MALAYSIAN UNIFIED PEAT CLASSIFICATION TECHNIQUE

WAHID OMAR; S PARAMANANTHAN; MOHD HANIFF HARUN; NORDIANA ABD AZIZ and A KUSHAIRI

627

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Peat or organic soils are soils in which organic soil materials (OSM) form an important portion of the upper 100 cm of the soil. These soils generally occur in lowland coastal swamps, inland swamps and valleys, and high altitudes (Paramananthan and Wahid, 2008). Most published data in Malaysia does not include highland peat or montane peat. The extent of peatlands in Peninsular Malaysia, Sabah and Sarawak were 716 944 ha, 121 514 ha and 1 588 142 ha respectively (Wahid *et al.*, 2010).

Malaysia consists of three main political regions namely, Peninsular Malaysia, Sabah and Sarawak. Due to historical and administrative reasons, soil maps and classifications in these regions were different in definitions, classification and mapping. These differences also occurred for organic soils during the early Malaysian reconnaissance soil surveys. The differences in peat classifications had caused difficulties in correlating the peat soils and the transferring of agro-technologies between Peninsular Malaysia, Sabah and Sarawak. In order to rectify these problems, the Malaysian Palm Oil Board (MPOB) in collaboration with Paramananthan Agricultural Soil Surveys (M) Sdn Bhd developed the Malaysian Unified Classification Technique for Organic Soils in Malaysia. This classification method had been successfully tested in classifying and mapping of peatland in Baram River Basin, Miri, Sarawak.

OBJECTIVE

To develop a Malaysian unified peat classification technique for Malaysia.

METHODOLOGY

Unified Peat Classification Technique

Definition and control section. Organic soil materials (*Figure 1*) must either:

i. Saturated with water for a long period (or artificially drained) and excluding living roots,

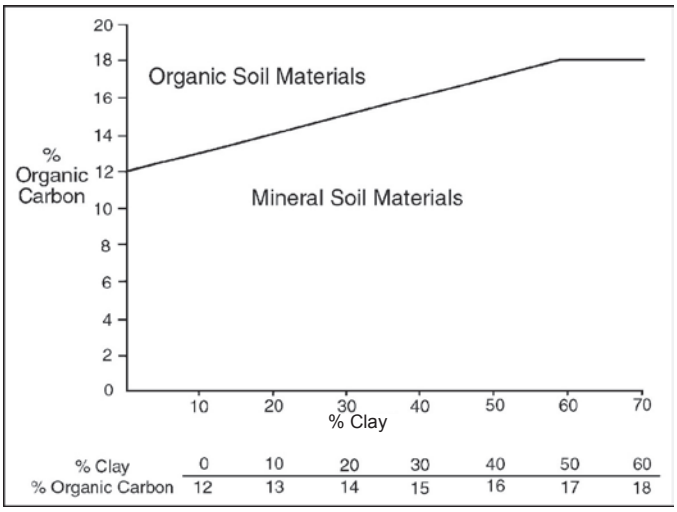

Figure 1. Definition of organic and mineral soil materials.

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Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia
P. O. Box 10620, 50720 Kuala Lumpur, Malaysia. Tel: 03-8769 4400 Fax: 03-8925 9446 Website: www.mpob.gov.my

has an organic carbon content by weight of:

- 18% or more if the mineral fraction contains 60% or more clay; or
- 12% or more if the mineral fraction contains no clay; or
- a proportional content of organic carbon between 12% and 18% if the clay content of the mineral fraction is between 0% and 60%; or

ii. Never saturated with water for more than a few days and contains 20% or more by weight organic carbon, or

iii. Has a loss on ignition of more than 65% by weight.

Types of OSM

Types of OSM are distinguished based on the origin and the degree of decomposition of the plant materials. The kind of organic materials that dominate the subsurface tier and/or presence of a sulphuric horizon or sulphidic materials determines the sub-group. These OSM are moss, fibres, fibric, hemic, sapric and woody materials.

Organic soils

Soils in Malaysia are defined as organic soils if they meet the following criteria (Soil Survey Staff, 1975):

i. OSM makes up more than half the total cumulative thickness of the upper 100 cm.

ii. The depth to bedrock (lithic, petroferric or paralithic contact) is between 50 and 100 cm and the total thickness of the organic soil layers taken cumulatively is more than half of the depth to bedrock.

iii. The depth to bedrock is less than 50 cm and the total thickness of the organic soil layers taken cumulatively is more than half the depth to bedrock.

