groups in association
	M.7

Typical landscape

See 35.

Parent materials

Old alluvial deposits mainly. Very quartzitic in nature. Mostly of sandy to sometimes gravelly nature.

Natural vegetation or land use

Mostly under secondary forest, partly used for wet paddy.

Description main soil series or soil groups

M.7 - Dark grey topsoils overlying white and grey coloured horizons with brownish yellow mottling. Gley horizon starts at watertable which is often not deeper than 2 feet. (mainly of sandy nature and quartzitic).

(drowned high level alluvium).

Description minor soil series or soil groups

Not investigated yet.

Tentative fertility level

Poor in plant nutrients, very leached.

Tentative crop suitability

Of marginal suitability for wet paddy cultivation. With incorporation of organic matter and manure suitable for market gardening in dry season.

Association: 351 - MUNDAI (composite)

Code nr. 354 (351/353)

Description of the association.

Code nrs. soil groups in association.

A.4(b) - M.6(b) - M.7

Typical landscape

As 35.

Parent materials

Mixture of recent and old alluvium, inseparable at reconnaissance level.

Natural vegetation or land use

Mainly under secondary forest or coarse grasses. Used for wet paddy.

Description main soil series or soil groups

Combination of 351 and Mundai associations.

Soils which occur are : A.4(b) see under 22 (sandy soils)
M.6(b) see under 35 (sandy soils)
M.7 - see under 353.

Description minor soil series or soil groups

Tentative fertility level

The A.4 and M.6 soils can be fertile depending on parent material. M.7 is invariably of low fertility.

Tentative crop suitability

Suitable for wet paddy and partly for market gardening and other annual crops if drained and grown outside the flooding season. (see under 35 and 353).

Association: SERIAN

Code nr. 41

Description of the association.	Code nrs. soil groups in association
	R.1 - R.2
	R.3 - A.C.1 - A.C.2 and L.

Typical landscape

Mountains and hills with steep to gentle slopes. More or less rounded. Typically found in 1st Division (Serian District).

Parent materials

Basic to Intermediate Igneous rocks (mainly basalts, andesites and allied rocks)

Natural vegetation or land use

Under Primary forest - Lowland Dipterocarp forest. At present mainly in use for hill paddy and under secondary forest, or lallang. Also in use for rubber and pepper.

Description main soil series or soil groups

R.1 - Deep, red to yellow red crumbly clays (depth can range from 2 - 10 feet). Homogeneous profile, overlying subsoils rich in weathered rock pieces of red colour.

R.2 - Deep, yellowish red - reddish yellow blocky clays (depth can range from 2 - 10 ft). Often faint mottling of stronger red or yellow colour in subsoil. Overlying weathering rock.

(there is a possibility that R.1 occurs on more basic material than is the case with R.2)

Description minor soil series or soil groups

Shallow phases of R.1 and R.2 as transitional soils to Skeletal soils.

R.3 - Very shallow gravelly clays to loams (brown to reddish brown), weathering rock often within 1 foot from surface. Occurring on slopes over 35°.

A.C.1 Deep, pale yellow blocky clays with gley features in subsoil. Often boulders of colluvial origin embedded in the soil (imperfectly drained).

A.C.2 Deep, well drained reddish yellow - yellowish red clays. As R.1 but with colluvial influence, often with boulders and/or gravel in profile.

L - Bouldery and rocky land without much soil cover, on very steep slopes and eroded slopes.

Tentative fertility level

Very much dependent on land use. Under Primary forest fertile. Under shifting cultivation deprived of most plant nutrients in available form. The skeletal soils can often give good rice crops after 5 years fallow. Physically very good, especially R.1 and R.2.

Tentative crop suitability

R.1 and R.2 and may be A.C.2 - pepper and further all deep rooting perennial crops. A.C.1 rubber mainly.

Association: TARAT (a) | Code nr. 411 (a)

Description of the association.	Code nrs. soil groups in association
	R.1 - A.C.2
	R.3

Typical landscape

Hills and mountains with moderate to gentle slopes not exceeding 35°).

Parent materials

See nr, 41

Natural vegetation or land use

See nr. 41

Description main soil series or soil groups

R.1 - described under 41.

A.C.2- described under 41.

(subdivision of 41 Association).

Description minor soil series or soil groups

Shallow phases of R.1

R.3 - described under 41.

Tentative fertility level

In general better than 41. The deep soils are physically of excellent quality and suitable for all deep rooting perennial crops. They are often low in plant nutrients especially when they have been in use for hill paddy and fertilizing is therefore often necessary for sustained good yields. It is possible that the soil is rich in plant nutrients in a non-available form.

Tentative crop suitability

Pepper, rubber, coffee (after incorporation of organic matter).

Association: TARAT (b)

Code nr. 411 (b)

Description of the association	Code nrs. soil groups in association
	R.3 - L
	R.1

Typical landscape

See 41 (steep slopes mainly exceeding 35°).

Parent materials

See 41.

Natural vegetation or land use

See 41 - mainly under Primary jungle.

Description main soil series or soil groups

Shallow phases of R.1 (described under 41).
R.3 - described under 41.
L. - bouldery and rocky land.

Description minor soil series or soil groups

R.1 described under 41.

Tentative fertility level

R.3 can be quite fertile for annual crops such as hill paddy because of the freshly weathered rock pieces in these skeletal soils. Erosion is main limitation and soil depth.

Tentative crop suitability

Of limited use. Only R.3 could be used if precautions are taken to avoid erosion.

Association: ANTAYAN (a)

Code nr. 412 (a)

Description of the association	Code nrs. soil groups in association
	R.2
	R.3

Typical landscape

Mountains and hills with moderate to gentle slopes (not exceeding 35°).

Parent materials

See 41

Natural vegetation or land use

See 41.

Description main soil series or soil groups

R.2 - described under 41.

Description minor soil series or soil groups

Shallow phases of R.1 (described under 41).

R.3 - described under 41.

Tentative fertility level

If virgin, fertile for Sarawak standards. If used, fertility declines quickly and fertilizing is necessary.

Tentative crop suitability

The deep phases can be used for all deep rooting perennials - especially pepper and rubber.

Association: ANTAYAN (b)	Code nr. 412 (b)
Description of the association	Code nrs. soil groups in association
	R.3 - L.
	R.2

Typical landscape

Steeply sloping mountains and hills (exceeding 35°).

Parent materials

See 41

Natural vegetation or land use

See 41, mainly under Primary forest.

Description main soil series or soil groups

Shallow phases of R.2 (described under 41).
R.3 - described under 41.
L. - bouldery and rocky land.

Description minor soil series or soil groups

R.2 - described under 41.

Tentative fertility level

See 411 (b)

Tentative crop suitability

See 411 (b).

Association: SUA	Code nr. 413
	Code nrs. soil groups in association
Description of the association.	A.C.1
	may be R.1 and R.2

Typical landscape

Hills. (moderate to gentle slopes not exceeding 35°)

Parent materials

See 41 but with colluvial influence.
(parent material might be of mixed nature).

Natural vegetation or land use

Mainly in use for hill paddy, rubber and pepper.

Description main soil series or soil groups

A.C.1 - described under 41.

Description minor soil series or soil groups

Probably R.1 and R.2 (not yet investigated in detail).

Tentative fertility level

Not much information available. Probably of same quality as R.1 and R.2 chemically but physically of lower quality.

