Oil Palm Bulletin 76 (May 2018) p. 1-7

Classification of Tropical Peat in Malaysia

Siti Khadijah Hajon*; Hasimah Mos*; Nurmaisarah Jantan* and Haniff MH*

ABSTRACT

Classifying tropical peat is crucial for the oil palm industry, especially studying the effects of different peat types on the agricultural sector in Malaysia. The different defined criteria used for grouping peat lead to different classification systems for temperate and tropical peats. In Malaysia, a better understanding of the differences in the classification systems for tropical peats is needed because the systems are varied further based on the three different regions of Malaysia, namely Peninsular Malaysia, Sabah and Sarawak. Very few studies have been carried out to categorise tropical peats using suitable classification systems. These include international schemes for classifying peats, such as Soil Taxonomy, Eleventh Edition (USDA) and the World Reference Base for Soil Resources (WRB). However, it has been claimed that these international schemes are unsatisfactory for classifying tropical peats. Hence, the local conditions so that it can be applied to most tropical lowland peats. Thus, this paper highlights an improved of tropical peat classification based on several different defined criteria. However, further work is still needed to understand the relationships among peat classification, greenhouse gas emissions and oil palm yield performance.

ABSTRAK

Klasifikasi gambut tropika adalah penting untuk industri sawit terutama sekali untuk mengkaji kesan jenis gambut yang berbeza terhadap sektor pertanian di Malaysia. Perbezaan definisi dan pengklasifikasian gambut membawa kepada klasifikasi yang berbeza untuk gambut iklim sederhana dan tropika. Di Malaysia, pemahaman yang lebih baik mengenai perbezaan sistem klasifikasi di kawasan tropika diperlukan kerana klasifikasi tersebut dibahagikan berdasarkan kawasan di Malaysia, seperti Semenanjung Malaysia, Sabah dan Sarawak. Hanya beberapa kajian yang telah dilakukan untuk mengklasifikasikan gambut tropika menggunakan sistem klasifikasi yang sesuai. Ini termasuk skim antarabangsa dalam mengklasifikasikan gambut seperti Soil Taxonomy – Eleventh Edition (USDA) *dan* World Reference Base for Soil Resources (WRB). *Walau bagaimanapun, skim antarabangsa ini dikatakan tidak berjaya untuk klasifikasi di gambut tropika. Oleh itu, sistem klasifikasi gambut Malaysia telah dihasilkan dengan penambahbaikan sistem USDA untuk disesuaikan dengan keadaan tempatan dan dapat diaplikasikan di kebanyakkan gambut tropika. Penulisan ini bertujuan untuk menekankan pemahaman yang lebih baik terhadap klasifikasi gambut tropika berdasarkan beberapa definisi yang berbeza. Kajian yang lebih mendalam diperlukan untuk memahami hubungan antara klasifikasi gambut, pelepasan rumah hijau, dan prestasi hasil sawit.*

* Malaysian Palm Oil Board,
6, Persiaran Institusi, Bandar Baru Bangi,
43000 Kajang, Selangor, Malaysia.
E-mail: sitikhadijahhajon@mpob.gov.my

Keywords: Tropical peat, temperate peat, peat types, classification system, oil palm.

INTRODUCTION

Peatlands cover an area of about 400 million hectares, or nearly 3% of the Earth's land surface. The area of tropical peatland is about 30 to 45 million ha, or 10% to 12% of the global peatland resource (Veloo *et al*., 2014). Tropical peatland is made up of layers of organic soil with an average thickness of 5.5 to 7.0 m that were formed over thousands of years by the accumulation of organic soil under waterlogged, anaerobic and often acidic conditions (Miettinen *et al*., 2012). In general, peatland can be classified into tropical highland peats (also known as temperate peats) and tropical lowland peats (also known as tropical peats). In the temperate, boreal and sub-arctic regions, the peat is formed from mosses, herbs, shrubs and small trees. However, tropical peat, especially at low altitude locations, is derived from the remains of rainforest trees (such as branches, leaves, roots and trunks), which have accumulated over thousands of years to form deposits that can be up to 20 m thick. Some tropical peatlands are also found at higher altitudes, where they support slower-growing vegetation that resembles that of the temperate and boreal zones (Rieley and Page, 2016).

