Training of Trainers (TOT) on Peatland Assessment and Management

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– Basic Concepts of Peat and Peatland and Its Importance –

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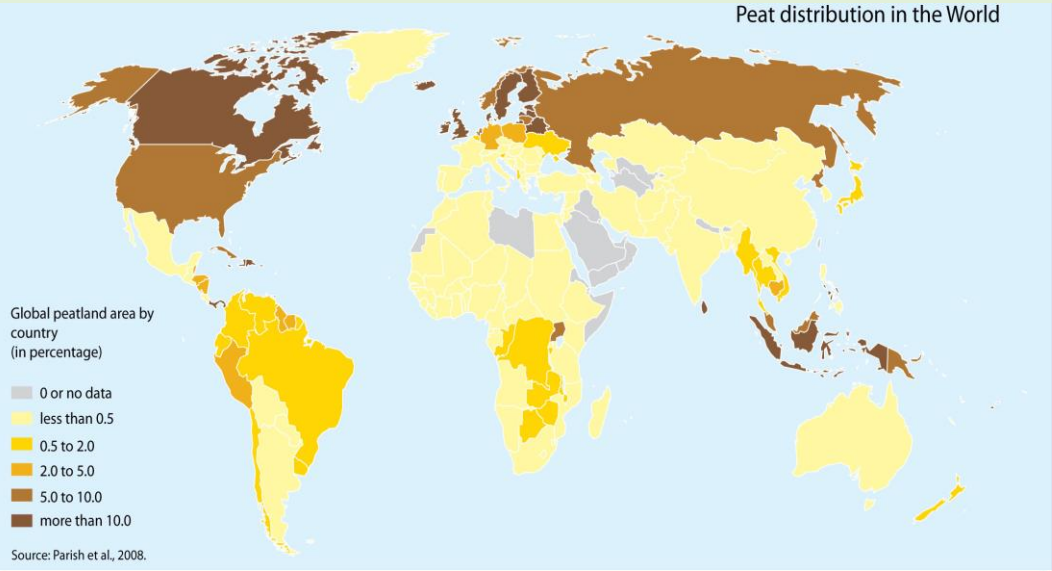
Basic Concepts of Peat and Peatland and Its Importance

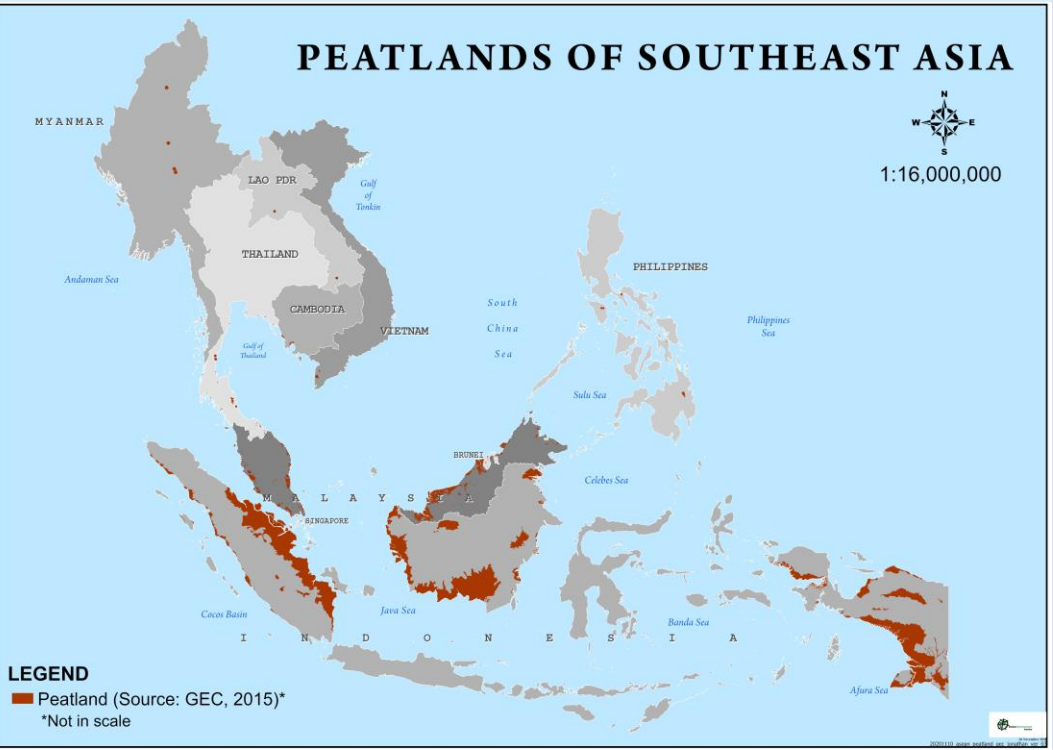
Le Phat Quoi – MAHFSA/GEC

Outline

1. Overview
2. What is peat and peatlands
3. Formation of peatlands
4. Characteristics of peat soils/peatlands
5. Identification of peatlands
6. Peatland Value and Function

1. Overview





- Peatlands are formed by the accumulation of plant residues that decomposed partly to organic materials or peat for thousand years, at least a hundred years.
- Peatlands (peat soils) cover just 3% of the Earth's land, but store approximately 30% of the Earth's soil carbon (Parish et al., 2008).
- Peat soil is considered very important because it preserves the largest amount of organic carbon and it sequesters more carbon amount than all other soils in the world combined.
- Peatlands' functions are also highly evaluated on their ability to retain water, nutrient retention, carbon storage, and sediment retention. Peatlands provide water to other ecosystems and are rich in biological diversity.
- Peatlands, a source of life for plants, animals, and people, are used for agro-forestry and nature conservation.