Tentative crop suitability

Mainly rubber (internal drainage is main limitation)

Association: JAGOI

Code nr. 42

Description of the association.

Code nrs. soil groups in association

R.4 - R.5 - R.6 - A.C.3

R.7 and L.

Typical landscape

Mountains and hills (steep to gentle slopes) but mainly slopes exceeding 35°.

Parent materials

Acid Igneous rocks - mainly granites to micro granodiorites and allied rocks.

Natural vegetation or land use

Mainly under Primary forest - Lowland Dipterocarp forest. Sometimes under shifting cultivation and rubber.

Description main soil series or soil groups

R.4 - Yellow to reddish yellow moderately well drained clay loams to clays. Subsoils often more reddish coloured than topsoils. Reddish and yellow mottles may occur in subsoil. Rock pieces and boulders sometimes occur in soils on lower slopes indicating colluvial influence.

R.5 - Pale yellow blocky gritty loams on heavier gritty subsoils, pale yellow, often greyish mottled. Imperfectly drained.

R.6 - Very sandy gritty loams, well drained, of pale yellow colour. In this group are intergrades to true sand deposits accumulated on more gentle slopes.

A.C.3- Soils derived from acid igneous rocks but covering soils of different parent material such as shales and sandstones. Often occurring at the foot of mountains.

Description minor soil series or soil groups

R.7 - Very shallow to skeletal soils - yellow gravelly to sandy loams overlying weathering granitic material.

L. - Bouldery and rocky land.

Tentative fertility level

Dependent on soil age and soil use. If young the soils can be quite rich in potash. In most instances of moderate to low fertility.

All soils are physically inferior to the ones derived from basic igneous rocks.

Tentative crop suitability

Mainly rubber. On the deep, sandy types citrus.

Main limitation - soil depth and slope.

Association: TABONG	Code nr. 421
	Code nrs. soil groups in association
Description of the association	R.7 - L
	R.5

Typical landscape

High isolated mountains, steep slopes mainly, exceeding 35°

Parent materials

See 42.

Natural vegetation or land use

See 42 (mainly Primary forest - Lowland Dipterocarp forest).

Description main soil series or soil groups

R.7 - described under 42.

L. - Bouldery and rocky land.

Description minor soil series or soil groups

In places R.5, R.6 and A.C.3 may occur. This depends on colluvial action and local differences in slopes.

Tentative fertility level

Chemically the soils might be quite fertile if virgin and young.

Tentative crop suitability

The shallow nature of the soils and the steepness of slopes renders them unsuitable for agriculture.

Association: ABOK

Code nr. 422

Code nrs. soil groups in association

R.4

Description of the association

Tropical landscape

Hills (moderate to gentle slopes, not exceeding 35°)

Parent materials

See 42 - mainly occurring as dykes

Natural vegetation or land use

Mainly under shifting cultivation. Sometimes used for rubber and pepper.

Description main soil series or soil groups

R.4 mainly - described under 42.

Description minor soil series or soil groups

Depth classes of R.4

Tentative fertility level

Of low fertility but physically a good soil.

Tentative crop suitability

Rubber and oil palm. Pepper.

Association: SERIN

Code nr. 431

Description of the association	Code nrs. soil groups in association
	R.26
	R.8 and R.13

Typical landscape

Mainly hilly country with moderate to gentle slopes. In general slopes are steeper than in shale - country and more similar to a cuesta landscape.

Parent materials

Mainly Arkose, some sandstone and shale (undifferentiated)

Natural vegetation or land use

At present generally used for hill paddy and under secondary vegetation.

Description main soil series or soil groups

R.26 - Yellow to yellowish-red deep loams on more clayey subsoil of stronger red colour. The colour is often a typical dusky red.

Frequently quartz gravel may be found in so-called stone lines. The weathering arkose found in the lower horizons is of a red colour and has a sandy and porous appearance.

R.26 (a) - as R.26 but with yellow mottling in red coloured subsoil.

Description minor soil series or soil groups

R.8 as described under 44

R.13 as described under 451

Both can often be found in border areas where arkose merges into other geological formations.

Tentative fertility level

There are indications that this association is in general of low fertility if under shifting cultivation. Physically the soils are good.

Tentative crop suitability

Pepper and rubber. In general suitable for deep rooting perennials preferring good drainage.

Association: BAYUR

Code nr. 432

Description of the association	Code nrs. soil groups in association
	R.27
	R.28

Typical landscape

Hills with moderate to gentle slopes.

Parent materials

Mainly schistoid rock types, some shales and sandstones (undifferentiated).

Natural vegetation or land use

At present mainly under shifting cultivation.

Description main soil series or soil groups

R.27 - Deep, reddish yellow to yellowish red clays, crumbly and well drained.

Often quartz stonelines are present and/or relics of quartz veins.

In places dirty white coloured bauxite nodules might be present in the lower horizons.

Description minor soil series or soil groups

R.28 - a poorly drained clay soils with gley features derived from schist, occurring at lower slopes. Quartz gravel usually present.

R. 8 - described under 44 } Occurring in border areas of
R.13 - described under 451 } different geological formations

Tentative fertility level

Under shifting cultivation usually poor, but physically a good soil.

Tentative crop suitability

Deep rooting crops such as rubber, oil palm.
Pepper will do well on this soils under good management.

Association: SABU

Code nr. 433

Description of the association.	Code nrs. soil groups in association
	R.29
	R.3 and L.

Typical landscape

Hills (steep to gentle slopes)

Parent materials

Mainly tuffaceous sandstones. Some undifferentiated shales and sandstones.

Natural vegetation or land use

Lowland Diperocarp forest if Primary, used mainly for hill-paddy at present.

Description main soil series or soil groups

R.29 - Reddish yellow loams to clays of blocky structure. With reddish coloured weathering rock pieces in the subsoil.

Soil depth ranging from 1 - 5 ft. overlying hard partly crystalline tuffaceous sandstones.

A weak grey mottling in the uppermost part of the soil is often noticeable (surface gleying?).

Description minor soil series or soil groups

Depth phases of R.29

R.3 - skeletal soils - very similar to the ones described under 41 (Serian Association).

L. - Bouldery and rocky land on top of hills and on very steep slopes.

Tentative fertility level

Under Primary forest of good quality.

When used for hill paddy medium to low. Physically a good soil.

Tentative crop suitability

Rubber and pepper mainly. Oil palm will do but topography is too difficult.

Association: PENRISSEN

Code nr. 44

Description of the association	Code nrs. soil groups in association
	R.8 - R.9 - R.10
	R.11 and L.

Typical landscape

Mountains and hills (steep to gentle slopes). Also flat mountain and hill tops.

Parent materials

Coarse to medium grained sandstones and conglomerates.

Natural vegetation or land use

Ranging from true Kerangas Forest on flat land to Poor lowland Dipterocarp forest on steep slopes.

Description main soil series or soil groups

R.8 - Pale yellow sandy loams on strong yellow, more clayey subsoils. Weak brown and grey mottling in subsoil may be present.

R.9 - Yellow sandy loams to loams on bleached (lighter coloured - pale yellow to white) sublayers often strongly yellow mottled.
(often occurring in coastal areas on low hills which are thought to have been submerged by seawater at one stage).

R.10 - White sands to sandy loams on well developed podsolic B horizons of heavy texture.