Control section. An arbitrary control section of 150 cm or the depth to a lithic or paralithic contact whichever is shallower has been established for the classification of organic soils in Malaysia to families, phases, sub-groups and a great group (Paramananthan *et al.*, 1984). A lithic or paralithic contact, if shallower than 150 cm, constitutes the lower boundary of the control section (*Figure 2*).

Thickness of OSM. Thickness of the OSM is used to separate the organic soils into two main classes at the great group level that is shallow (Topogenous) and deep (Ombrogenous). Two depth phases are recommended for shallow organic soils, namely 50 -100 cm (shallow) and 100-150 cm (moderately deep) of OSM respectively. Where the surface

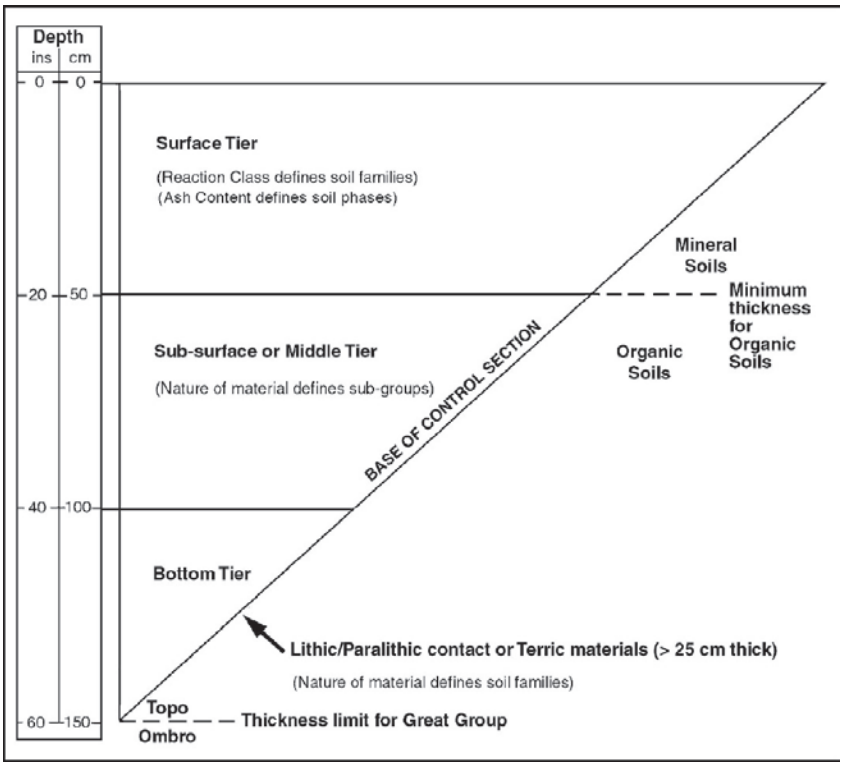


Figure 2. Control section for organic soils of Malaysia.

OSM are 25 cm to 50 cm thick, they are defined as histic epipedon. For deep organic soils, two depth phases are recommended for field mapping. These are depth phases which are 150-300 cm (deep) and more than 300 cm (very deep) OSM.

Categorical level of organic soil. Organic soils are soils which have a cumulative thickness of organic layers of 50 cm or more within the upper 100 cm. Water-logged lowland organic soils are placed in the suborder Gambists. At great group level, peat with organic deposits thickness of less than 150 cm and more than 150 cm is called Topogambists and Ombrogambists, respectively. At suborder level, the dominant nature of the soil materials in the sub-surface tier (50-100 cm) is used to separate the soils into terric, sapric, hemic or fibric subgroups. At the family level, the nature of the underlying substratum and the soil temperature regime are used, while at the series level, the presence/absence and nature of wood and the nature of the organic deposit are used. The criteria used are summarised in *Table 1*.

Testing of Unified Peat Classification Technique. Testing of the Unified Peat Classification Technique was carried out in Baram River Basin, Miri, Sarawak. It was carried out in two phases covering an area of 635 036 ha of Lower and Middle Baram River Basin (*Figure 3*). The study area consists of a contiguous parcel of land bound in the north and west by the South China Sea. The international boundary with Brunei Darussalam lies to the east. The southern boundary is delineated by the steep hills of the Lambir and Dulit mountain ranges.