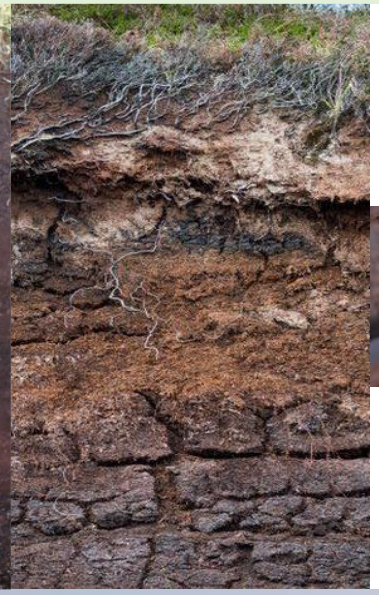
2. What is peat and peatlands ?

- Organic materials in soils were formed from the accumulation of partially decomposed vegetation (plant residues) under waterlogged and hypoxic conditions.
- Organic matter that contains a high proportion of the soil composition in the soil profile is considered **peat**.
- In the lowland humid tropics, peat materials are derived mostly from rainforest trees, grasses, and ferns (leaves, branches, trunks and roots).
- Organic materials in peat soils have been accumulated over thousands of years, at least hundreds of years.

2. What is peat and peatlands ?

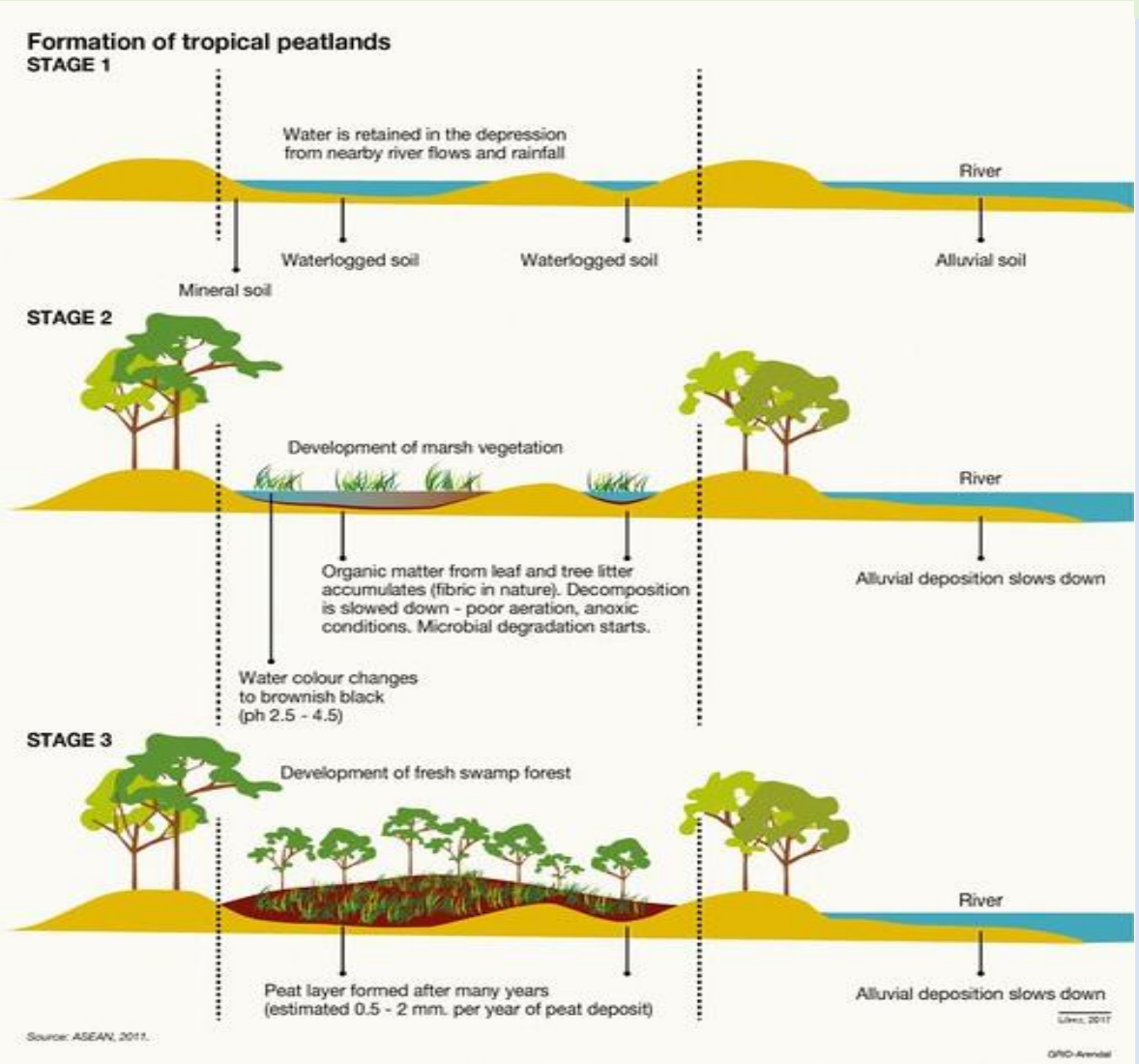
- Peatlands are ecosystems that are characterized by the accumulation of organic matter that is derived from decaying plant material under permanent water saturation (C. Max Finlayson and G. Randy Milton, 2018).
- Peatland is a *terrestrial wetland ecosystem* in which the production of organic matter exceeds its decomposition and a net accumulation of dead organic matter as peat, often to considerable thickness (IPS).

2. What is peat and peatlands ?



- **Peat**: sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material.
- **Peat soil**: organic soil materials which have sedentarily accumulated and have at least 30% (dry mass) organic matter over a depth of at least 45 cm on undrained land and 30 cm deep on drained land; the depth requirement does not apply in the event that the peat layer is over bedrock.
- **Peatland is the term used to encompass peat-covered terrain, and usually, a minimum depth of peat has required for a site to be classified as peatland. ????**
- **Peatlands are terrestrial wetland ecosystems in which waterlogged conditions prevent plant material from fully decomposing.**
- If the areas contain adequate peat material and are unique to natural areas known as **peatlands**.
- Peatland is a geographical area where peat occurs with or without vegetation with a naturally accumulated peat layer at the surface.

