NEW UNIFIED CLASSIFICATION ON TROPICAL PEAT
- An update on issues
- Best management practices

S. PARAMANANTHAN
B.Sc., (Hon), Dip. Trop. Agron., D.Sc., FIGM, FMSSS, FISP, FASc
PARAM AGRICULTURAL SOIL SURVEYS (M) SDN. BHD.
**MINERAL SOILS vs ORGANIC SOILS**
Are they really different?

**TROPICAL PEAT vs TEMPERATE PEAT**
- Extent
- Differences
- Crops Planted / Uses

**PAST DEFINITIONS OF PEAT**
- Peninsular Malaysia
- Sabah
- Sarawak

**CHARACTERISTICS OF TROPICAL PEAT**
- Dome shape
- Peat maturity
- Wood
- Stumps of Shorea
- Underlying substratum
- Depth
- Surface wood
- Hydric layer
CLASSIFICATION SYSTEMS
- USDA - Soil Taxonomy
- IUSS / FAO Map Legend
- MALAYSIA – UPCS

Which is better for Tropical Peat?

CURRENT ISSUES
- WILMAR – Zero peat
- GAR – PT Smart Consortium
- Hooijer et al 2012
- Attacks by NGOs

RECENT FINDINGS
- Yields / Economic Viability
- GHG Emissions
- Biodiversity
- Rehabilitation of peat

MALAYSIAN SUSTAINABLE PALM OIL CERTIFICATION SCHEME
- Partitioning of peat land
- Improving / Maintaining Biodiversity
- Sustainability
- Implication of MSPO in Sarawak
Mineral Soils vs Organic Soils:

CURRENT SITUATION
MINERAL AND ORGANIC SOILS
(A) PARTICLE SIZE CLASS / PEAT MATURITY

MINERAL SOILS

ORGANIC SOILS

>60% CLAY
VERY FINE

18-35% CLAY
FINE LOAMY

15-18% CLAY
COARSE LOAMY

PEAT (SAPRICE)

PEAT (HEMIC)

PEAT (FIBRIC)
CURRENT SITUATION
MINERAL AND ORGANIC SOILS
(B) PRESENCE OF SKELETAL GRAINS / WOOD

MINERAL SOILS

CLAYEY-SKELETAL

CLAYEY OVER CLAYEY-SKELETAL

CLAYEY

PEAT WOOD WITHIN 50 CM

ORGANIC SOILS

PEAT WOOD 50-100 CM

PEAT NO WOOD
DEEP (>100 CM) KANDIUDULT
MODERATELY DEEP (50-100 CM) KANHAPLUDULT
SHALLOW (<50 CM) LITHIC SUB-GROUP
VERY DEEP PEAT (>300 CM)
DEEP PEAT (>150 CM)
SHALLOW (50-100 CM)
FOCUS ON MAPPING:
If we are separating mineral soils using particle-size classes, skeletal families, depth
WHY NOT FOR ORGANIC SOILS?

SOIL TAXONOMY:

- HAPLOSAPRIST/HAPLOHEMIST/HAPLOFIBRIST

- DOES NOT SEPARATE WOOD/DEPTH CLASSES

- TECHNICAL PAPERS/JOURNALS “PEAT” – NOT SCIENTIFIC
Temperate Peat vs Tropical Peat: Current Situation:

- All peats treated equally
- Use of temperate definitions / classification and management for tropical peats
- Inherently Wrong
CHARACTERISTICS OF LOWLAND PEATS
– Different from Temperate Peats

TEMPERATE PEAT

TROPICAL LOWLAND PEAT

TEMPERATE PEAT

TROPICAL PEAT FOREST
Distribution of Peat Lands:
Temperate vs Tropical: MINERAL SOILS

**Temperate Area**
- Alternating high and low temperature
- Wet/dry season
- Weathering/Leaching Seasonal
- Weathering/Partial leaching of bases/silica
- Weathering zone often < 2 m
- Moderate to High Fertility (high CEC/BS pH 6.0 to 8.0)

**Tropical Area**
- Continuous high temperature
- Wet throughout year
- Continuous weathering/leaching
- Intensive weathering and leaching of bases and silica
- Weathering zone > 10 m
- Infertile Soils (low CEC/BS pH less than 5.0)
Temperate vs Tropical: PEAT

**Temperate Peat**
- Developed over Grass / Sedges / Sphagnum
- More fertile (pH >4.0)
- Little wood
- Short term Crops
  - Rapeseed / Soya / Fodder crops
- Burn for fuel
- Generate Electricity
- Peat pots

**Tropical Peat**
- Developed over forest
- Low fertility (pH <4.0)
- Plenty of wood
- Long term Crops
  - Robber / Oil Palm / Acasia / Sago
- Mostly not developed, if other lands are available
- Recent rush to plant Oil Palm
## Extent of Peatlands:

### GLOBAL

<table>
<thead>
<tr>
<th>CONTINENT</th>
<th>AREA (KM²)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH AMERICA</td>
<td>2,096,400</td>
<td>49.19</td>
</tr>
<tr>
<td>EASTERN EUROPE</td>
<td>1,519,578</td>
<td>35.65</td>
</tr>
<tr>
<td>GLOabal PEATLAND</td>
<td>4,261,890</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Data summarised from Bord Na Mona (1984) and Andriesse (1988)

### TROPICAL

<table>
<thead>
<tr>
<th>REGION</th>
<th>AREA (KM²)</th>
<th>GLOBAL (%)</th>
<th>TROPICAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOUTHEAST ASIA</td>
<td>202,600</td>
<td>4.65</td>
<td>56.6</td>
</tr>
<tr>
<td>CARIBBEAN</td>
<td>56,700</td>
<td>1.3</td>
<td>15.8</td>
</tr>
<tr>
<td>TROPICAL AND SUBTROPICAL PEATLAND</td>
<td>358,000</td>
<td>8.21</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Andriesse (1988)

### SOUTH EAST ASIA

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>RIELEY et al. (1995) (X MILLION)</th>
<th>TIE, 1990 (X MILLION HA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MINIMUM (HA)</td>
<td>MAXIMUM (HA)</td>
</tr>
<tr>
<td>INDONESIA</td>
<td>17.00</td>
<td>27.00</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>2.25</td>
<td>2.73</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19.93</td>
<td>32.94</td>
</tr>
</tbody>
</table>

Source: Rieley et al. (1995) and Tie (1990)
## Extent of Peatlands in Malaysia:

### Extent of Organic Soils in Malaysia

<table>
<thead>
<tr>
<th>REGION</th>
<th>HA</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SARAWAK</td>
<td>1,697,847</td>
<td>69.08</td>
</tr>
<tr>
<td>PENINSULAR MALAYSIA</td>
<td>642,918</td>
<td>26.16</td>
</tr>
<tr>
<td>SABAH</td>
<td>116,965</td>
<td>4.76</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>2,457,730</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

## Past Classifications in Malaysia: - Peninsula

<table>
<thead>
<tr>
<th>Author</th>
<th>Definitions Used</th>
</tr>
</thead>
</table>
| Coulter, 1950 | Eutropic  
Mesotrophic  
Oligotrophic |
| Null, Acton and Wong, 1965 Wong, 1966 | Inland Swamp Association |
| Leamy and Panton, 1966 | Organic clay  
– Loss on Ignition 20-35%.  
Minimum thickness 15 cm  
Muck  
– Loss on Ignition 35-65%  
Minimum thickness 60 cm  
Peat  
– Loss on Ignition >65%  
Shallow <60 cm  
Moderately deep 60-150 cm  
Deep >150 cm |
| 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, 2010b | Developed Keys to the Identification of organic soils |
## Past Classifications in Malaysia: - Sabah

<table>
<thead>
<tr>
<th>Soil Units</th>
<th>Parent Materials</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dystric Histosol (pH &lt; 5.5 in some part between 20-50 cm depth)</td>
<td>Peat (groundwater)</td>
<td>Klias</td>
</tr>
<tr>
<td></td>
<td>Peat (surface water)</td>
<td>Kaintano</td>
</tr>
<tr>
<td></td>
<td>Sulfidic Peat (&gt; 0.75% sulfur)</td>
<td>Arang</td>
</tr>
<tr>
<td>Eutric Histosol (pH &gt; 5.5 in all horizons 20-50 cm depth)</td>
<td>Calcareous Peat</td>
<td>Mengalum</td>
</tr>
</tbody>
</table>
### Past Classifications in Malaysia: - Sarawak - Tie (1972)

<table>
<thead>
<tr>
<th>Differentiae</th>
<th>Criteria Used</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Section</td>
<td>150 cm or depth to lithic/paralithic contact</td>
<td></td>
</tr>
</tbody>
</table>
| 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 1,000 m                      |
| Groundwater Table                    | Present                                               | Unless artificially drained                 |
|                                      | Absent                                                | Non-present but material may be saturated   |
| 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%) |
| Mode of Derivation                   | Autochthonous                                         | In-situ build-up                            |
|                                      | Allochthonous                                         | Alluvial accumulation                       |
Past Classifications in Malaysia:
- Sarawak (continued) - Reconnaissance Soil Survey

- **SAND** (Igan)
  - 50 cm
  - 100 cm

- **CLAY - Non sulfidic** (Mukah)
  - 50 cm
  - 100 cm

- **CLAY - Sulfidic** (Meraok)
  - 50 cm
  - 100 cm
  - [Indicators of sulfidic layers]

- **Anderson**
  - 1 = 100 to 200 cm
  - 2 = 200 to 300 cm
  - 3 = >300 cm
Past Classifications in Indonesia:

- Organosol
  (>50 cm OSM)
  - Fibrik
  - Hemik
  - Saprik
FAO/UNESCO 1990 – IUSS WRB 2014:

Histosols
(>40 or 60 cm)

- Gelic
- Thionic
- Folic
- Fibric
- Terric
### Unified Malaysian Classification: ORGANIC SOILS (Paramananthan, 2010)

<table>
<thead>
<tr>
<th>CATEGORIC LEVEL</th>
<th>CRITERIA USED</th>
<th>EXAMPLE</th>
</tr>
</thead>
</table>
| ORDER           | • Minimum thickness  
                  • 50 cm in upper 100 cm or 50% of Solum if less than 100 cm | HISTOSOLS |
| SUB-ORDER       | • Well drained  
                  • Poorly drained | FOLISTS  
                  GAMBISTS |
| GREAT GROUP     | • Thickness of organic layer  
                  • 50-150 cm  
                  • 150-300 cm | Topogambist  
                  Ombrogambist |
| SUB-GROUPS      | • Dominant material in Middle (50-100 cm) Tier | Sapric Ombrogambist |
| SOIL FAMILY     | • Nature of substratum  
                  • Soil temperature regime | Marine clayey  
                  Isohyperthermic |
| SOIL SERIES     | • Wood Classes  
                  • Mode of origin | Kenyana Series  
                  Undecomposed wood  
                  Autochthonous |
| SOIL PHASE      | • Ash content  
                  • Reaction Class  
                  • Salinity  
                  • Nature of Surface Tier  
                  • Drained Phases  
                  • Depth Phase | Low ash, dysic, non-saline, sapric, drained, very deep |
## Comparison between USDA Soil Taxonomy and Malaysia Soil Taxonomy:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Naman Series</td>
<td>Kenyana Series</td>
</tr>
<tr>
<td>ORDER</td>
<td>HISTOSOL</td>
<td>HISTOSOL</td>
</tr>
<tr>
<td></td>
<td>HISTOSOL</td>
<td>HISTOSOL</td>
</tr>
<tr>
<td>SUBORDER</td>
<td>SAPRIST</td>
<td>SAPRIST</td>
</tr>
<tr>
<td></td>
<td>SAPRIST</td>
<td>GAMBIST</td>
</tr>
<tr>
<td>GREAT GROUP</td>
<td>HAPLOSAPRIST</td>
<td>HAPLOSAPRIST</td>
</tr>
<tr>
<td></td>
<td>HAPLOSAPRIST</td>
<td>OMBROGAMBIST</td>
</tr>
<tr>
<td>SUB-GROUP</td>
<td>Typic Haplosaprist</td>
<td>Typic Haplosaprist</td>
</tr>
<tr>
<td></td>
<td>Typic Haplosaprist</td>
<td>Sapric Ombrogambist</td>
</tr>
<tr>
<td></td>
<td>Sapric Ombrogambist</td>
<td>Sapric Ombrogambist</td>
</tr>
<tr>
<td>FAMILY</td>
<td>Dysic, isohyperthermic</td>
<td>Dysic, isohyperthermic</td>
</tr>
<tr>
<td></td>
<td>Dysic, isohyperthermic</td>
<td>Marine-clayey, isohyperthermic</td>
</tr>
<tr>
<td></td>
<td>Marine-clayey, isohyperthermic</td>
<td>Marine-clayey, isohyperthermic</td>
</tr>
<tr>
<td>SOIL SERIES</td>
<td>Criteria used, non-applicable</td>
<td>Criteria used, Non-applicable</td>
</tr>
<tr>
<td></td>
<td>Criteria used, Non-applicable</td>
<td>Non-woody, autochthonous</td>
</tr>
<tr>
<td></td>
<td>Criteria used, Non-applicable</td>
<td>Non-woody, autochthonous</td>
</tr>
<tr>
<td>PHASE</td>
<td>Criteria used, Non-applicable</td>
<td>Criteria used, Non-applicable</td>
</tr>
<tr>
<td></td>
<td>Criteria used, Non-applicable</td>
<td>Low ash, dysic, non-saline, sapric, drained, very deep</td>
</tr>
<tr>
<td></td>
<td>Criteria used, Non-applicable</td>
<td>Low ash, dysic, non-saline, sapric, drained, very deep</td>
</tr>
</tbody>
</table>
EXAMPLES OF MALAYSIAN ORGANIC SOILS

Penor
Gondang
Anderson
Salleh
EXAMPLES OF FOREST TYPES

- **Padang Alan Forest (PC-3)**
  - *Shorea Albida*

- **Tristania-Parastemon-Palaquium Forest (PC-5)**

- **Padang Paya Forest (PC-6)**
SURFACE MORPHOLOGY
(Tie, 1990)
SUB-SURFACE WOODINESS