The assessment of soil characteristics was carried out using semi-detailed soil survey. Intensity of the examination was one auger examination point per 20 ha on 1000 x 200 m grid. Soil pits were dug and sampled for analysis on the major soil types encountered. Slopes and landuse were determined every 50 m along traverse lines 1 km apart (1 point/5 ha). The unit of mapping in the assessment was the soil series. The soil series were

TABLE 1. DIFFERENTIATE USED AT THE DIFFERENT CATEGORICAL LEVELS OF ORGANIC SOILS IN MALAYSIA

Category	Criteria	Example
Order	Minimum thickness • 50 cm in upper 100 cm or 50% of solum if less than 100 cm (lithic/paralithic or terric layer)	Histosols
Sub-order	Drainage class • Well drained • Poorly drained	Folists Gambists
Great group	Thickness of the organic layer • 50-150 cm • 150-300 cm	Topogambist Ombrogambist
Sub-groups	Dominant material in the middle (50 -100 cm) tier • Terric, sapric, hemic, typic (fibric)	Hemic topogambist Sapric ombrogambist
Soil family	Nature of substratum • marine clay/sand • riverine clay/sand Soil temperature regime • isohyperthermic/isomesic	Baram family Adong family
Soil series	Presence and nature of wood • no wood • wood decomposed • wood undecomposed Mode of origin autochthonous/allochthonous	Baram series: sapric topogambist, marine-sandy, isohyperthernic, non-woody, autochthonous. Adong series: hemic ombrogambist, marine-sandy, isohyperthermic, decomposed wood, autochthonous.
Soil phase	Depth • shallow: 50-100 cm • moderately deep: 100-150 cm • deep: 150-300 cm • very deep: 300+ cm	Baram/shallow Baram/moderately deep Adong/deep Adong/very deep

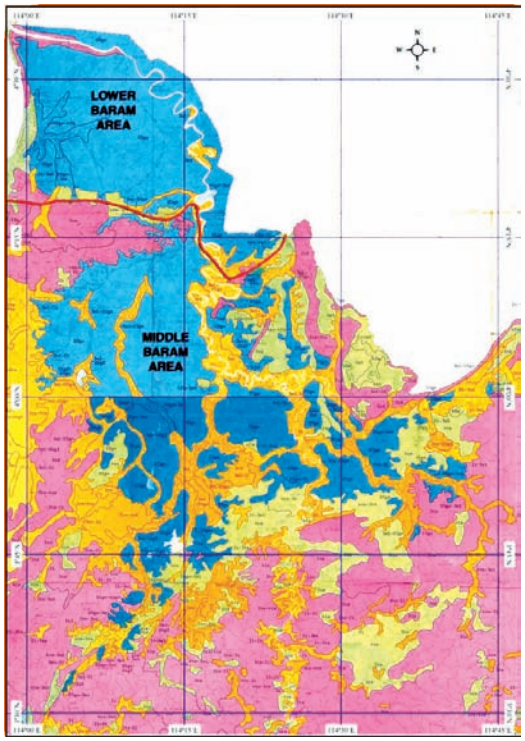


Figure 3. Study area in Lower and Middle Baram River Basin Sarawak (peatland in blue).

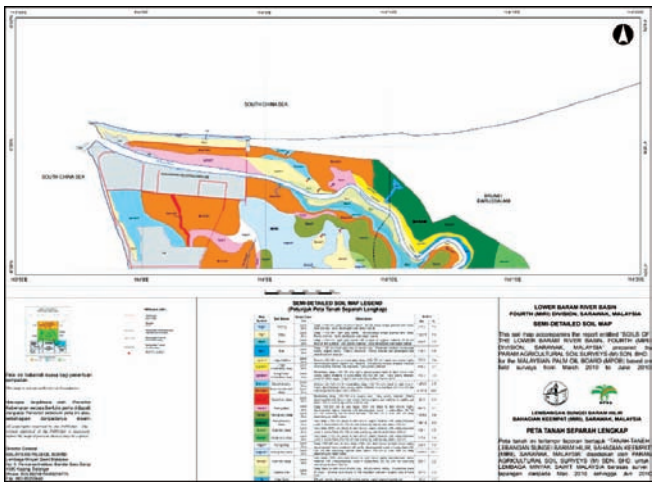
identified based on the Keys to the Identification of Malaysian Soils According to Parent Materials (Paramananthan, 2010) and Unified Peat Classification Technique for organic soils. The soil series were divided into phases using criteria visible in the field such as texture, colour, soil depth, drainage class and slope class. For organic soils the dominant OSM in the subsurface tier (50-100 cm), the presence or absence and nature of wood, thickness of OSM, soil temperature and moisture regime were used to separate the peat types (*Tables 2a* and *2b*).