R.10 (a) - yellow mottled textural B only.

R.10 (b) - weakly developed humus pan (brown - B2 horizon - related to A.6 (see nr. 24).

R.10 (c) - strongly developed humus pan (brown) - B2 horizon - related to A.8 (see nr. 24)

R.10 to R.10 (c) - all have bad internal drainage.

Description minor soil series or soil groups

R.11 - skeletal soils (yellow to white thin sandy soils overlying parent material).

L. - Bouldery and rocky land.

Tentative fertility level

Very low - Base deficient - High acidity.

Tentative crop suitability

Marginal suitability for agriculture (R.8) - rubber.

All others unsuitable.

Association: MATANG

Code nr. 441

Description of the association	Code nrs. soil groups in association
	R.8 - R.9 - L.
	R.11

Typical landscape

Mountain and hills with steep to moderate slopes.

Parent materials

See 44.

Natural vegetation or land use

See 44 (poor lowland Dipterocarp forest mainly).

Description main soil series or soil groups

R.8 (described under 44).

R.9 (described under 44).

L. - bouldery and rocky land.

Description minor soil series or soil groups

Depth phases of R.8 and R.9 (both described under 44)
R.11 (described under 44).

Tentative fertility level

Low fertility. (Low base status).

Tentative crop suitability

R.8 only suitable for rubber and may be other tree crops if properly fertilised. Rest unsuitable. Slope limitation.

Association: BAKO

Code nr. 442

Description of the association	Code nrs. soil groups in association
	R.10 - R.10 (a, b and c), R.11 & L.

Typical landscape

More or less flat lying areas, mainly on top of hills or mountains.

Parent materials

See 44.

Natural vegetation or land use

Kerangas forest mainly.

Description main soil series or soil groups

R.10)
R.10 (a))
R.10 (b)) all described under 44.
R.10 (c))
R.11)

L. - bouldery and rocky land.

Internal drainage very bad.

Description minor soil series or soil groups

Tentative fertility level

Very low.

Tentative crop suitability

Unsuitable for agriculture.

Association: SILANTEK

Code nr. 443

Description of the association

Code nrs. soil groups in association

R.10 - R.10 (a, b and c) R.11, L.

Typical landscape

Low hilly to flat terrain found at foot of mountains.

Parent materials

As 44 but mainly of colluvial nature.

Natural vegetation or land use

Primary forest is typical Kerangas - under secondary forest vegetation mainly somaha, semapak.

Description main soil series or soil groups

R.10)
R.10 (a))
R.10 (b)) described under 44.
R.10 (c))
R.11)

L. - bouldery and rocky land.

Agriculturally there is little difference between Bako and Silantek associations. The main difference being the nature of the parent materia.

Description minor soil series or soil groups

Tentative fertility level

Very low fertility.

Tentative crop suitability

Unsuitable for agriculture.

Association: NYALAU

Code nr. 444

Description of the association.

Code Nrs. soil groups in association

R.12

Typical landscape

Mountains and hills (moderate to gentle slopes)

Parent materials

Medium to fine grained sandstones.
(possibly shale influence)

Natural vegetation or land use

Primary forest - Lowland dipterocarp forest (poor) - used for hill paddy and under secondary forest.

Description main soil series or soil groups

R.12 - Weakly developed Ao horizon overlying yellow sandy loam merging into reddish coloured more clayey subsoils frequently mottled yellow and grey. Moderately well drained.

(typical red-yellow podsolic)

Description minor soil series or soil groups

Depth phases of R.12

R.8 (described under 44)

R.9 (described under 44, possibly in coastal areas only)

Tentative fertility level

Poor in bases, high acidity - Low fertility.

Tentative crop suitability

Suitable for tree crops, mainly for rubber. Possibly oil-palm with heavy fertilizing.

Association: BEDUP

Code nr. 451

Description of the association	Code nrs. soil groups in association
	R.13
	R.8

Typical landscape

Hilly landscape with moderate to gentle slopes

Parent materials

Sandy shales to shales, possibly graywacke.
(influence of feldspathic sandstone is to be expected).

Natural vegetation or land use

Lowland Dipterocarp forest if primary. Used for hill paddy and under secondary vegetation.

Description main soil series or soil groups

R.13 - Moderately well drained yellow to reddish yellow clays, overlying strongly red-mottled yellow subsoils often with small iron concretions or iron accumulations in the form of filled up old root-channels. Iron accumulations increase gradually sometimes forming a weak pan in the deeper subsoil.

At lower depths (more than 6 feet), a white and grey coloured layer with red mottles will often be present, which merges into parent material (mainly grey shales). In the shales iron accumulations are found in cracks and between shale layers.

Upon drying the soil has a strong blocky structure. It is normally in the moist state with a massive structure.

The profile is deep and the texture is clay throughout.

Description minor soil series or soil groups

R.8 - described under 44 (sandstone influence).

Truncated profiles of R.13.

Tentative fertility level

Low fertility in general. Low base status.
Physically a moderately good soil.

Tentative crop suitability

Rubber mainly, pepper with adequate fertilizing is possible.

Suitable for oil palm with heavy fertilizing.

Association: KAPIT

Code nr. 452

Description of the association	Code Nrs. soil groups in association
	R.14
	R.15

Typical landscape

Mountains and hills with moderate to steep slopes.

Parent materials

Sandy shales - shales, possibly graywacke.

Influence of feldpathic sandstone is to be expected.

Natural vegetation or land use

Lowland Dipterocarp forest of Primary. Used for hill paddy and rubber. Under secondary forest.

Description main soil series or soil groups

R.14 - Moderately well drained, shallow (often not deeper than 2 or 3 feet), yellow to reddish yellow clays with red and grey mottling in subsoil. Iron concretions hard and soft are normally present. Sublayers merge gradually into parent material (soft weathered shale, multi-coloured - grey-yellow and red).

Upon drying soils have a strong blocky structure.

Texture is usually clay but influence from nearby sandstone might give sandier soils.

Description minor soil series or soil groups

Deeper phase of R.14.

R.15 - Skeletal soils over shale on very steep slopes. Thin yellow brown clay layer mixed with flaky shale rubble merging into parent material. (grey, yellow and red coloured weathering shale)

Tentative fertility level

Low to medium fertility. Low base status.

R.14 is often younger than R.13 described under 451 because of erosion.

Tentative crop suitability

Mainly tree crops as rubber. May be oil palm. Main limitations are shallowness of soil and steepness of slope.

Association: SEMONGO

Code nr. 453

Description of the association	Code nrs. soil groups in association
	R.16
	R.13, R.15

Typical landscape

Mountains and hills with moderate to gentle slopes.

Parent materials

Shales (possibly carbonaceous), graywacke.

Natural vegetation or land use

Primary forest - Lowland Dipterocarp forest. Mainly used for hill paddy and under secondary forest.

Description main soil series or soil groups

R.16 - Imperfectly to moderately well drained yellow heavy clay overlying yellow clays with strong grey mottling (sometimes weak red mottling occurs) overlying partly weathered grey to to black shales.

Description minor soil series or soil groups

R.13 (described under 451)

R.15 (described under 452)

R.8 - might occur if sandstone occurs mixed with shales.

Tentative fertility level

Low to medium fertility - low base status.

Tentative crop suitability

At present only rubber is recommended. Oil palm might be a possibility.