3. Formation of peatlands



Sketches illustrating a possible evolution from a planar peat deposit to a domed peat deposit.

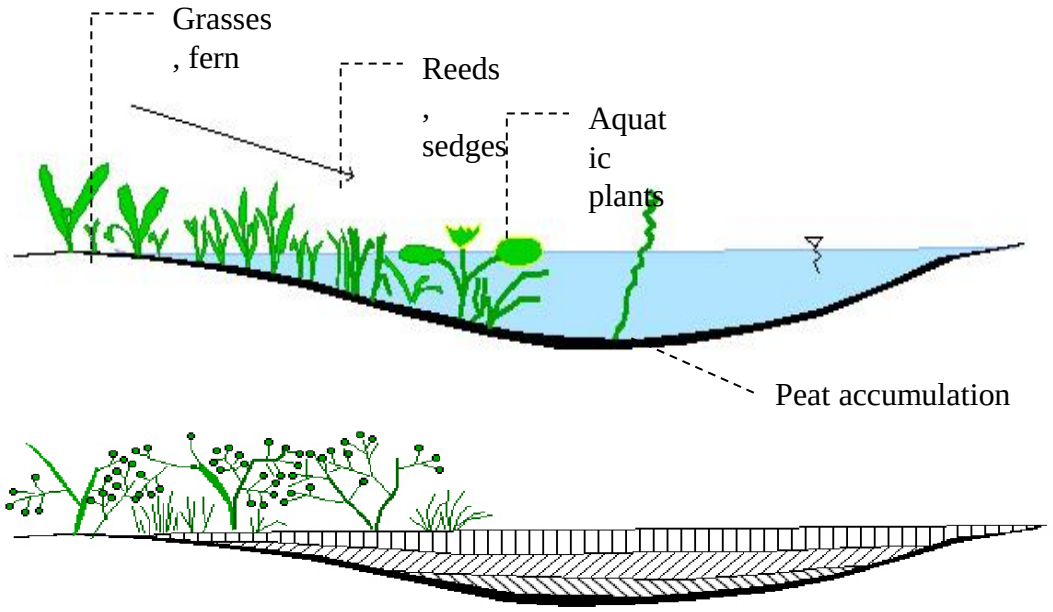
Cartographer: Nieves Lopez Izquierdo

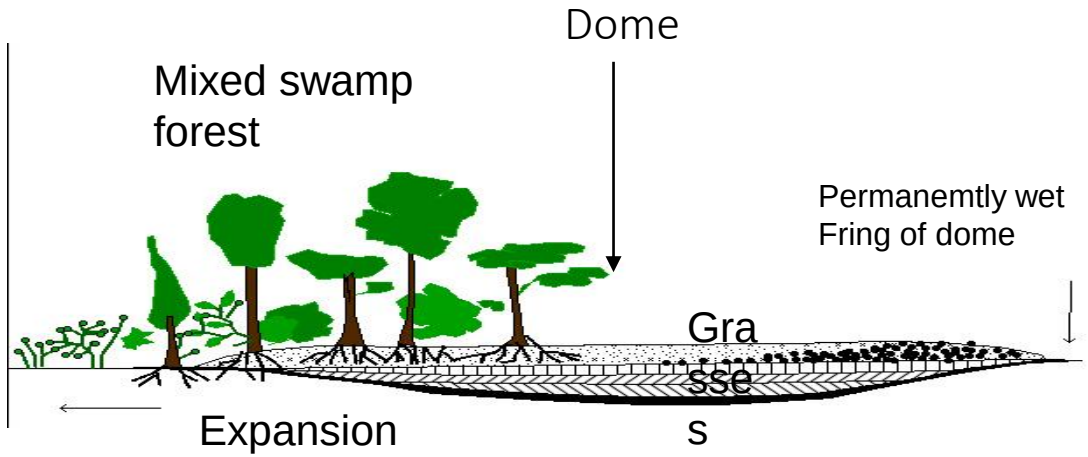
- Most peatlands are formed in low-lying areas such as fens, swamps, and marshes where many plant species grow and their residues accumulate in place after death.
- Plant residues including woody parts, leaves, rhizomes, roots, and bryophytes (notably sphagnum peat mosses) may be involved in peat formation.

Forming process:

a. *Filling of shallow lakes by wetland vegetation.*
b. *Formation of topogenous peat; and*
c. *Formation of peat dome.*