While peat resources in the temperate zones have been well surveyed, classified and quantified, there is a lack of in-depth studies on tropical peat resources (Veloo *et al*., 2014). According to Malawska *et al*. (2006), peatlands are difficult to classify because of their floristic diversity and their stratigraphic, hydrological and geomorphological variations. In the past, they have been classified on the basis of origin, but the most widely used classifications are based either on vegetation type, or on the water source (Malawska *et al*., 2006). In order to have a universal classification, systems based on Soil Taxonomy, Eleventh Edition (USDA) and the World Reference Base for Soil Resources (WRB) are used. However, according to Veloo *et al.* (2014), these systems are more suitable for temperate peats. Thus, this paper highlights the differences in tropical peat soil classification systems based on several aspects.

HISTORY OF PEAT CLASSIFICATION IN MALAYSIA

Different peat classification systems have been developed as a result of different defined criteria used in classification. In Malaysia, different tropical peat classification systems have evolved in the three regions of Malaysia, namely Peninsular Malaysia, Sarawak and Sabah. For Peninsular Malaysia, Coulter (1950) suggested that the peat be classified based on its inherent fertility status, such as the *Eutrophic*, *Oligotrophic* or *Mesotrophic* groups. Meanwhile, Law and Selvadurai (1968) made use of different criteria, based on carbon loss by ignition and peat depth. In their classification method, the organic soils are separated into organic clay (20%-35%), muck (35%-65%) and peat (>65%). From the peat depth perspective, Paramananthan *et al.* (1984) proposed a different peat classification method based on peat thickness, such as shallow (50-100 cm), moderate (100-150 cm), deep (150-300 cm) and very deep (>300 cm). Therefore, peat classification systems in Peninsular Malaysia are based on the different defined criteria used for classification as shown in *Table 1* (Paramananthan, 2016).

In Sarawak, the peat classification is based on the thickness of the peat component, the ash content and mineral substratum layer (Melling, 2016). Surface vegetation is one of the criteria used in peat classifications because vegetation or forest types determine the type of peat formed and will also influence both biophysical and chemical properties of the peat (Melling *et al*., 2008). This is in accordance with the most complete and excellent known study of the ecology of the Tropical Lowland Peat Swamp Forests that was conducted by Anderson J.A.R over a 10-year period in the 1950s. The Tropical Lowland Peat Swamp Forests show obvious changes in vegetation type from the periphery to the centres of the dome-shaped peat swamp basins. The term 'Phasic Community' (PC) is used to designate a dominant vegetation zone. There are six distinct PCs according to their floristic composition and structure of the vegetation in each zone as shown in *Figure 1* (Paramananthan, 2008). Some of the characteristics of the six phasic communities are shown in *Table 2*. The peat classification systems in Sarawak (Paramananthan, 2008) are also based on the different defined criteria for classification (*Table 3*).

The FAO/UNESCO Legend for soil classification is used in Sabah, where the peat is classified as Dystric or Eutric Histosols (Melling, 2016). The peat classification system in Sabah (Paramananthan, 2008) is based on defined criteria different from those used for classification in Peninsular Malaysia and Sarawak as shown in *Table 4*.

CLASSIFICATION SYSTEMS

Unfortunately tropical peatlands are quite often classified using systems developed in the humid regions. The existing classification systems (including the Von Post system) used for temperate and boreal peatlands in the temperate regions fail to fully characterise tropical peat because temperate and boreal peats are covered with vegetation made up of bryophytes and shrubs. In contrast, tropical peatlands have various large tree species with root penetration to several meters in depth. This results in a higher rate of biomass production and decomposition contributed by decaying roots and root exudates (Veloo *et al*., 2014).