Association: RAPAK

Code nr.454

Description of the association	Code nrs. soil groups in association
	R.17
	R.17(a)

Typical landscape

Mountains and hills with moderate to gentle slopes.

Parent materials

Carbonaceous shales mainly, shales and mudstone.

Natural vegetation or land use

If primary Lowland Dipterocarp forest.
Mainly under secondary vegetation and hill paddy.

Description main soil series or soil groups

R.17 - Well drained reddish yellow clay soils with layers of iron concretions loosely packed occurring at varying depths (range 2 to 4 feet). Iron concretions layers ofter directly overlies parent material.

Quite similar to R.13 described under 451 but stronger red colours and less mottling. White layer might sometimes be present in the form of a white/grey discolouration of the parent material.

Description minor soil series or soil groups

Depth phases of R.17

R.17 (a) with weak yellow mottling in the otherwise strong reddish yellow soil. Further as R.17.

Tentative fertility level

Low to medium fertility. (Low base status).
Structure is moderately good.

Tentative crop suitability

Suitable for tree crops such as rubber and oil palm (Depen-dent on soil depth). Pepper is recommended but only with heavy fertilizer applications.

Association: MERIT

Code nr. 455

Description of the association	Code nrs. soil groups in association
	R.12(a)
	R.9 - R.10

Typical landscape

Mountain and hills with steep to gentle slopes.

Parent materials

Sandy shales, shales and mudstones (possibly influence from feldspathic sandstone).

Natural vegetation or land use

Poor Lowland Dipterocarp forest when Primary. Used for hill paddy and under secondary forest.

Description main soil series or soil groups

R.12(a) - as R.12 described under 444

Soil more clayey (clay loams in the top soil to pure clays in the subsoil).

Often occurring together with R.9 and R.10 described under 44.

Description minor soil series or soil groups

Depth phases of R.12(a).

R.11 - Skeletal soils (see 44).

Tentative fertility level

In general low fertility - low base status and high acidity.

Tentative crop suitability

At present rubber is recommended. Possibly oil palm.

Association: KERAIT

Code nr. 456

Description of the association	Code nrs. soil groups in association
	R.18
	R.13

Typical landscape

Mountain and hills with moderate to gentle slopes.

Parent materials

Uncertain - soils are underlain by carbonaceous sandy shales.

Natural vegetation or land use

Only found under secondary forest. Used for hill paddy. (probably Poor Lowland Dipterocarp forest if Primary).

Description main soil series or soil groups

R.18 - Deep, white sticky clays with faint yellow mottling in subsoils. The white clays often overly clearly black coloured carbonaceous shales. A grit layer above the shale is often present. Gritty material sometimes occurs scattered within whole profile.

A sandy type of R.18 occurs, having more sandy topsoils. This soil type occurs in relation with R.9 (described under 44) or might be an intergrade to R.9.

Description minor soil series or soil groups

R.13 (described under 451).
R.8 (described under 44).

Tentative fertility level

Low fertility - low base status - high acidity.

Association: BEKENU (composite) | Code nr. 457

Description of the association	Code nrs. soil groups in association
	Heterogeneous

Typical landscape

Mountain and Hills with moderate to gentle slopes.

Parent materials

Thin bedded shales and sandstones (carbonaceous, feldspathic or quartzose).

Natural vegetation or land use

Heterogeneous-primary vegetation can range from Lowland Dipterocarp to Kerangas, but mainly the former.

Description main soil series or soil groups

A wide range of soils - soil groups depending on locality.
R.8 - R.9 and R.12 to R.18 can occur.
Mainly R.12 and R.12(a) soils described under 444 and 455.
Textures are of a mixed nature and depend on local variations in shales and sandstones.

Description minor soil series or soil groups

Skeletal soils of R.15 (described under 452).

Tentative fertility level

In general of low fertility.

Tentative crop suitability

Mainly rubber, possibly oil palm in places.

Association: RAN

Code nr. 458

Description of the association	Code nrs. soil groups in association
	R.19(a)
	R.19(b)

Typical landscape

Hills with gentle slopes.

Parent materials

Mainly shales and mudstones, minor sandstones.

Natural vegetation or land use

Thus far only found under secondary forest (sec. forest somaha - semapak type if overfarmed).

Description main soil series or soil groups

R.19 (a) - Imperfectly drained pale yellow sandy loams on reddish yellow to yellowish red clay loams to clays with yellow mottling. Increasingly more gley features in the lower horizons - red disappears giving way to yellow (olive) and grey colours until bluish/grey layer is reached.

(watertable low).

Top of the profile resembles R.12 (described under 444) but the bottom part seems to be influenced by ground watertable. (semi-gley).

(a) clayey type.

Description minor soil series or soil groups

R.19 (b) - sandy type of R.19(a). The reddish colours are replaced by dark yellow and the whole profile is more sandy. In all the B-horizon appears to be poorer in iron.

Is very similar to R.9 described under 44 and might appear to be of the same series.

Tentative fertility level

Low fertility - low base status - high acidity.

Tentative crop suitability

At present only rubber is recommended, although in certain areas pepper is planted on R.19(a).

Association: BEGUNAN

Code nr. 459

Description of the association	Code nrs. soil groups in association
	R.20
	R.21 - R.22

Typical landscape

Mountains and hills (steep to gentle slopes)

Parent materials

Mainly red, grey and green mudstones. (Might be only red mudstones).

Natural vegetation or land use

Lowland Dipterocarp forest when virgin - often used for pepper, and hill paddy.

Description main soil series or soil groups

R.20 - Deep to shallow (18 inches) dark brown to dusky red homogenous clay soils.
Moderately well drained.

Description minor soil series or soil groups

R.21 - Imperfectly drained type of R.20 with strong grey mottling in subsoil; occurring at lower slopes (possibly intergrade to R.19 (a) described under 458).

R.22 - Very shallow dusky red clays overlying weathering mudstone coloured red and grey.

Tentative fertility level

Low fertility - low base status - high acidity.

Tentative crop suitability

At present only rubber is recommended. But is often used for pepper.

Code nr. 46

Association: BAU

Description of the association	Code nrs. soil groups in association
	L.
	R.23 and R.24, R.25

Typical landscape

Limestone mountains - very steep slopes.

Parent materials

Limestone.

Natural vegetation or land use

Typical primary vegetation on limestone hills.

Description main soil series or soil groups

L. - Bouldery and rocky land mainly.

Description minor soil series or soil groups

R.23 - Skeletal soils on Limestone. Very thin yellow clays with limestone fragments directly overlying fresh limestone. Soil cover often not more than 6 inches.

R.24 - Deep, red, crumbly clays (accumulated in hollows). Some quartz rubble present. Directly overlying fresh limestone. Influence from nearby metamorphosed rocks can be expected (Terra Rossa).

R.25 - Very thin organic soils directly overlying limestone (not investigated yet).

Tentative fertility level

R.24 - Physically good. Fertility medium to good.

Tentative crop suitability

In general unsuitable for agriculture or very limited use because of topography and soil depth.

Association: BAU

Code nr. 46

Description of the association	Code nrs. soil groups in association
	L.
	R.23 and R.24, R.25

Typical landscape

Limestone mountains - very steep slopes.

Parent materials

Limestone.

Natural vegetation or land use

Typical primary vegetation on limestone hills.