RESULTS AND DISCUSSION

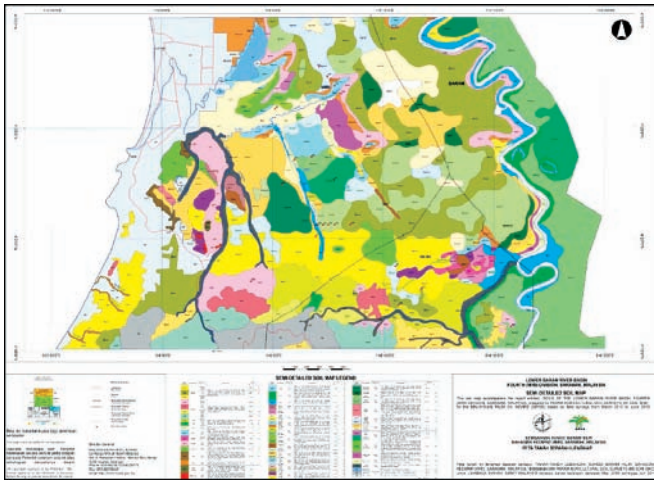
Soil Classification

A reconnaissance soil map of the Lower and Middle Baram River Basin has been produced by the Department of Agriculture, Sarawak at a scale of 1:750 000. The map indicated that the soils belong to 11 soil associations namely (i) Semilajau/Bemang/Seduau/Kabong (alluvial and arenaceous soil), (ii) Anderson (deep peat), (iii) Bijat/Tatau/Semadoh, (iv) Kapit, (v) Kapit/Merit/Bekenu/Nyalau/Abok, (vi) Meluan, (vii) Merit/Bekenu/Nyalau, (viii) Miri/Buso, (ix) Mukah, (x) Rajang, and (xi) Saratok/Bandang/Kerait. Soils developed over organic deposits occupied a large area of the Lower and Middle Baram River Basin study area. On the reconnaissance soil map most of these soils have been mapped either as the Mukah Series (shallow) or the Anderson Series (deep).

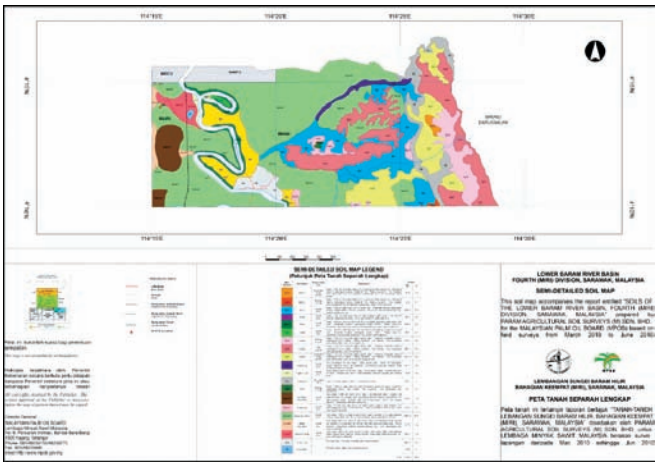
All the soils located in the study area were examined and mapped. The gross total area surveyed was 635 036 ha, which include the upland, peatland, urban, steepland and water bodies. *Figure 4* shows the soil maps of the surveyed areas in phase I divided into three sheets.



a. Semi-detailed soil map of Lower Baram River Basin Sheet 1 (Kuala Baram).



b. Semi-detailed soil map of Lower Baram River Basin Sheet 2 (Miri)



c. Semi-detailed soil map of Lower Baram River Basin Sheet 3 (part of Marudi).

Figure 4. Semi-detailed soil map of Lower Baram River Basin, Sarawak.