International schemes are being applied for peat classification. These international schemes are Soil Taxonomy, Eleventh Edition (USDA) and the World Reference Base for Soil Resources (WRB). However, these systems fail to describe and address the differences in tropical peats, especially in relation to their depth, presence of wood and the underlying substratum. In fact, the USDA classification system and WRB do not provide the criteria to define peats at series and phase mapping levels for a peat area (Veloo *et al*., 2014). Hence, the Malaysian classification system was developed by Paramananthan (1998) by modifying the USDA system to suit local conditions, and can be applied to most tropical lowland peat areas. The system has been tested in Malaysia and Indonesia, and seems to work well. A total of 700,000 ha of tropical lowland peat in Southeast Asia were evaluated and mapped using the system. The system uses the same principles as USDA's Soil Taxonomy, and is applicable for mapping and interpreting soil surveys (Veloo *et al*., 2014).

The most crucial aspects of the Malaysian classification system which are not emphasised in the USDA and WRB systems are the depth of the peat and the presence of wood, as well as the

TABLE 1. PEAT CLASSIFICATION SYSTEMS IN PENINSULAR MALAYSIA

Reference	Defined criteria used
Coulter (1950)	• Eutropic • Mesotropic • Oligotropic
Law and Selvadurai (1968)	Loss on ignition • Organic clay: 20%-35% • Muck: 35%-65% • Peat: >65%
Paramananthan (1976)	• Organic Soils – Minimum thickness of 50 cm within upper 100 cm • Control Section – 0-30, 30-90, 90-120 cm
Paramananthan *et al*. (1984)	• Organic soils – minimum thickness of 50 cm • Control Section – 0-50, 50-100, 100-150 cm Topogambist Peat 50-150 cm Ombrogambist Peat > 150 cm • Proposed use; - Folist – Well drained peats - Gambist – Poorly drained peats
Paramananthan (1998)	• Proposed the terms – Topogenous, Ombrogenous, Gambists
Paramananthan (2010)	• Developed keys for identification of organic soils

Modified from: Paramananthan (2016).