Description main soil series or soil groups

L. - Bouldery and rocky land mainly.

Description minor soil series or soil groups

R.23 - Skeletal soils on Limestone. Very thin yellow clays with limestone fragments directly overlying fresh limestone. Soil cover often not more than 6 inches.

R.24 - Deep, red, crumbly clays (accumulated in hollows). Some quartz rubble present. Directly overlying fresh limestone. Influence from nearby metamorphosed rocks can be expected (Terra Rossa).

R.25 - Very thin organic soils directly overlying limestone (not investigated yet).

Tentative fertility level

R.24 - Physically good. Fertility medium to good.

Tentative crop suitability

In general unsuitable for agriculture or very limited use because of topography and soil depth.

THE SOIL GROUP INDEX

Group B - comprises soils occurring in coastal areas. They are derived from marine deposits mainly but may partly be of riverine origin. At a later stage when enough information has been accumulated and the riverine origin can be proved such soils will be placed under the A-group described below.

Soils having a peat or muck top with a maximum of 3 feet thickness have been placed into the B-group because of the dominant influence of the underlying material on Land-use, especially if such soils are drained and reclaimed.

Group A - comprises soils of riverine origin and deposited along rivers and in river valleys. They often merge gradually into peat swamps without distinct boundaries and soils with a peat or muck top of a maximum thickness of 3 feet have therefore been classed under this group. This way the boundary of the soil group will often coincide with the boundary between different soil suitability classes. As well, the underlying mineral deposits have still an important bearing on crop-production.

Group M - comprises marsh and swamp deposits. They are mostly of organic origin and must be deeper than 3 feet deep. As well, clays deposited in swamp areas by alluvial or colluvial actions and not forming part of a defined riverine landscape system have been placed in this group.

Group R - comprises residual soils which have weathered in situ.

Miscellaneous group - A/C - soils of mixed alluvial and colluvial nature not classified under other groups.

In instances there is a close affinity between soils of one group and another. This will happen when soil development has given rise to morphologically similar soil profiles on different types of parent material or found in different landscape units, e.g. humus podsols can occur either on old marine sandy deposits or on old riverine sandy deposits and as well on residual sandy soils derived from quartzitic sandstone. In this scheme they have been grouped separately but it is possible that they will eventually be classed as one.

B- GROUP

Mainly recent marine deposits

B.1 - Undifferentiated to slightly differentiated sands with Watertable above 24 inches. Non-calcareous. Usually light grey to brown in colour. When light grey may be dark grey beneath W.T. and faint red-yellow mottling above.

Beginnings of peat accumulation often as topsoil. Always too wet to dig pits below watertable. Excessive drainage above W.T., waterlogged below.

B.1.1 - brown sands (peat-humus staining, or B_2 remnant?)

B.1.2 - very pale brown, grey and light grey sands.

B.1(ca) - as B.1 but with shelly layers in horizons.

B.2 - as B.1 but with 3 feet peat or muck as topsoil.

B.2.1 - peat topsoil.

B.2.2 - muck topsoil.

B.3 - marine or possibly riverine clays covered with up to 3 feet peat or muck.

B.3.1 - peat.

B.3.2 - muck.

(if riverine clays are involved A.4(a)1 and A.4(a)2 are concerned).

B.4 - Undifferentiated to slightly differentiated very pale brown to yellow sands. W.T. normally more than 24 inches deep. Below W.T., soils are olive grey to dark grey (containing abundant minute organic fragments). Excessive drainage to W.T.

B.4.1 - as B.4 but with red-yellow to strong brown mottling in subsoil.

B.4(ca) - as B.4 but with shelly layers in profile.

B.5 - Saline peats or mucks, 0 - 3 feet deep on mixed, saline clays and sands (not subdivided yet) - see M.5.

B.6 - Deep ferruginous sands, slightly podsolised in top. Subsoil may have soft iron concretions. Imperfectly drained in lower horizons.

Mainly old marine deposits

B.7 - Podsolic sands - B horizons might be beyond 4 feet. Excessive drainage to B.2 horizon, then waterlogged. Can be found on present coastline.

B.7.a - with weakly developed humus B1/2 horizon.

B.7.b - with strongly developed humus B1/2 horizon.

(Strong affinities with A.6 and A.8 in case of old alluvial deposits, and with R.10.b and R.10c if on residual sandy soils).

B.8 - Deep, white to pale yellow clays and silty clays. May be faint red-yellow mottles in subsoil. White colour probably due to old marine influences, i.e. relic gleying. Drainage poor to medium.

B.8(a) - as B.8 but with quartz grit (possibly old disintegrated pebbles).

B.9 - as B.8 but with yellow topsoil. (affinity with R.9 as residual type).

A- GROUP

Mainly young riverine alluvium

A.1 - Weakly developed yellow brown sandy to clayey deposits. Sometimes faint mottling in subsoil indicating stagnant water in heavier textured layers. The texture in the profile often ranges from sandy to clay loam layers. In general, well drained soils.

A.1.1 - sandy soils.

A.1.2 - clayey soils.

A.1.3 - alternating layers of sand and clayey material.

A.2 - Deep, moderately well drained clay loams to clays. Yellow brown to strong brown in the top overlying yellow brown subsoils with intense red mottling throughout.

The A.2 is thought to be older than the A.1 or the material might be more iron rich.

A.3 - Deep, dark brown to dusky red friable clays which become blocky on drying. Faint grey mottling may occur in subsoils. Moderately well drained.

A.4 - A range of soils with hydromorphic features such as gleying and redox layers. Can be covered with organic deposits up to three feet of depth. Typical description: dark reddish brown to greybrown or grey sands to clays overlying red, brown or yellow mottled grey subsoils which are merging into dirty white to bluish grey gley horizons. Sandy soils often have strong brown mottles, while clay soils show distinct reddish mottles.

A.4 (a) - dominantly clay soils.

A.4 (b) - dominantly sandy soils.

A.4.(a)1 - covered with up to 3 feet of peat.

A.4.(a)2 - " " " " " " muck.

A.4.(b)1 - " " " " " " peat.

A.4.(b)2 - " " " " " " muck.

Mainly old marine alluvium

A.5 - Yellow to very pale yellow (sometimes white) topsoils on darker yellow or white with yellow mottled subsoils. Texture of subsoils often heavier than topsoils. Quartz pebble layers frequently present in profiles (pebbles often partly disintegrated).

A.5.(a) - overlying other older alluvial deposits (often pebbles coincides with lower boundary of younger deposits).

A.5.(b) - overlying residual soils or rocks (often pebble layer indicates lower boundary of the old alluvium).

A.6 - White topsoils (pronounced A.2 horizon) on well developed humus pan.

A.6.a - overlying alluvium.

A.6.b - overlying residual soils in which case the B horizon is residual.

A.7 - Truncated podsols (strongly developed humus pan found on top of the soil).

A.8 - White topsoils with pronounced bleached A.2 horizon on weakly developed B humus horizon.

A.8.a - overlying alluvium.

A.8.b - overlying residual soils.

(It is often difficult to distinguish A.6 and A.8 from B.7.a and B.7.b).

A.9 - Yellow coloured soils, sands to loams often with interlayers of pebbles of medium age. They are intergrades between the regosols of A.1 and the podsolised soils of A.5 to A.8 (pebbles hard and well-preserved).