3. Formation of peatlands





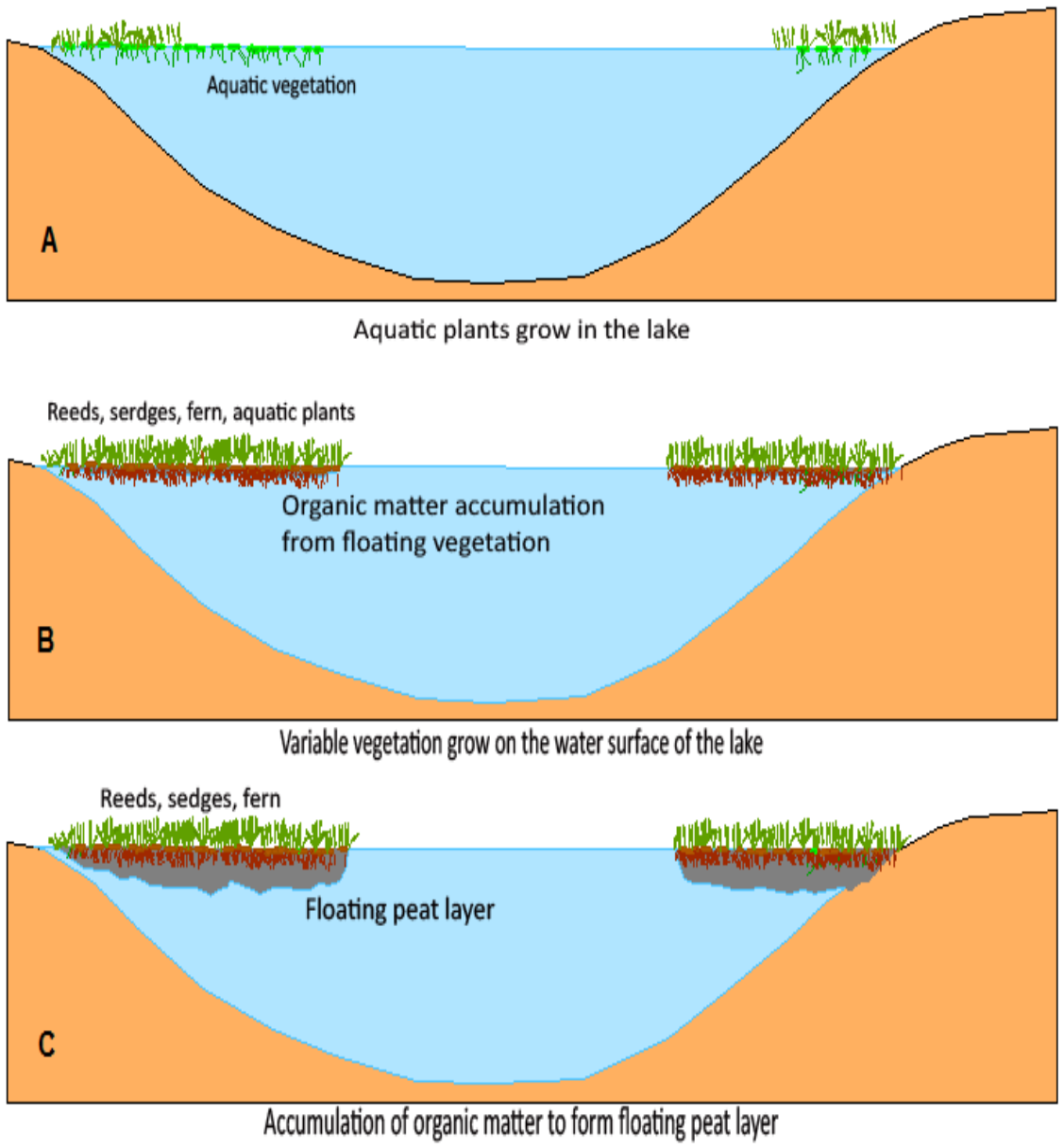
Types of peat formation

Generally, hypothetical peat isochrones resulting from self-sealing mire formation (bottom-up) and floating mat terrestrialisation (top-down).

- Bottom-up: accumulation of plant residues from bottom of pond/lake and filled up gradually. The peat grows "bottom up", parallel to the rising water surface.

A depression is gradually filled in with topogenous peat, which is then overgrown by a laterally expanding ombrogenous peat mass. Note the changing composition of the vegetation