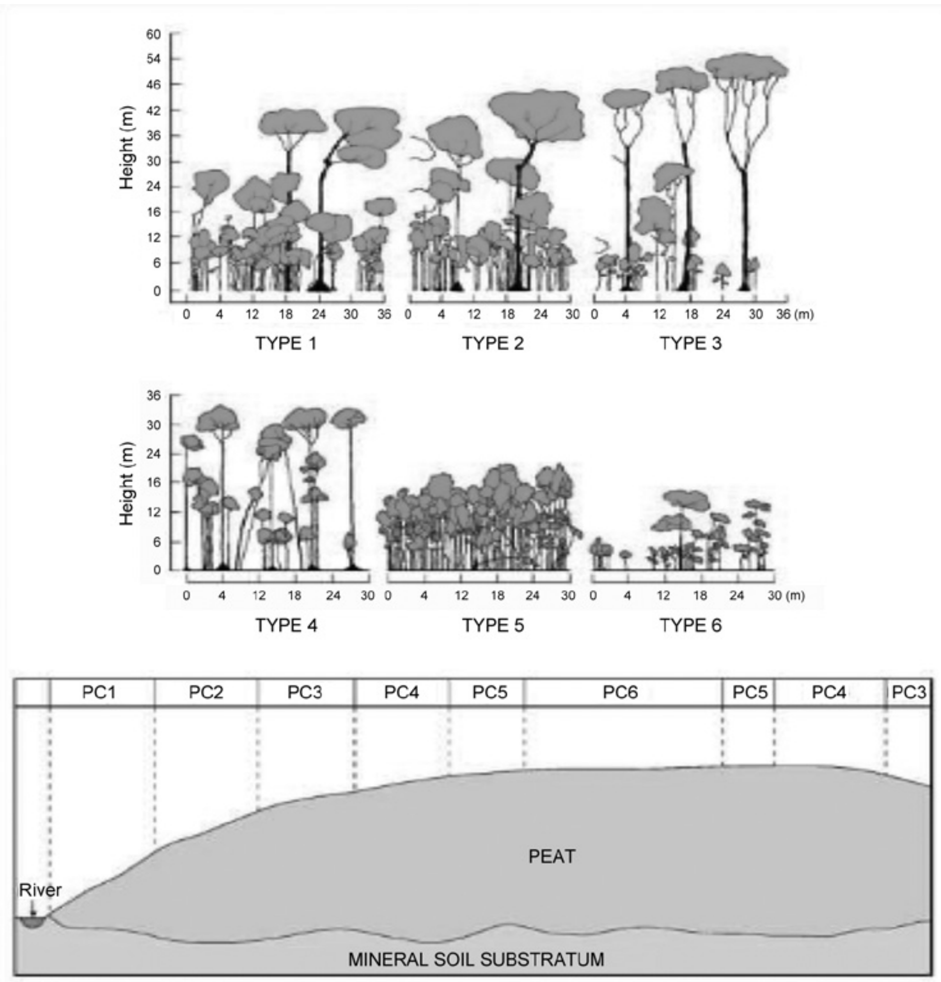

Figure 1. Lateral vegetation zones in the six phasic communities (Paramananthan, 2008).

TABLE 2. CHARACTERISTICS OF THE SIX PHASIC COMMUNITIES

PC	Name	Emergent height (m)
1	Gonystylus-Dactylocladus-Neoscortechinia Association (Mixed Swamp Forest)	40 – 50
2	Shorea albida-Gonystylus-Stemonurus Association (Alan Forest)	Up to 60
3	Shorea albida Association (Alan Bunga Forest)	45 – 60
4	Shorea albida-Litsea-Parastemon Association (Padang Alan Forest)	30 – 40
5	Tristsania-Parastemon-Palaquium Association (Padang Selunsor Forest)	15 – 20
6	Combretocarpus-Dactylocladus Association (Padang Paya Forest)	Few > 12

Modified from: Paramananthan (2008).

TABLE 3. PEAT CLASSIFICATION SYSTEMS IN SARAWAK

Differentiae	Criteria	Remarks
Depth of organic soil materials (cumulative)	Shallow (50 - 150 cm)	Depth phases: 1 = 50-100 cm 2 = 100-150 cm
	Deep (> 150 cm)	Depth phases: 1 = 150-200 cm 2 = 200-250 cm 3 = > 250 cm
Nature of mineral substratum	Sandy substratum (<15% clay)	Applied only to shallow families
	Clayey, sulfidic substratum (>15% clay)	
	Clayey, non-sulfidic substratum (>15% clay)	
Surface vegetation	Peat swamp forest	Lowland swamp forests
	Montane forests	Altitudes over 1000 m
Ash content	High ash content	Weighted average ash content to 50 cm is > 10% (*i.e.* loss of ignition < 90%)
	Low ash content	Weighted average ash content to 50 cm is < 10% (Loss of ignition > 90%)

Modified from: Paramananthan (2008).

TABLE 4. PEAT CLASSIFICATION SYSTEM IN SABAH

Soil unit	Parent material	Family
Dystric Histosol (pH <5.5 in some parts between 20-50 cm depth)	Peat (groundwater)	Kilat
	Peat (surface water)	Kaintano
	Sulfidic peat (> 0.75% sulphur)	Arang
Eutric Histosol (pH > 5.5 in all horizons 20-50 cm depth)	Calvareous peat	Mengalum

Source: Paramananthan (2008).

extent the wood has decomposed. The inclusion of these criteria will upgrade the global classification scheme without upsetting the classification systems for temperate peats, making it applicable for both temperate and tropical peats (Veloo *et al*., 2014). Thus, the Malaysian Unified Classification system highlights the criteria of wood content and peat depth for the classification of different peat types (*Tables 5* and *6*).