TABLE 2a. KEY TO THE IDENTIFICATION OF OMBROGAMBISTS – DEEP TO VERY DEEP POORLY DRAINED ORGANIC SOILS

Soil moisture regime	Aquic – Poorly Drained - GAMBIST												
Cumulative thickness of OSM	>150 cm - OMBROGAMBIST												
Dominant nature of subsurface tier (50-100 cm)	Lithic	Fluventic	Terric	Sapric			Hemic			Fibric (Typic)			Woody (>50% wood)
Nature of underlying materials/ substratum				Non-woody	Decomposed wood	Undecomposed wood	Non-woody	Decomposed wood	Undecomposed wood	Non-woody	Decomposed wood	Undecomposed wood	
Marine clay sulphidic (>15% clay)				PRIMALUCK			PONTIAN			ARANG/LUK			
				Primaluck		Teraja		Pontian		Arang	Klias Luk		
Marine clay (>15% clay)				NAMAN			BAYAS			ANDERSON			
				Naman	Retus	Kenyana		Bayas	Gedong			Anderson	
Marine sand calcareous (<15% clay)													
Marine sand suphidic (<15% clay)													
Marine sand (<15% clay)				TELONG			ADONG						
					Telong	Suai		Adong	Alan				
Riverine/colluvial clay (>15% clay)				LIKU			GONDANG			SALLEH			
				Liku		Karap		Gondang	Taniku		Salleh	Tinjar	
Riverine/colluvial sand (<15% clay)													
Acid igneous residuum													
Basic igneous residuum													
Calcareous residuum													
Calcareous residuum													
Sedimentary residuum										BAREO			
												Bareo (isomesic)	
Ironstone residuum													
Fragmental													

Key:
BAYAS, Soil Family, Luk = allochthonous.
Bayas, Soil Series f = sulphidic.

TABLE 2b. KEY TO THE IDENTIFICATION OF TOPOGAMBISTS – SHALLOW TO MODERATELY DEEP POORLY DRAINED ORGANIC SOILS

Soil moisture regime	Aquic – Poorly Drained - GAMBIST												
Cumulative thickness of OSM	<150 cm - TOPOGAMBIST												
Dominant nature of subsurface tier (50-100 cm)	Lithic	Fluventic	Terric	Sapric			Hemic			Fibric (Typic)			Woody >50% wood
Nature of underlying materials / substratum				Non-woody	Decomposed wood	Undecomposed wood	Non-woody	Decomposed wood	Undecomposed wood	Non-woody	Decomposed Wood	Undecomposed Wood	
Marine clay sulphidic (>15% clay)				PENOR			BAKRI			MERAPOK			
				Penor			Nipis	Bakri			Merapok Mahat		
Marine clay (>15% clay)				LINGGI			EPAI			MUKAH			
				Linggi		Trus			Epai		Mukah		
Marine sand calcareous (<15% clay)			MENGALUM										
			Mengalum										
Marine sand sulphidic (<15% clay)				LONG PUTAT									
				Long Putat									
Marine sand (<15% clay)				BARAM						IGAN			
				Baram	Kabala	Simalau					Igan		
Riverine / colluvial clay (>15% clay)				ERONG			GALI			CHANGKAT LOBAK			
				Erong				Gali		Changkat Lobak			
Riverine / colluvial sand (<15% clay)							PAK BONG						
							Pak Bong						
Acid igneous residuum													
Basic igneous residuum													
Calcareous residuum													
Calcareous residuum										KAPOR			
											Kapor		
Sedimentary residuum										MELINAU / UMOR			
											Melinau	Umor (Isomesic)	
Ironstone residuum													
Fragmental													

Key:
GALI, Soil Family, isomesic = isomesic soil temperature regime.
Gali, Soil series, mahat = allochthonous.