3. Formation of peatlands

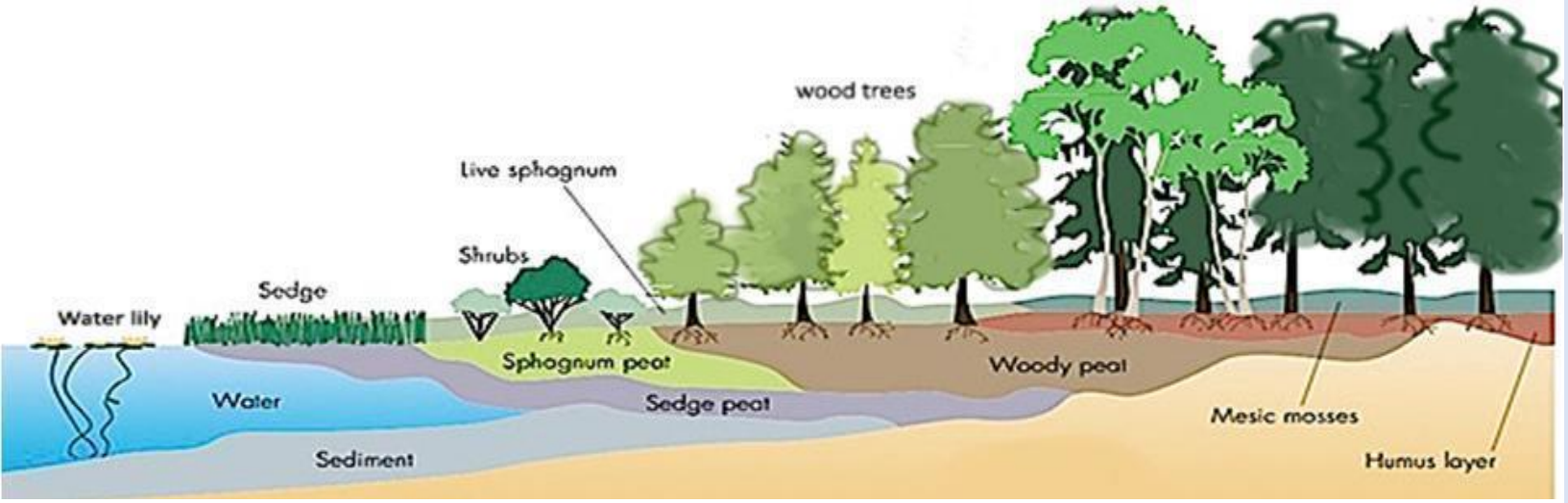


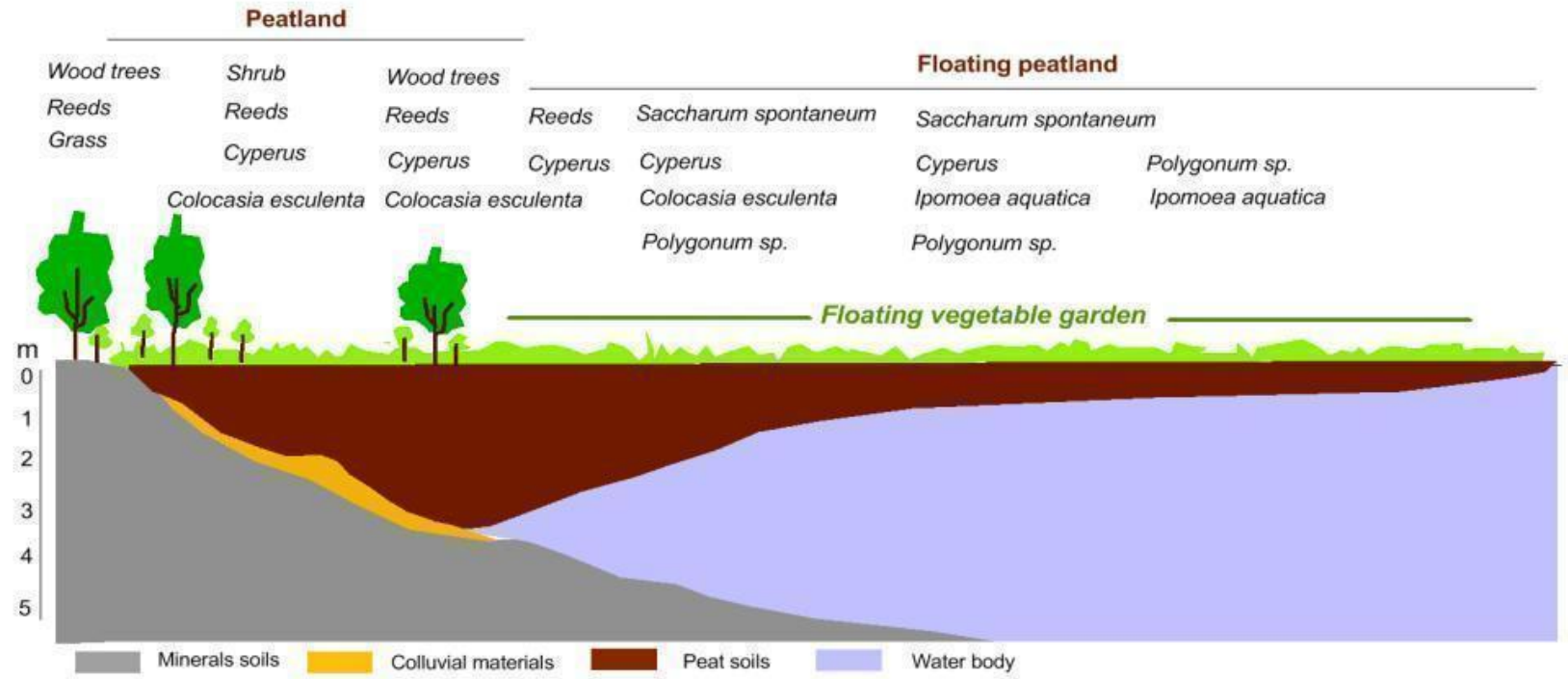
Types of peat formation

Floating plant mats occur naturally in a variety of water bodies of lakes, ponds, and marshes, which consist of a thick floating organic mat that supports the growth of plants.

- In lakes, swamps, or marshes rapid peat formation may take place by peat forming downwards (top-down) from an accumulation of plant residues of floating mats under stable water level conditions (terrestrialization).
- Top-down: accumulation of plant residues from floating vegetation mat (aquatic plants) on water surface of lake/pond.
- A floating or submerged vegetation mat did not cover the entire basin/lake.
- Peat is formed beneath the vegetation mat and gradually sinks into the water body under the weight of peat that subsequently formsabove it, until the basin is filled completely.
- The floating-mat mechanism must lead to concave peat isochrones throughout the basin.