The chronology in the development of the Malaysian Unified Classification System is as follows (Paramananthan, 2011):

- Paramananthan *et al*. (1984)
  Committee for the Standardisation of Soil Survey and Evaluation in Malaysia (COMSSSEM): Circulated for testing
- Paramananthan *et al*. (1992)
  Committee for the Standardisation of Soil Survey and Evaluation in Malaysia (COMSSSEM): Revised Classification
- Paramananthan *et al*. (1998)
  Malaysian Soil Taxonomy – Second Approximation
- Paramananthan *et al*. (2008)
  Malaysian Soil Taxonomy – Second Edition (Mimeo)
- Paramananthan *et al*. (2010)
  Malaysian Soil Taxonomy – Revised Second Edition
- Uyo L.J., Ngab D.S, Choo S.B., As'ari H., Malangkig E. and Roslan M. (2010)
  A Unified Classification System for Organic Soils of Malaysia

The structure of the Unified Classification system as shown in *Figure 2* (Paramananthan, 2011) is based on histosol classification. It is further divided into three sub-orders, which are Ombrogenist, Topogenist and Folist.

CONCLUSION

There has been very few attempts to classify tropical peats using suitable classification systems. These include the international schemes, such as the Soil Taxonomy, Eleventh Edition (USDA) and the World Reference Base for Soil Resources (WRB). However, these international schemes are claimed to be unsatisfactory for classifying tropical peats. Hence, a Malaysian peat classification system was developed by modifying the USDA system to suit local conditions, and this system can be applied to most tropical lowland peats. However, further work is still needed to understand the relationships among peat classification, greenhouse gas emissions and oil palm yield performance.

ACKNOWLEDGEMENT

The authors thank the Director General of MPOB for permission to publish this paper. They also wish to thank the Director of the Biological Research Division for his support.

REFERENCES

Coulter, J K (1950) Peat formations in Malaya. *Malaysian Agricultural Journal, 33*: 63-81.

Law, W M and Selvadurai, K (1968). The 1968 reconnaissance soil map of Malaya. Paper presented at the third Malaysian Soil Conference, Kuching, May 1968.

Malawska, M; Ekonomiuk, A and Wilkomirski, B (2006). Chemical characteristics of some peatlands in southern Poland. *Mires and Peat, 1(2)*: 1.

TABLE 5. CLASSIFICATION BASED ON THE WOOD CONTENT

Degree of woodiness		Size of wood	
Terminology	Wood volume (%)	Terminology	Wood diameter (cm)
Few	0 – 5	Fibre	< 2
Common	>5 – 15	Small	2 – 5
Many	>15 – 35	Medium	5 – 10
Abundant	> 35	Large	10 – 15
		Very large	> 15

Source: Melling (2016).

TABLE 6. CLASSIFICATION BASED ON PEAT DEPTH

Organic soil material depth (cm)	Terminology
<50	Peaty phase
50 – 100	Very shallow
>100 – 200	Shallow
>200 – 300	Moderately deep
> 300	Deep

Source: Melling (2016).