No wood

Decomposed wood

Undecomposed wood
SURFACE WOODINESS

- Stumps of *Shorea Albida* on cleared land
SURFACE WOOD LITTER

- Surface wood litter after land clearing
HYDRIC LAYER (VACANT LAYER)

- Layer of water in peat profile
### Kinds of Organic Soil Materials

<table>
<thead>
<tr>
<th>Kind</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moss</td>
<td>High Altitude – Low B Density</td>
</tr>
<tr>
<td>Fibric</td>
<td>&gt;2/3 Fibres after rubbing (Remove Wood)</td>
</tr>
<tr>
<td>Hemic</td>
<td>1/3 – 2/3 Fibres after rubbing (Remove Wood)</td>
</tr>
<tr>
<td>Sapric</td>
<td>&lt;1/3 fibres after rubbing (Remove Wood)</td>
</tr>
<tr>
<td>Wood</td>
<td>Decomposed or undecomposed pieces with cross-section diameter ≥2 cm</td>
</tr>
</tbody>
</table>
WOOD

Decomposed or undecomposed pieces with cross-section diameter ≥2 cm

No wood

Decomposed wood

Undecomposed wood
# Current Issues - Peat Depth:

<table>
<thead>
<tr>
<th>Depth of OSM</th>
<th>Name</th>
<th>Mineral/Organic Soils</th>
<th>Current Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 25 cm</td>
<td>Organic Phase</td>
<td>Mineral Soils</td>
<td>1. <strong>WILMAR</strong> - Zero Peat</td>
</tr>
<tr>
<td>25 – 50 cm</td>
<td>Histic Epipedon</td>
<td></td>
<td>2. <strong>RSPO</strong> - No new planting on peat</td>
</tr>
<tr>
<td>50 – 100 cm</td>
<td>Shallow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 – 150 cm</td>
<td>Moderately Deep</td>
<td>Organic Soils</td>
<td>3. <strong>Indonesia</strong> - &gt;300 cm no planting</td>
</tr>
<tr>
<td>150 – 300 cm</td>
<td>Deep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;300 cm</td>
<td>Very Deep</td>
<td></td>
<td>4. <strong>GAR-PT Smart</strong> - No Plantation on Peat &gt;300 cm overlying Sand / Sulfate</td>
</tr>
</tbody>
</table>
## Current Issues – Subsidence:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Subsidence Rate</th>
</tr>
</thead>
</table>
| **Past Values** | • Drainage with no control  
• First 2 years 100 cm  
• 5 cm per year  
• 2 cm per year |
| **Kool et al. (2006)** | • Subsidence : 220 – 400 cm  
• Actual decomposition : 2 – 47 cm |
| **RSPO**      | • Subsidence 50%  
• Decomposition 50% |
| **Hooijer et al. (2012)** | • First 5 years 142 cm  
Subsequently 5 cm per year  
20 years cycle of oil palm  
• 1<sup>st</sup> cycle 142+75 = 217 cm  
• 2<sup>nd</sup> cycle = 100 cm  
• 3<sup>rd</sup> cycle = 100 cm  
• After 3 cycle = 417 cm  
United Plantation- No more peat ? |
| **Recent Findings** | • Thailand – 3 cm per year  
• Malaysia – 2 to 3 cm per year |
Current Issues – GHG Emission:

NGOs
- 35 – 112 MtC/ha/year

ICCC
- ‘Cutoff’ 42 MtC/ha/year

MALAYSIA
- Current values on peat 42 – 60 MtC/ha/year
- Recent High Carbon Stock (HCS) Study – No new planting on peat
<table>
<thead>
<tr>
<th>CATEGORIC LEVEL</th>
<th>CRITERIA USED</th>
<th>EXAMPLE</th>
</tr>
</thead>
</table>
| ORDER                   | • Minimum thickness  
                          - 50 cm in upper 100 cm or 50% of Solum if less than 100 cm | HISTOSOLS                      |
| SUB-ORDER               | • Well drained  
                          • Poorly drained               | FOLISTS GAMBISTS               |
| GREAT GROUP             | • Thickness of organic layer  
                          - 50-150 cm  
                          - 150-300 cm                  | Topogambist Ombrogambist       |
| SUB-GROUPS              | • Dominant material in Middle (50-100 cm) Tier                               | Sapric Ombrogambist            |
| SOIL FAMILY             | • Nature of substratum  
                          • Soil temperature regime     | Marine clayey Isohyperthermic  |
| SOIL SERIES             | • Wood Classes  
                          • Mode of origin               | Kenyana Series                 |
|                         | • Ash content  
                          • Reaction Class  
                          • Salinity  
                          • Nature of Surface Tier  
                          • Drained Phases  
                          • Depth Phase          | Undecomposed wood Autochthonous |
| SOIL PHASE              |                                                                                   | Low ash, dysic, non-saline, sapric, drained, very deep |
### Comparison between USDA soil taxonomy and Malaysia soil taxonomy:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Naman Series</td>
<td>Kenyana Series</td>
</tr>
<tr>
<td>ORDER</td>
<td>HISTOSOL</td>
<td>HISTOSOL</td>
</tr>
<tr>
<td>SUBORDER</td>
<td>SAPRIST</td>
<td>GAMBIST</td>
</tr>
<tr>
<td>GREAT GROUP</td>
<td>HAPLOSAPRIST</td>
<td>OMBROGAMBIST</td>
</tr>
<tr>
<td>SUB-GROUP</td>
<td>Typic Haplosaprist</td>
<td>Sapric Ombrogambist</td>
</tr>
<tr>
<td>FAMILY</td>
<td>Dysic, isohyperthermic</td>
<td>Marine-clayey, isohyperthermic</td>
</tr>
<tr>
<td>SOIL SERIES</td>
<td>Criteria used, non-applicable</td>
<td>Non-woody, autochthonous</td>
</tr>
<tr>
<td></td>
<td>Criteria used, Non-applicable</td>
<td>Woody-unde decomposed, autochthonous</td>
</tr>
<tr>
<td>PHASE</td>
<td>Criteria used, Non-applicable</td>
<td>Low ash, dysic, non-saline, sapric, drained, very deep</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low ash, dysic, non-saline, sapric, drained, very deep</td>
</tr>
</tbody>
</table>
Summary of Findings:

MALAYSIAN UNIFIED PEAT CLASSIFICATION – BETTER characterize TROPICAL PEAT SOILS

- Separates fibric / hemic / sapric
- Recognizes Depth Classes
  - Topo
  - Ombro
- Recognizes:
  - Presence / absence of wood
  - Nature of wood:
    - Decomposed
    - Undecomposed
- Identifies – underlying mineral substratum
- Can be used to map deep organic soil up to PHASE LEVEL (very detailed) and important for agronomic management / GHG emissions
- All current classifications – Soil Taxonomy / IUSS WRB / COMSSSEM – cannot do this.
POTENTIAL USES OF UNIFIED PEAT CLASSIFICATION IN MSPO CERTIFICATION SCHEME
MSPO vs RSPO:

• **RSPO makes blanket ruling**
  - No new oil palm on peat

• **MSPO must face reality**
  - Need to eradicate poverty (smallholders)
  - What to do with oil palms already on peat
  - Can these areas be replanted
  - RSPO – No
  - MSPO?
  - Deep peat (>3 m) – Indonesia Presidential Decree
    No development
New Areas for Development on Peat

Existing Oil Palms on Peat

Can We Certify Them?
Yes, Subject to guidelines from UPCS and the National Biodiversity Policies
New Areas:

- Conduct Semi-detailed Soil Survey
- Use Unified Peat Classification System

NEW AREAS

- Technically suitable and economically viable: CERTIFY AND PLANT
- UNSUITABLE AREAS
  - Soils Unsuitable
  - Economically not viable: DO NOT CLEAR FOR PLANTING
Existing Areas:

EXISTING AREAS
Due for replanting

Carry out Semi-Detailed Soil Survey using Unified Peat Classification

Technically suitable
Economically viable
BMPs Compliant
REPLANT

Technically unsuitable
OR
Economically not suitable
REHABILITATE TO FORESTRY
Criteria to be used for Decision:

TECHNICAL SUITABILITY
YIELD ON DIFFERENT PEAT TYPES

Example:
PEAT CHARACTERISTICS AND ITS IMPACT ON YIELD
(RAMESH ET AL., 2014)
## Mean 11 Years Yield (2003–2013)

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Soil Management Group</th>
<th>Mean</th>
<th>Range</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naman/deep</td>
<td>Oa (organic, sapric, no wood)</td>
<td>19.50</td>
<td>18.71-20.62</td>
<td>0.89</td>
</tr>
<tr>
<td>Telong/deep</td>
<td>Oawd (organic, sapric, decomposed wood)</td>
<td>22.92</td>
<td>19.65-25.18</td>
<td>2.26</td>
</tr>
<tr>
<td>Bayas/very deep</td>
<td>Oewd (organic, hemic, decomposed wood)</td>
<td>13.37</td>
<td>11.71-15.33</td>
<td>1.31</td>
</tr>
<tr>
<td>Gedong/very deep</td>
<td>Oewu (organic, hemic, undecomposed wood)</td>
<td>9.467</td>
<td>8.17-10.70</td>
<td>0.91</td>
</tr>
<tr>
<td>Bako</td>
<td>Mineral soil</td>
<td>13.65</td>
<td>10.28-16.01</td>
<td>2.19</td>
</tr>
</tbody>
</table>
MEAN YIELD BY SOIL TYPE FROM YEAR 1 TO YEAR 11 (2003-2013)
ECONOMIC VIABILITY