3. Formation of peatlands



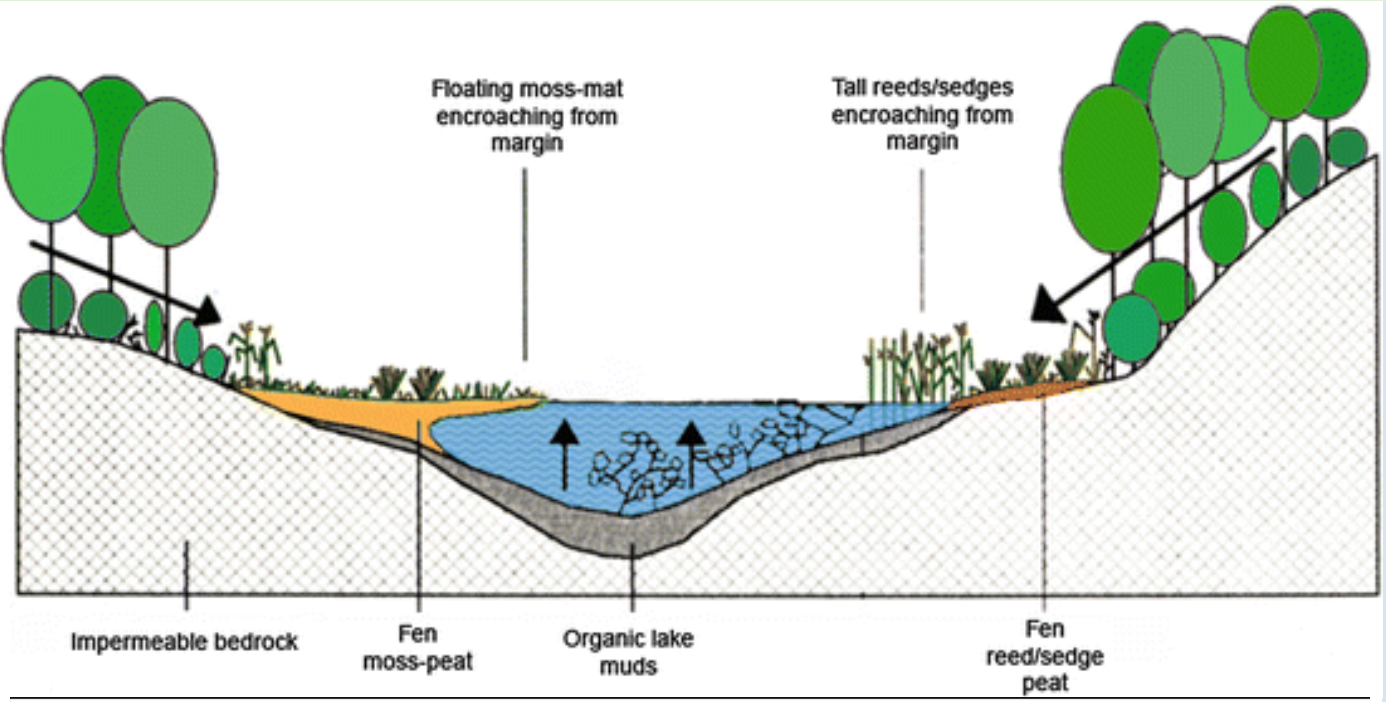


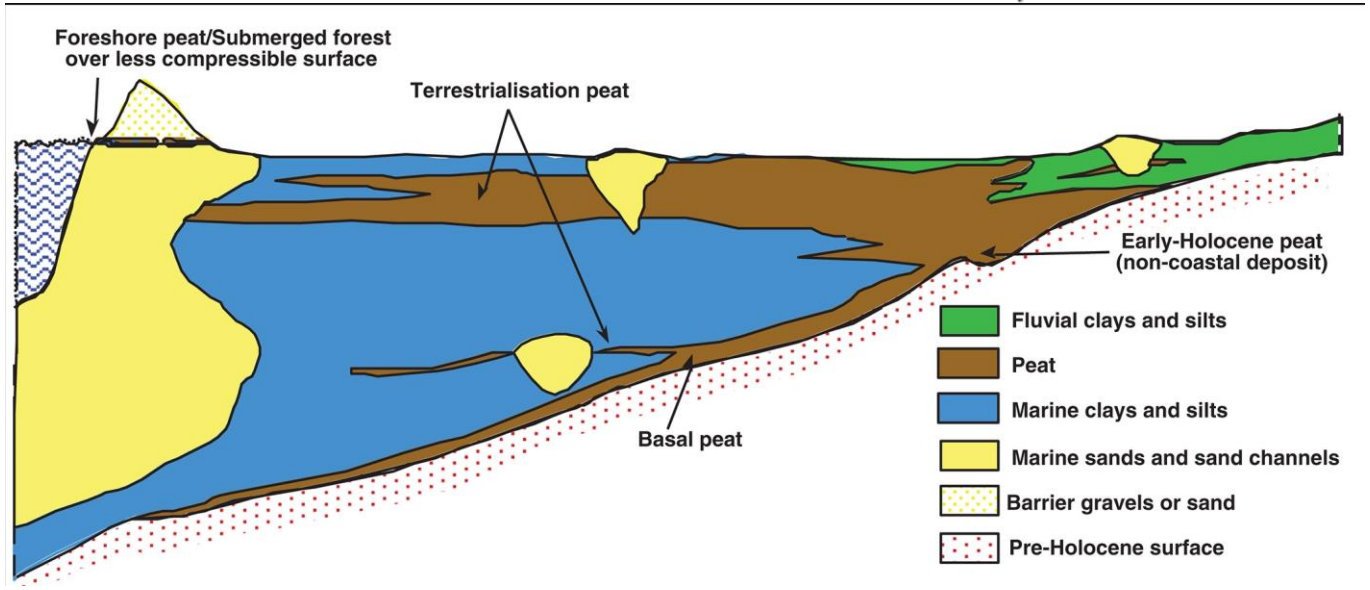
Transect of peatland and floating peatland in Inle Lake Basin (2014)

Top-down type of formation

- Floating peat mats were formed in the intinial stage. After accumulating and depositing full of peat materials, peat soil will be formed at the lake edges.
- In such type of formation, the peat floating-mat mechanism leads to concave peat isochrones throughout the basin.
- Under the root zone is a layer of decomposed peat and decaying plant detritus called the peat layer whose thickness is determined by the rooting depth of the plants.
- Beneath the peat layer exists a free-water zone (or water column) whose depth varies with the water level of the water body.

3. Formation of peatlands



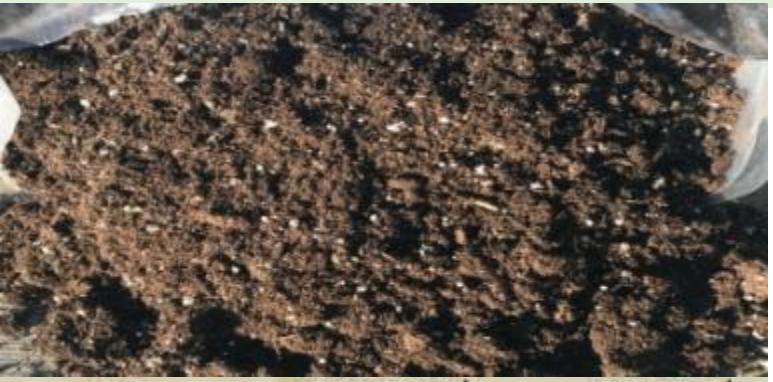


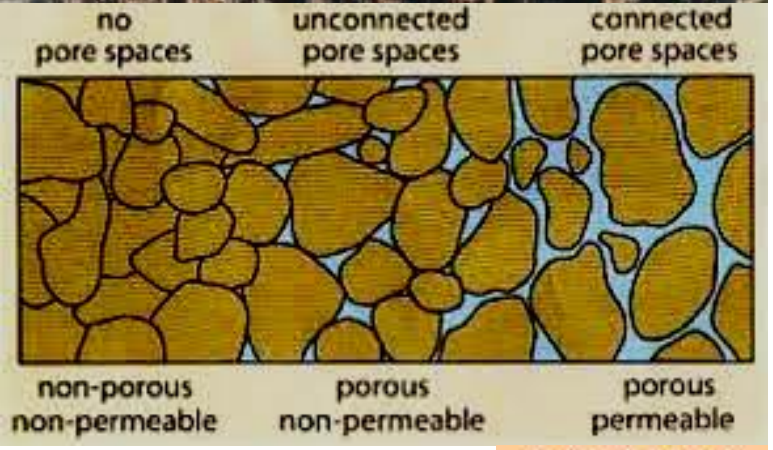
Two types of peatland formation together developed in lakes, marshes.