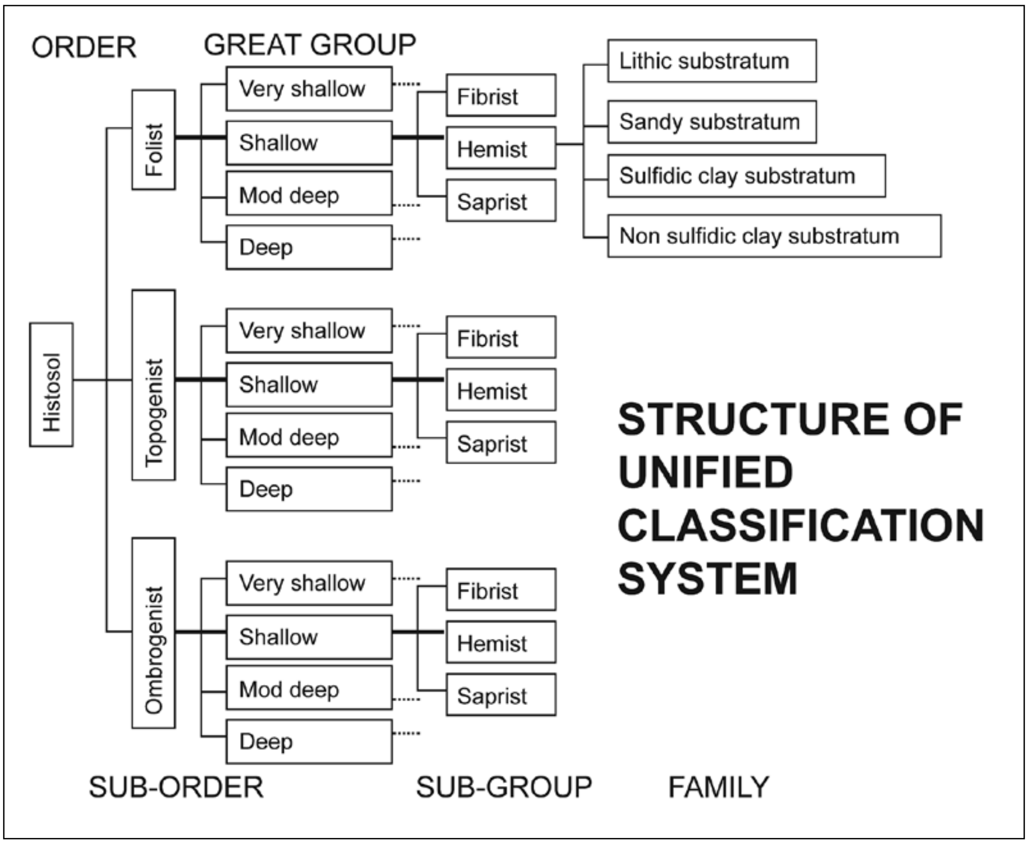

Figure 2. The structure of the Unified Classification system (Paramananthan, 2011).

Melling, L; Chua, K and Lim, K (2008). *Managing Peat Soils Under Oil Palm.* [Online] https://www.google.com/l?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwi28cOS_brXAhVMgI8KHaUCAk0QFggsMAA&url=http%3A%2F%2Ftropicalpeat.sarawak.gov.my%2Fmodules%2Fweb%2Fpages.php%3Fmod%3Ddownload%26sub%3Ddownload_show%26id%3D16&usg=AOvVa, accessed 7 October 2017.

Melling, L (2016). Peatland in Malaysia. In: O Mitsuru and T Nobuyuki, eds. *Tropical Peatland Ecosystem.* Sapporo, Japan, Springer. p. 59-70.

Miettinen, J; Hooijer A; Shi C; Tollenaar D; Vernimmen R; Liew S C; Malins C and Page S E (2012). Extent of industrial plantations on Southest Asian peatlands in 2010 wih analysis of historical expansion and future projections. *GCB Bioenergy, 4*: 908-918.

Paramananthan, S (2016). *One Oil Palm.* [Online] http://www.oneoilpalm.com/wp-content/uploads/2016/11/New-Unified-Classification-on-Tropical-Peat.pdf, accessed 13 November 2017.

Paramananthan, S (1998). Malaysian Soil Taxonomy (Second Approximation): A Proposal for the Classification of Malaysian Soils. *Malaysian Society of Soil Science, Param Agricultural and Soil Surveys (M) Sdn. Bhd., Kuala Lumpur, Malaysia.*

Paramananthan, S (2008). *Tropical Lowland Peats: To Conserve or Develop Them?.* [Online] http://iet.jrc.ec.europa.eu/remea/sites/remea/files/files/documents/events/%3Cem%3EEdit%20Event%3C/em%3E%20Direct%20and%20indirect%20impact%20of%20biofuel%20policies%20on%20tropical%20deforestation%20in%20Malaysia/paramananthan_tropical_lowland_peats_full, accessed 10 October 2017.

Paramananthan, S (2011). *Peat Classification.* MPOB, Bangi.

Rieley, J and Page, S (2016). Tropical Peatland of the World. In: M. Osaki & N. Tsuji, eds. *Tropical Peatland Ecosystems.* Japan: Springer. p. 3-7.

Veloo, R; Paramananthan, S and Ranst, E V (2014). Classification of tropical lowland peats revisited: The case of Sarawak. Catena. p. 1-7.