A.10 - Dark brown to reddish brown gravelly loams, often with boulders and pebbles embedded in profile. Sandy layers may occur together with more clayey deposits. Shallow and deep soils both occur. They can overly either parent material or residual soils of different parent material. (Not differentiat yet).

M- GROUP

Mainly organic soils

M.1 - Woody peat deposits (more than 65% loss on ignition). From 3 feet to 60 feet plus.

M.2 - Mucks (mineral matter more than 35%) from 3 feet to 60 feet plus.

M.1.a - peat on clays.

M.1.b - peat on sands.

M.2.a - mucks on clay.

M.2.b - mucks on sand.

M.3 - Muck overlying woody peat (muck top 0 - 3 ft deep).

M.3.a - M.3 on clays.

M.3.b - M.3 on sands.

M.4 - Woody peat with muck interlayers deeper than 3 feet.

M.4.a - M.4 on clays.

M.4.b - M.4 on sands.

M.1 (s)
M.2 (s)
M.3 (s)
M.4 (s)
} as M.1 to M.4 with same subdivision but all under saltwater influence.

Mainly mineral soils

M.5 - Greyish brown (rusty mottled) topsoil on bluish grey to dark grey subsoil. Shells might occur in these soils. Sometimes a thin organic layer is found on top, while in the sublayers sometimes remnants of old mangrove and Nipah swamps can be traced. Groundwater - salty.

Soils show often a yellow discolouration upon drying showing sulphuric acids present in the soil.

M.5.(a) - clays.

M.6 - This group of soils is very similar to A.4 but they are underlain by subsoils rich in organic matter. Greyish brown topsoils overlying reddish and grey mottled sublayers which merge into an olive grey mottled bluish gley horizon. In this gley horizon layers high in organic carbon (peaty layers) may occur.

M.6(a) - clay type and hydromorphic in nature.

M.6(b) - sandy type. Soils have been found similar to A.1.1 overlying peat. They have no gley horizon. They are tentatively classed under this group.

M.7 - Dark grey topsoils overlying white and grey coloured horizons with brownish-yellow mottling. Gley horizon starts at watertable which is often not deeper than 2 feet. Soils are very sandy and quartzitic in nature (drowned high level alluvium), and although morphologically similar to A.4.(b) of much poorer quality because of their origin.

R- GROUP

On Igneous rocks

R.1 - Deep, red to yellow crumbly clays (depth can range from 2 - 10 feet). Homogeneous profile. In subsoil weathering rock pieces of bright red colour. Overlying partly decomposed basic igneous rock types.

R.2 - Deep, yellowish red-reddish yellow blocky clays (depth range from 2 - 10 feet). Often faint mottling of stronger red or yellow colour in subsoil. Overlying weathering rock. (Basic igneous rock or possibly more acid).

R.3 - Very shallow, gravelly clays to loams (brown to reddish brown), weathering rock often within 1 foot from surface. Overlying Basic igneous rock types.

R.4 - Yellow to reddish yellow moderately well drained clay loams to clays. Subsoils often more reddish coloured than topsoils. Reddish and yellow mottles may occur in subsoil. Rock pieces and boulders sometimes occur on lower slopes indicating colluvial influence. (see A.C.1 and A.C.2)

R.5 - Pale yellow blocky gritty loams on heavier gritty subsoils, pale yellow, often greyish mottled. Imperfectly drained.

R.6 - Very sandy gritty loams, well drained, pale yellow colour. In this groups are intergrades to true colluvial sand deposits accumulated on more gentle slopes.

R.7 - Very shallow to skeletal soils, yellow, gravelly to sandy loams overlying weathering granitic material

On sedimentary rocks

R.8 -- Pale yellow sandy loams on strong yellow, more clayey subsoils. Weak brown and grey mottling in subsoil may be present.

R.9 - Yellow sandy loams to loams on bleached (lighter coloured - pale yellow to white) sublayers, often strongly yellow mottled.

(often occurring in coastal areas on low hills which are thought to have been submerged by seawater at one stage).

R.10 - White sands to sandy loams on well developed podsolic B-horizons of heavier texture.

R.10 (a) - yellow mottled textural B only.

R.10 (b) - weakly developed humus pan (brown) - B_2 horizon - related to A.6, B7.

R.10 (c) - strongly developed humus pan (brown) - B_2 horizon - related to A.8, B7.

R.10 to R.10 (c) all have bad internal drainage.

R.11 - Skeletal soils (yellow to white thin sandy soils overlying sandstone).

R.12 - Weakly developed A.o horizon overlying yellow sandy loam merging into reddish coloured more clayey subsoils frequently mottled yellow and grey (typical red-yellow podsolic). Moderately well-drained.

R.12(a) - as R.12 but more clayey (clay loam in top to pure clays in the subsoil).

R.13 - Moderately well drained yellow to reddish yellow clays, overlying strongly red-mottled yellow subsoils often with small iron concretions or iron accumulations in the form of in filled old root channels. Iron accumulations increase gradually sometimes forming a weak pan in the deeper subsoil.

At lower depths (more than 6 feet), a white and grey coloured layer with red mottles will often be present, which merges into parent material (mainly grey shales). In the shales iron accumulations are found in cracks and between the layers. Upon drying the soil has a strong blocky structure. It is normally in the moist state with a massive structure.

The profile is deep and the texture is clay throughout.

R.14 - Moderately well drained, shallow (often not deeper than 2 or 3 feet) yellow to reddish yellow clays with red and grey mottling in subsoil. Iron concretions hard and soft are normally present. Sublayers merge gradually into parent material (soft weathered shale, of multi-coloured grey-yellow and red).

Upon drying the soil has a strong blocky nature. Texture is usually clay but influence from nearby sandstone might give sandier soils.

R.15 - Skeletal soils over shale on very steep slopes - Thin yellow brown clay - layer mixed with flaky shale rubble merging into parent material.

(grey, yellow and red coloured weathering shale).

R.16 - Imperfectly to moderately well drained yellow heavy clay overlying yellow clays with strong grey mottling (sometimes weak red mottles occur) overlying partly weathered grey to black shales.

R.17 - Well drained reddish yellow clay soils with layer of concretions loosely packed occurring at varying depths (range 2 to 4 feet). Iron concretions layer often directly overlies parent material.

Related to R.13 but colours are stronger red and there is less mottling. White layer might be present in the form of a white/grey discolouration of the parent material.

R.17 (a) - with weak yellow mottling in the otherwise strong reddish yellow soil.

R.18 - Deep, white sticky clays with faint yellow mottling in subsoils. The white clays often overlie clearly black coloured carbonaceous shales. A grit layer above the shale is often present. Gritty material sometimes occurs scattered within the whole profile.
There are sandy types of R.18 occurring in relation with R.9 or it might be an intergrade to R.9.

R.19 - Imperfectly drained, pale yellow sandy loams on reddish yellow to yellowish red clay loams to clays with yellow mottling. Increasingly more gley features in the lower horizons - red disappears giving way to yellow (olive) and grey colours until bluish/grey layer is reached. (watertable low).

Top of the profile resembles R.12 but the bottom part seems to be influenced by ground watertable (Semi-gleying)

R.19(a) - clayey type as described for R.19

R.19(b) - sandy type of R.19. The reddish colours are replaced by dark yellow and the whole profile is more sandy. In all the B-horizons appear to be poorer in iron. Is very similar to R.9 and might appear to be of the same series.