Peat Characteristics and Cost of Development
## Mean Cost of Development (COD) to Maturity by Soil Type and Soil Management Group

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Description of Soils</th>
<th>N</th>
<th>Cost of Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Naman/deep (150-300 cm)</td>
<td>Oa (organic soil, sapric, with no wood); underlying material marine clay.</td>
<td>4</td>
<td>5,552</td>
</tr>
<tr>
<td>Suai/very deep (&gt;300 cm)</td>
<td>Oawu (organic soil, sapric with undecomposed wood); underlying material marine sand.</td>
<td>6</td>
<td>7,123</td>
</tr>
<tr>
<td>Bayas/very deep (&gt;300 cm)</td>
<td>Oewd (organic soil, hemic with decomposed wood); underlying material marine clay.</td>
<td>5</td>
<td>6,037</td>
</tr>
<tr>
<td>Gedong/very deep (&gt;300 cm)</td>
<td>Oewu (organic soil, hemic with undecomposed wood); underlying material marine clay.</td>
<td>5</td>
<td>8,545</td>
</tr>
<tr>
<td>Bako (weakly cemented) (spodic 50-100 cm)</td>
<td>Mineral soil, underlying material sandstone.</td>
<td>6</td>
<td>5,068</td>
</tr>
</tbody>
</table>
FIELD COST OF DEVELOPMENT TO MATURITY FOR OIL PALM BY SOIL TYPE

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Naman</th>
<th>Bayas</th>
<th>Suai</th>
<th>Gedong</th>
<th>Bako</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Group</td>
<td>Oa</td>
<td>Oewd</td>
<td>Oawu</td>
<td>Oewu</td>
<td>Mineral Soil</td>
</tr>
</tbody>
</table>

COD (USD)

- Naman: 5552 USD
- Bayas: 6037 USD
- Suai: 7123 USD
- Gedong: 8545 USD
- Bako: 5068 USD
MAINTAINING BIODIVERSITY OF OIL PALM ESTATES ON ORGANIC SOILS
National / State Level:

- Maintain / Increase extent of pristine peat swamp forest
- Undeveloped peat swamp forests (>50% undeveloped)

Studies to be conducted:

- Semi-detailed soil survey
- Identify high conservation value areas
- Technically unsuitable
- Economically not viable
- Potential GHG emissions
- Presence of endangered species
- Other factors which favour conservation

Designate as conservation area
DELINEATE AREAS FOR BIODIVERSITY CONSERVATION

- RIPARIAN AREAS
- ACTIONS TO ATTRACT WILDLIFE
- FISH PONDS
- BENEFICIAL PLANTS
- BIRD PERCHES
- INCREASE FOOD SOURCES
IMPLICATIONS OF MSPO IN SARAWAK
### Baram River Basin:

<table>
<thead>
<tr>
<th>Depth of Organic Soil Materials</th>
<th>Soil Moisture Regime</th>
<th>Sapric</th>
<th>Hemic</th>
<th>Fibric (Typic)</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Underlying Substratum/Mineral Materials</td>
<td>Non Woody</td>
<td>Decomposed Wood</td>
<td>Undecomposed Wood</td>
<td>Non Woody</td>
<td>Decomposed Wood</td>
</tr>
<tr>
<td>Marine Clay Sulfidic (&lt; 15% clay)</td>
<td>On</td>
<td>Oewd</td>
<td>Oswu</td>
<td>Oe</td>
<td>Oewd</td>
</tr>
<tr>
<td>Marine Clay (&lt; 15% clay)</td>
<td>2,202.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Sand Calcareous (&lt; 15% clay)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Sand Sulfidic (&lt;15% clay)</td>
<td>752.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Sand (&lt; 15% clay)</td>
<td>8,825.1</td>
<td>855.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Riverine/ Colluvial Clay (&lt; 15% clay)</td>
<td>2,029.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Riverine/ Colluvial Sand (&lt; 15% clay)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sub-Total Shallow-Moderately Deep Pint (50-150 cm):</td>
<td>14,434.8</td>
<td>855.3</td>
<td>-</td>
<td>82.4</td>
<td>-</td>
</tr>
<tr>
<td>Shallow (&lt;50-100 cm) and Moderately Deep (100-150 cm):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Clay Sulphidic (&lt; 15% clay)</td>
<td>1,778.7</td>
<td>-</td>
<td>7,868.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Clay (&lt; 15% clay)</td>
<td>3,726.0</td>
<td>-</td>
<td>3,650.8</td>
<td>-</td>
<td>93.7</td>
</tr>
<tr>
<td>Marine Sand Calcareous (&lt; 15% clay)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Clay Sulfidic (&lt;15% clay)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marine Sand (&lt; 15% clay)</td>
<td>-</td>
<td>13,649.4</td>
<td>7,462.9</td>
<td>-</td>
<td>4,794.2</td>
</tr>
<tr>
<td>Riverine/ Colluvial Clay (&lt; 15% clay)</td>
<td>12,849.4</td>
<td>-</td>
<td>102,682.6</td>
<td>-</td>
<td>12,434.7</td>
</tr>
<tr>
<td>Riverine/ Colluvial Sand (&lt; 15% clay)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sub-Total Deep to Very Deep Pint (150-300 cm):</td>
<td>18,354.1</td>
<td>13,649.4</td>
<td>121,665.2</td>
<td>-</td>
<td>17,322.6</td>
</tr>
<tr>
<td>Deep (&gt;300 cm)</td>
<td>32,788.9</td>
<td>14,504.7</td>
<td>121,665.2</td>
<td>82.4</td>
<td>17,322.6</td>
</tr>
<tr>
<td>GRAND TOTAL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