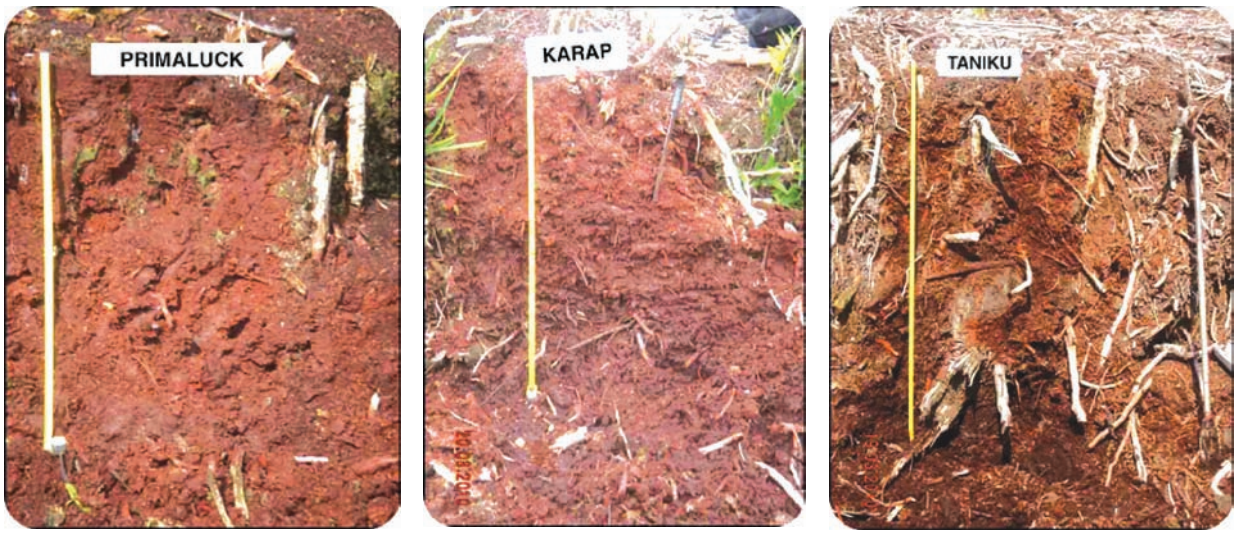
A total of 107 soil mapping units were identified in the study area. These mapping units belong to 63 soil series and six miscellaneous land units (*Table 3*). There were 36 mapping units and 21 soil series belonging to organic soil were identified during the survey. The organic soil series were Penor, Linggi, Long Putat, Baram, Erong, Kabala, Nipis, Primaluck (*Figure 5a*), Naman, Liku, Telong, Teraja, Kenyana, Suai, Karap (*Figure 5b*), Bayas, Adong, Gondang, Alan, Taniku (*Figure 5c*) and Klias Series.

CONCLUSION

The different definitions, classifications and mapping of organic soils in Peninsular, Sabah and Sarawak has caused difficulties in correlating soils and transfering of agro-technology in Malaysia. Recognising this problem, MPOB developed the Malaysian Unified Peat Classification Technique. The classification technique has been tested in characterising, classifying and mapping of lowland peats in Baram River Basin, Sarawak. Results of the study indicated that the new peat classification technique was able to differentiate the different peat types according to the new criteria. Based on the semi-detailed soil survey, a total of 107 soil mapping units were identified belonging to 63 soil series and six miscellaneous land units. There were 36 mapping units and 21 soil series belonging to organic soil. Soil map at a scale of 1:50 000 of the Lower and Middle Baram River Basin have been produced.

TABLE 3. SUMMARY OF SOILS MAPPED IN LOWER AND MIDDLE BARAM RIVER BASIN, SARAWAK

Parent materials	Map units (No.)	Soil series (No.)	Area	
			ha	%
Mineral Soils				
Sedimentary rock	29	11	184 490.4	29.1
Sub-recent alluvium	13	10	9 818.0	1.6
Recent riverine alluvium	15	13	102 414.8	16.1
Beach ridges	4	4	4 567.9	0.7
Marine alluvium	4	4	3 863.4	0.6
Sub-total mineral soils	65	42	305 154.5	48.1
Organic soils				
Shallow to moderately deep (50-150 cm)	12	7	15 372.5	2.4
Deep to very deep (150-300+cm)	24	14	191 086.3	30.1
Sub-total organic soils	36	21	206 458.8	32.5
Miscellaneous Land Units				
Local alluvium	1	-	2 227.3	0.4
Organic clay muck	1	-	14 713.9	2.3
Steepland	1	-	80 149.0	12.6
Urban land	1	-	16 032.3	2.5
Water bodies	1	-	10 292.5	1.6
Rock outcrops	1	-	7.7	-
Sub-total miscellaneous land units	6	-	123 422.7	19.4
Grand total	107	63	635 036.0	100.0



a. Primaluck Series b. Karap Series c. Taniku Series

Figure 5. Examples of organic soil series of the Lower and Middle Baram River Basin, Sarawak.

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For more information, kindly contact:

Director-General
MPOB
P. O. Box 10620
50720 Kuala Lumpur, Malaysia.
Tel: 03-8769 4400
Fax: 03-8925 9446
www.mpob.gov.my