R.20 - Deep to shallow (18 inches) dark brown to dusky red homogeneous clay soils. Moderately well drained. (derived mainly from mudstones).

R.21 - Imperfectly drained type of R.20 with strong grey mottling in subsoil, occurring at lower slopes (possibly intergrade to R.19 (a).

R.22 - Very shallow dusky red clays overlying weathering mudstone coloured red and grey.

On Limestone

R.23 - Skeletal soils on Limestone. Very thin yellow clays with limestone fragment directly overlying fresh limestone. Soil cover often not more than 6 inches.

R.24 - Deep, red crumbly clays (accumulated in hollows). Some quartz rubble present. Directly overlying fresh limestone. Influence from nearby metamorphosed rocks can be expected (Terra Rossa).

R.25 - Very thin organic soils directly overlying limestone (not investigated yet).

On Miscellaneous rock types

R.26 - Yellow to yellowish-red deep loams on more clayey subsoils of stronger red colour. The colour is often a typical dusky red. Frequently quartz may be found in so-called stone lines. The weathering arkose found in the lower horizons is of a red colour and has a sandy and porous appearance.

R.26(a) - as R.26 but with yellow mottling in red coloured subsoil.

R.27 - Deep, reddish yellow to yellowish red clays, crumbly and well drained. Often quartz stone lines are present and/or relics of quartz veins. In places dirty white coloured bauxite nodules might be present in the lower horizons.

R.28 - A poorly drained clay soils with gley features derived from schist, occurring at lower slopes. Quartz gravel usually present.

R.29 - Reddish yellow loams to clays of blocky structure. With reddish coloured weathering rock pieces in the subsoil. Soil depth ranging from 1 - 5 ft., overlying hard partly crystalline tuffaceous sandstones.

Miscellaneous soil groups - A/C group of colluvial soils mainly.

A.C.1 - Deep, pale yellow blocky clays with gley features in subsoil. Often boulders of colluvial origin embedded in soil (imperfectly drained) (mainly from basic igneous rock origin).

A.C.2 - Deep, well drained reddish yellow - yellowish red clays. Similar to R.1 but with colluvial influence and often with boulders and/or gravel in profile.

A.C.3 - Soils derived from acid igneous rocks but covering soils of different parent material such as shales and sandstones. Often occurring at the foot of mountains built up by Acid Igneous rock formations. Mainly of sandy loam to clay loam nature.

L. - Bouldery and rocky land (not further differentiated).

CLASSIFICATION OF VEGETATION TYPES

(Prepared by J.A.R. Anderson,
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i. Beach forest

Occurrence: narrow strip behind sandy beaches or rocky headlands.

Soil: almost pure sand.

Principal species: Rhu laut (Casuarina sumatrana)
penaga laut (Calophyllum inophyllum)
baru laut (Hibiscus tiliaceus)

ii. Mangrove forest

Occurrence: On coastal, estuarine or deltaic soils subject to saline influence.

Aerial photographs: Flat coastal land with numerous creeks and channels. Canopy dense and usually even showing a patchwork of different forest types.

Soil: Clay or silt.

Principal species: Api api (Avicennia spp.) usually a coastal fringe,
Bakau (Rhizophora spp.)
Nipa (Nipa fruticans) - pure dense stands along tidal rivers,
Pedada, perepat (Sonneratia spp) - sheltered muddy bays,
Nibong (Oncosperma filamentosa) - on inland margins of mangrove.

iii. Peat swamp forest.

Occurrence: On flat coastal or deltaic land, inland from mangrove. Not, or only margins, subject to inundation.

Principal sub-types: (a) Pelai-terentang-asam paya forest.

Occurrence: Coastal, narrow zone between mangrove forest and (b).

Aerial photographs: Canopy uneven moderately dense and mixed; individual large crowns of dominant Pelai visible.

Soil: Shallow peat, usually less than 6' in depth, overlying clay or silt.

Principal species:

Pelai (Altonia spathulata)
Terentang (Campnosperma coriacea)- sometimes forming almost pure strands.
Asam paya (Zalacca conferta) - a spiny stemless palm, often very dense.
Pinang laka (Cyrtostachys lacca)

b. Mixed swamp forest

Occurrence: large zone on margins of swamps or, near coast, covering the whole swamp surface.

Aerial photographs: Topography flat, canopy uneven and mixed.

Soil: Peat, depth very variable from 6 to 50 ft.

Principal species: Ramin (Gonystylus bancanus)
Jongkong (Dactylocladus stenostachys)
Sepetir paya (Copaifera palustris)
Meranti (Shorea spp).

c. Alan forest.

Occurrence: Large areas in centre of swamps or a transitional zone between (b) and (d) or (e).

Aerial photographs: Topography flat, canopy uneven, and dense with large individual white crowns of Alan clearly visible.

Soil: Deep peat.

Principal species: Alan (Shorea albida)
Ramin (Gonystylus bancanus)
Jongkong (Dactylocladus stenostachys)

Note: Vernacular synonyms of Alan in Sarawak are Empenit (2nd Div.) Alan or Meraka alan (3rd Div.) and Seringawan (4th Division).

d. Alan bunga forest.

Occurrence: Large areas in centre of swamps in 2nd and 4th divisions or a zone between (c) and (e); generally absent from 3rd Division.

Aerial photographs: Pure even white canopy with scattered small black spots caused by breaks in canopy as a result of lightning damage.

Soil: Deep peat.

Principal species: Pure (in upper canopy) forest of Alan (Shorea albida)

e. Padang paya forest.

Occurrence: Central areas of swamps in 2nd, 3rd and 4th Divisions.

Aerial photographs: Dense even canopy, entirely composed of small crowns, frequently pure and white (Alan) in appearance, occasionally mixed.

Soil: Deep peat.

Principal species: Alan (Shorea albida)

Medang padang (Litsea palustris)
Keruntum (Combretocarpus rotundatus)
Bintangor Kuning (Calophyllum obliquinervum)

Note: Central areas of swamps in Baram, upriver from Kuala Bakong, have a low stunted open forest known as the Padang Keruntum dominated by Combretocarpus rotundatus.

iv. Kerangas forest (lowland heath forest)

Occurrence: Scattered, sometimes extensive, areas of lowland forest on poorer soils. Topography usually level or gently undulating, frequently on plateaus or ridges.

Aerial photographs: Dense (occasionally rather open) even or slightly uneven canopy, all crowns small and generally indistinguishable; mixed or rarely pure.

Soil: Usually a white sand, coarse or fine in texture, frequently podzolic. Surface is almost invariably covered in a 'mor' layer.

Principal species: Rhu ronang (Casuarina sumatrana)
Sempilor (Dactydium elatum)
Bindang (Agathis dammara)
Kawi (Whiteodendron moultonianum)
Keruing Sindor (Dipterocarpus borneensis)
Alan (Shorea albida)

Note: The composition of Kerangas forest is very variable (dependent on different soil formations) even in localised areas, and a number of different forest types can be distinguished. At least one of the above species is likely to be present in each type.

v. Riparian forest (Empran)

Occurrence: Along river banks or strips of flat land, subject to occasional flooding.

Aerial photographs: Topography flat, canopy very variable, usually dense and uneven.