%: 15.9, 7.0, 58.9, 8.4, 9.4, 0.4
<table>
<thead>
<tr>
<th>Type of Soil Group</th>
<th>Soil Management Group</th>
<th>Soil Map Units</th>
<th>Main Characteristic/ Limitation</th>
<th>Management Practices Needed</th>
<th>Peak Yield Potential mt/ha/yr</th>
<th>Retus (Sibu) Complex Ha %</th>
</tr>
</thead>
</table>
   - Cover crop establishment.  
   - Terracing.  
   - Frond stacking.  
   - EFB application.  
   - Good fertilizer programme.  
   - Monitor K levels. | 24-28 | 260.8 | 1.5 |
|                    | D                     | Tka/3 Tka/4 Bko/3 Bko/4 | Moderately deep (50-100 cm) sandy (<10% clay) soils with albic and spodic horizons. Excessively drained. Moisture stress and yield fluctuation. | EFB application.  
   - Frond stacking.  
   - Erosion monitoring and mitigation.  
   - Soil moisture conservation.  
   - Cover crop (Mucuna) establishment.  
   - Additional fertilizers (split). Break cemented pan. | 18-24 | 594.2 | 3.4 |
| Organic Soil       | Oa                    | Oc/1 Lgi/sh/1 Nmn/d/1 Nmn/vd/1 | Shallow (50-100 cm), deep (150-300 cm) and very deep (300+ cm) sapric material, non-woody. Poorly drained. Low fertility. | Compaction of planting rows.  
   - High planting density.  
   - Water control and management.  
   - Good fertilizer programme with Cu, B and Zn. | 26-28 | 7,491.2 | 42.6 |
|                    | Oawd                  | Rts/d/1 Rts/vd/1 | Deep (150-300 cm) to very deep (300+ cm) sapric material with decomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility. | Compaction of planting rows.  
   - High planting density.  
   - Water control and management.  
   - Good fertilizer programme with Cu, B, Zn.  
   - Thinning of stunted palms. | 24-26 | 2,394.0 | 13.7 |
|                    | Oawu                  | Kna/vd/1       | Very deep (300+ cm) sapric material with undecomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility.  
   - High cost of drain construction. | Compaction of planting rows.  
   - High planting density.  
   - Water control and management.  
   - Good fertilizer programme with Cu, B, Zn.  
   - Thinning of stunted palms. | 22-24 | 3,339.4 | 19.1 |
|                    | Oewd                  | Bys/vd/1       | Very deep (300+ cm) hemic material with decomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility.  
   - High cost of drain construction. | Compaction of planting rows.  
   - High planting density.  
   - Water control and management.  
   - Good fertilizer programme with Cu, B, Zn.  
   - Thinning of stunted palms. | 20-22 | 1,414.2 | 8.1 |
|                    | Oewu                  | Ged/vd/1       | Very deep (300+ cm) hemic material with undecomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility.  
   - High cost of drain construction. | Compaction of planting rows.  
   - High planting density.  
   - Water control and management.  
   - Good fertilizer programme with Cu, B, Zn.  
   - Thinning of stunted palms. | 20-22 | 1,986.5 | 11.3 |