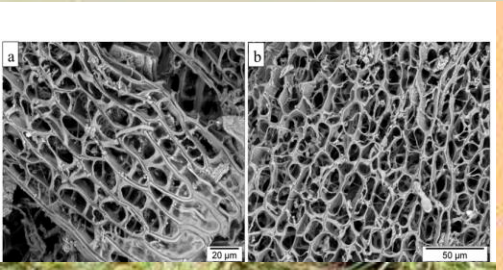
Peat soil formation process from plant growth and accumulation of their residues in the lake:

- *The initial stage is formation of the floating peat beds that will become gradually their thickness.*
- *Filling shallow lakes gradually with plant residues to form peat soils.*

4. Characteristics of peat soils/peatlands

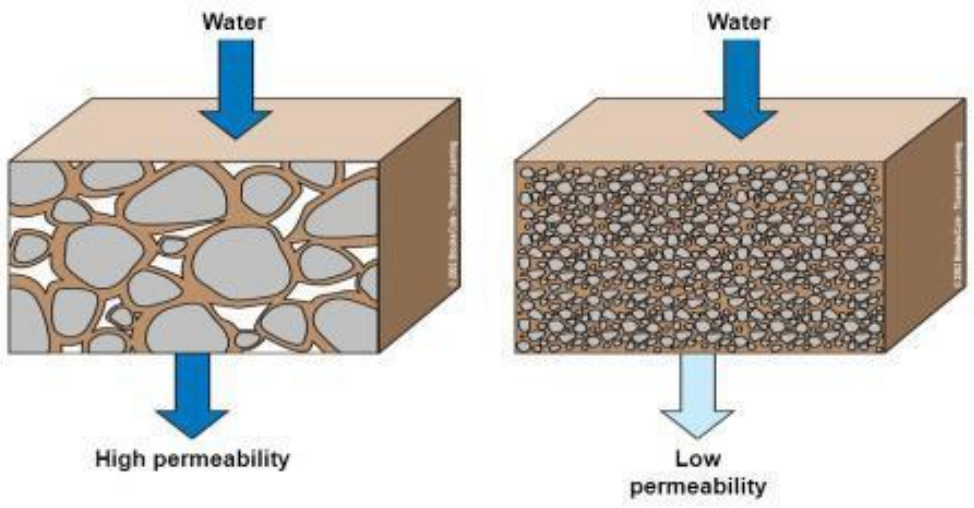


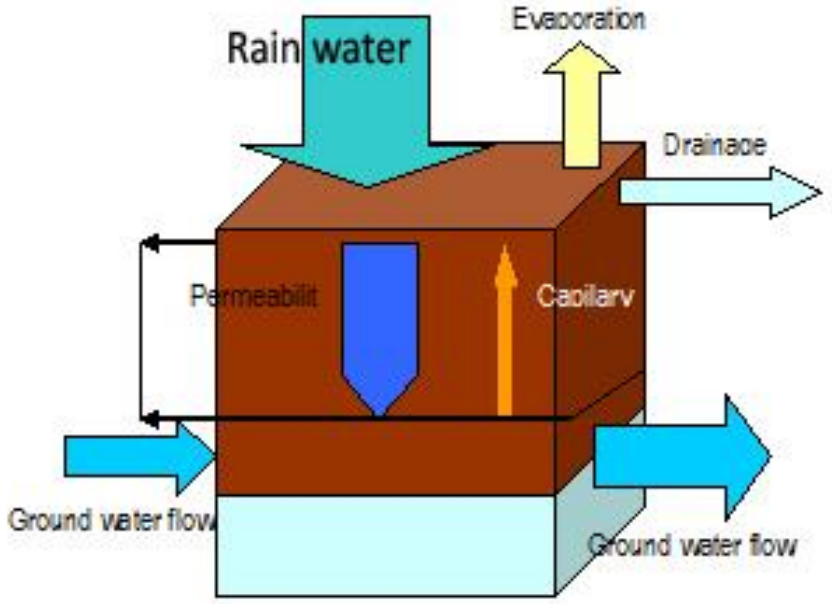




- Organic compounds: *The high content of organic matter and organic carbon*
- High porosity (pore space).
- Low bulk density (0.1 g/cm^3).
- Ability to shrink physically under dry conditions.
- Water retention – water holding capacity (high water content as saturated)
- Acidity (organic acid).