Soil: Frequently alluvium, very variable, dependent on conditions and materials of deposition.

Principal species: Belian (Ensideroxylon zwageri)
Engkabang (Shorea spp)
Keruing latek (Depterocarpus apterus)
Peran (Parashorea macrophylla)
Merbau (Intsia palembanica)

Note: Little remains of the original extensive areas of riparian forest. Most is now either under cultivation or secondary forest.

vi. Lowland Dipterocarp forest (LDF)

Occurrence: Covers enormous areas of dry land on hills, mountains and gently undulating topography. Excluding small areas of montane forest on higher slopes (above 4,500') primary forest of this type clothes all land not included in types (i) - (v) and (vii).

Aerial photographs: Topography steep to gently undulating, rarely flat. Canopy uneven, dense, mixed and very variable in texture, colour and size of crowns.

Principal species : Exceptionally mixed, frequently with as many as 100-200 different species (over 12" girth) per acre. Forest is to a large extent dominated by Dipterocarps, which include:

Merantis (Shorea spp),
Kapurs (Dryobalanops spp),
Keruings (Dipterocarpus spp),
Selangan batus (Shorea spp).

vii. Secondary forests

Occurrence: On all land previously farmed or cleared, old secondary forests, such as in the Ulu Rejang, abandoned for over sixty years are sometimes difficult to distinguish from primary forest.

Aerial photographs: Canopy usually dense and frequently showing a patchwork of clearly demarcated types. Sometimes difficult to distinguish from Kerangas forest.

Principal species : Very variable, depending on previous soil and vegetation types and age of secondary growth. The following are typical secondary species:

Benuang (Octomeles sumatrana) - secondary riparian forest,
Selimpoh (Anthocephalus cadamba) - secondary forest, (riparian forest)
Geronggang (Cratoxylon spp) - secondary forest (peat swamps and LDF),
Meranti (Shorea spp),
Selunsur (Tristania spp) - old secondary LDF),

The following species are typical of secondary forest on poor or degraded soils.

Lalang (Imperata cylindrica)
Somaha (Ploiarium alterniolium)
Semapak (Adinandra dumosa)
Pitcher plants (Nepenthes spp)
Lycopodium cernum
Bennah (Macaranga spp.) - young secondary forest (peat swamps + LDF).

Landscape Units and forms as related to Soil Development in Sarawak

Code No.	Description or definition
A.	A. Coastal forms
A1.	1. Beaches
A11.	11. recent
A12.	12. recent to old
A2.	2. Terraces (raised beach formations)
A3.	3. Sand bars
A31.	31. young, still accumulating
	32. old.
A4.	4. Lagoons
A41.	41. saline (influence of salt water)
A42.	42. fresh (often old and no influence of salt water)
A5.	5. Coastal flats
A51.	51. present (saline)
A52.	52. raised (often as A2 but larger in extent)
B.	B. Riverine forms
B1.	1. Levees
B11.	11. low: W.T. usually shallower than 1 foot
B12.	12. high:" " " lower than 3 feet
B2.	2. Abandoned meanders
B21.	21. fresh water
B22.	22. saline
B3.	3. Terraces (old levees)
B4.	4. Cones - (alluvial fans)
C.	C. Swamps and marshes
C1.	1. Freshwater swamps
C11.	11. basin swamps (extensive, normally enclosed by rivers and coastline)
C12.	12. paya swamps
C121.	121. small and narrow, usually dry during less wet season.
C122.	122. larger, wider and wetter throughout the year.
C123.	123. underlain by limestone.
C2.	2. Saline (coastal swamps)
C21.	21. delta and tanjong swamps (Nipah-Mangrove swamps) (lagoon swamps classified under lagoons (saline)(A41))
C3.	3. On top of "terrace"
C4.	4. On top of mountains.
D.	D. Mountain and Hill forms
D1.	1. Steep mountains and hills (slopes usually exceeding 35°)
D11.	11. High 3000 ft
D12.	12. Medium 500-3000 ft ft approx.
D13.	13. Low 50-500 ft approx
D14.	14. Very low below 50 ft.
D2.	2. Mountains and hills with moderate slopes (10-35°)
D21.	21. High 2000 ft.
D22.	22. Medium 500-2000 ft. approx.
D23.	23. Low 50-500 ft approx.
D24.	24. Very low below 50 ft.
D3.	3. Mountains and hills with gentle slopes (less than 10°)
D31	31. 500-2000 ft. approx.
D32.	32. 50-500 ft. approx.
D33.	33. below 50 ft. "
D4.	4. Steep limestone mountains
D5.	5. Single flat topped table mountains.

Composite landscapes

Note In case a single landscape unit cannot be mapped or distinguished, composite landscapes are used instead. Composite landscapes can be used for soil classification as single units but it might also occur that in the composite unit one or two single units can be taken out, and mapped or classified separately.

Code No.	Description or definition
I.	I. Recent coastal landscape (not raised, approx. at sea level).
	Members in this unit are: A11 and A12 A31 A41 and sometimes A42 A51
	I is differentiated into:
I.1	I.1 - A31 with A4 or/and all with A4
I.11	I.11 - with A41
I.12	I.12 - with A42
I.2	I.2 - Sequence of A11 and A12 or/and A31 with intermittent A41
I.2.1	I.2.1 - with A41
I.2.2	I.2.2 - with A42
II.	II. Old coastal landscape (raised, above sea level approx. up to 50 feet)
II.1	II.1 Undisturbed, not eroded, extensive flat raised area with old lagoons or undulations filled up with peat (A52 with A42 and/or C3)
II.2	II.2 Not eroded, raised beach formations (A2 and or A32) with old lagoons (A42).
II.3	II.3 Eroded form of II.1 partly removed and replaced by recent coastal forms as A41 and C21 (coastal swamps).
II.4	II.4 Eroded form of II.2 Dissected terraces, composed mainly of remnants of the terraces (A2) with C121 and 122 paya swamps. Sometimes also partly C21 swamp.
III	III. Riverine Landscape
III.1	III.1 Recent-young. Members are: B11 and B12 levees and C12.
III.2	III.2 Mixed Recent and Old. Members: B11 and B12, B21 and B3.
III.3	III.3 Old - Abandoned river system with exclusively B3 and old river channels.
IV.	IV. Dissected peneplain formations
IV.1	IV.1 - Low stage
IV.11	IV.11 - Composed of C122 and D33
IV.12	IV.12 - Composed of C122 and D24 mixed D33.
IV.13	IV.13 - Composed of C122 and exclusively D24 (sometimes also D23).
IV.2	IV.2 - Intermediate stage
IV.21	IV.21 - Composed of C121 and C122 with D32 and D23
IV.22	IV.22 - Composed of C121 and C122 with D32, D23 and D13.
IV.23	IV.23 - Composed of mainly C121 with D24 and D13 (occasionally some D14 and D24).
IV.3	IV.3 - Strongly dissected stage
IV.31	IV.31 - Composed of C121 with D23
IV.32	IV.32 - Composed of C121 with D23 and D13
IV.33	IV.33 - Composed of C121 with D13 only.
V.	V. - Mountain landscapes Usually mapped as single units (Mountain and hill forms with Riverine forms.
VI.	VI. Limestone landscape Usually mapped as single units namely C123 and D4. If not to map separately, as composite VI landscape.

LECTURE NOTES

by

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