Miscellaneous Land Units (TEMUDA, Mill Complex, Quarry, Water body)  
Total: 17,530.8 100.0
<table>
<thead>
<tr>
<th>Soil Management Group</th>
<th>Soil Map Units</th>
<th>Main Characteristic/Limitation</th>
<th>Management Practices Needed</th>
<th>Peak Yield Potential</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Bdp/3</td>
<td>Deep (&gt;100 cm), fine sandy clay to clay (&gt;35% clay) textured soils. Soil erosion on steeper slopes. Low fertility.</td>
<td>Soil erosion monitoring and mitigation: • cover crop establishment. • terracing. • frond stacking. Good fertilizer programme.</td>
<td>28-32</td>
<td>31.2  0.2</td>
</tr>
<tr>
<td>C</td>
<td>Bjt/1</td>
<td>Deep (&gt;100 cm), imperfect to poorly drained alluvial soils. Textures clay to sandy clay to sandy clay loam. Flooding and high water tables. Low fertility status.</td>
<td>• Drainage and flood mitigation. • Good fertilizer programme.</td>
<td>28-34</td>
<td>51.6  0.4</td>
</tr>
<tr>
<td>Oa</td>
<td>Pnr/sh/1</td>
<td>Shallow (50-100 cm), moderately deep (100-150 cm), deep (150-300 cm) to very deep (300+ cm) sapric material, non-woody. Poorly drained. Low fertility.</td>
<td>Compaction of planting rows. High planting density. Water control and management. Good fertilizer programme with Cu, B and Zn.</td>
<td>26-28</td>
<td>4,677.6 34.6</td>
</tr>
<tr>
<td>Oawu</td>
<td>Krp/3d/1</td>
<td>Very deep (300+ cm) sapric material with undecomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility. High cost of drain construction.</td>
<td>Compaction of planting rows. High planting density. Water control and management. Good fertilizer programme with Cu, B, Zn. Thinning of stunted palms.</td>
<td>22-24</td>
<td>8,744.1 64.8</td>
</tr>
</tbody>
</table>

Total: 13,504.5 100.0
<table>
<thead>
<tr>
<th>Soil Management Group</th>
<th>Soil Map Units</th>
<th>Main Characteristic/Limitation</th>
<th>Management Practices Needed</th>
<th>Yield Potential</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mt/ha/yr</td>
<td></td>
</tr>
<tr>
<td>Cc</td>
<td>Oc/1</td>
<td>Deep (&gt;100 cm) light gray clay to brown organic clay. Poorly drained. Flooding and high watertables.</td>
<td>Drainage and flood mitigation. Good fertilizer programme.</td>
<td>28-30</td>
<td>171.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.3</td>
</tr>
<tr>
<td>Cs</td>
<td>Ttu/1 Mtu/1</td>
<td>Deep (&gt;100 cm), light gray to brown sand. Poorly drained. Low fertility. Sandy textures. Yield fluctuations.</td>
<td>Drainage and water control. Good fertilizer programme.</td>
<td>26-28</td>
<td>540.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>Oa</td>
<td>Lgl/md/1 Brm/sh/1 Brm/md/1 Nmn/d/1</td>
<td>Shallow (50-100 cm), moderately deep (100-150 cm), deep (150-300 cm) to very deep (300+ cm) sapric material, non-woody. Poorly drained. Low fertility.</td>
<td>Water control and management. Good fertilizer programme with Cu, B and Zn.</td>
<td>26-28</td>
<td>2,166.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29.6</td>
</tr>
<tr>
<td>Oawd</td>
<td>Tel/d/1 Tel/vd/1</td>
<td>Shallow (50-100 cm), moderately deep (100-150 cm), deep (150-300 cm) to very deep (300+ cm) sapric material with decomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility.</td>
<td>Water control and management. Good fertilizer programme with Cu, B, Zn. Thinning of stunted palms.</td>
<td>24-26</td>
<td>3,739.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51.1</td>
</tr>
<tr>
<td>Oawu</td>
<td>Sui/d/1 Sui/vd/1</td>
<td>Shallow (50-100 cm), moderately deep (100-150 cm), deep (150-300 cm) to very deep (300+ cm) sapric material with undecomposed wood. Poorly drained. Stunted growth common after five years. Termites. Low fertility. High cost of drain construction.</td>
<td>Water control and management. Good fertilizer programme with Cu, B, Zn. Thinning of stunted palms.</td>
<td>22-24</td>
<td>709.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.7</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,328.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
New Studies:

GHG Measurements using chamber method to obtain quick results

Using UPCS to locate areas with different types of peat

<table>
<thead>
<tr>
<th>Oa</th>
<th>Oawd</th>
<th>Oawu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oe</td>
<td>Oewd</td>
<td>Oewu</td>
</tr>
<tr>
<td>Oi</td>
<td>Oiwd</td>
<td>Oiwu</td>
</tr>
</tbody>
</table>

MPOB / SOP / PASS Co-operation

- Preliminary results – 4 months
- Long term results – 1 year
Mapping Peat areas using UPCS is pivotal to management of oil palm in a scientific, responsible, economic manner without compromising social considerations.
Therefore mapping of peat areas using UPCS assumes cardinal importance for:

- Oil Palm establishment & Management
- MSPO Certification
- Potential landuse planning on a catchment scale
UPCS is realistic and practicable in addressing sustainability certification for oil palm on peat.
Conclusions: *(continued)*

**MSPO embodies all the five FAO principles for sustainable development**

- Improving efficiency in the use of resources;
- Conserving, protecting and enhancing natural ecosystems;
- Protecting and improving rural livelihoods and social well-being;
- Enhancing the resilience of people, communities and ecosystems; and
- Promoting good governance of both natural and human systems.
THANK YOU