4. Characteristics of peat soils/peatlands





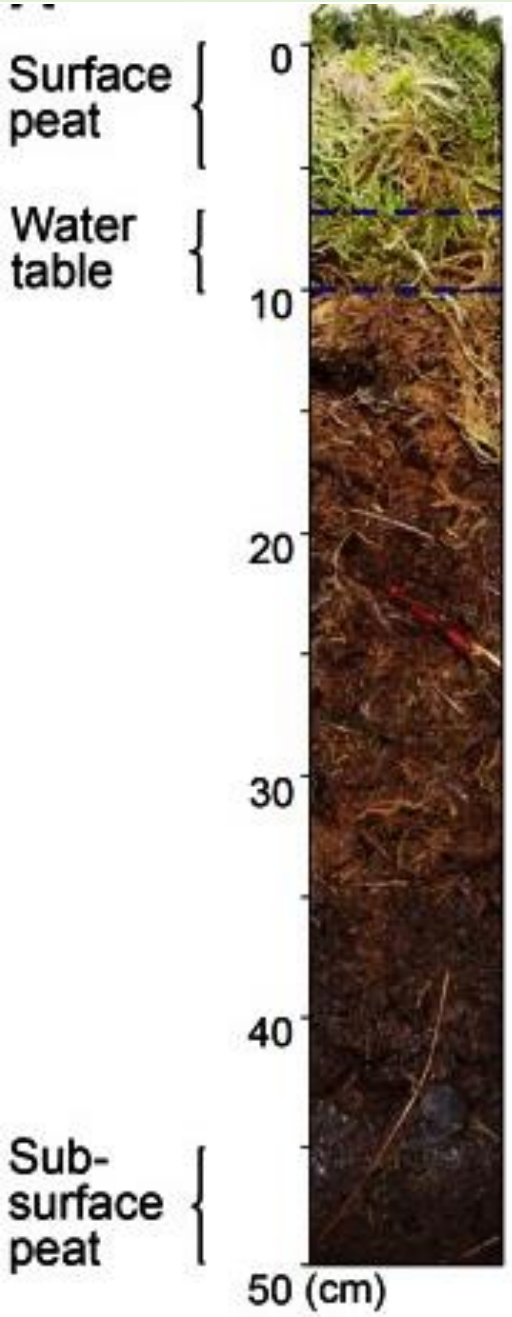
Porosity refers to the amount of pore space in soil.

The total porosity of **organic soils** compared with **mineral soils** is typically quite large, and the pore spaces classified as **macropores (*Size >75 µm*).**

High porosity in peatlands results in:

- Contains a high amount of water as submerged/saturated;
- High permeability – Easy movement of water by vertical and horizontal directions; however, easily dehydrated as low water level drop-down in the dry season.
- As the water level drops (by drainage):
  - *air enters fairly easily into the peat layers, which facilitates the oxidation of peat materials.*
  - *makes the peat layer dry so it is easy to burn.*

4. Characteristics of peat soils/peatlands



Bulk density

- Value of bulk density of peatlands is quite low (0.05 – 0.5 g/cm^3) due to a high amount of pores (high porosity) in the soil body.
- The value of bulk density varies according to the types of plants decayed that form peatlands (*See following table*).
- Typically, the value of bulk density in the top layer is higher than that of the bulk density in subsoil layers.
- Value of bulk density increases in drained peatlands.
- The value of bulk density increased will result in reducing the amount of space pores and then limit the movement of water in the peatlands.

4. Characteristics of peat soils/peatlands

The bulk density and porosity of peat soil depend on the type of plant residues accumulated. Mean values of the physical – bulk density (g/cm^3) and porosity (%) in types of peatlands.

Peat type	Parameters	Values		
		Mean	Minimum	Maximum
Sphagnum	Bulk density (g/cm^3)	0.08	0.01	0.2
	Porosity	91.9	82	98
Woody	Bulk density	0.13	0.02	0.21
	Porosity	89.5	82.2	98.6
Sedge	Bulk density	0.24	0.02	0.76
	Porosity	83.9	68.4	95
All	Bulk density	0.18	0.01	0.76
	Porosity	87.2	62	98.6

4. Characteristics of peat soils/peatlands

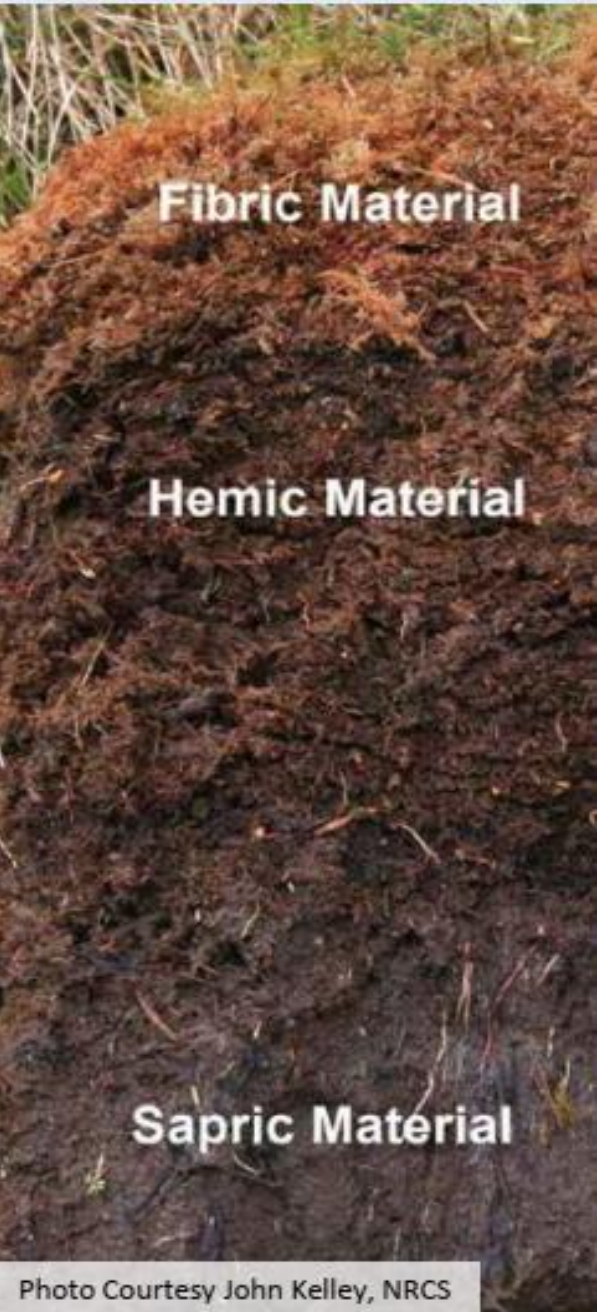


Photo Courtesy John Kelley, NRCS

- Water holding capacity varies depending on organic materials decomposed.
- Comparative water-absorbing and water-retaining capacities of three organic soil horizons.

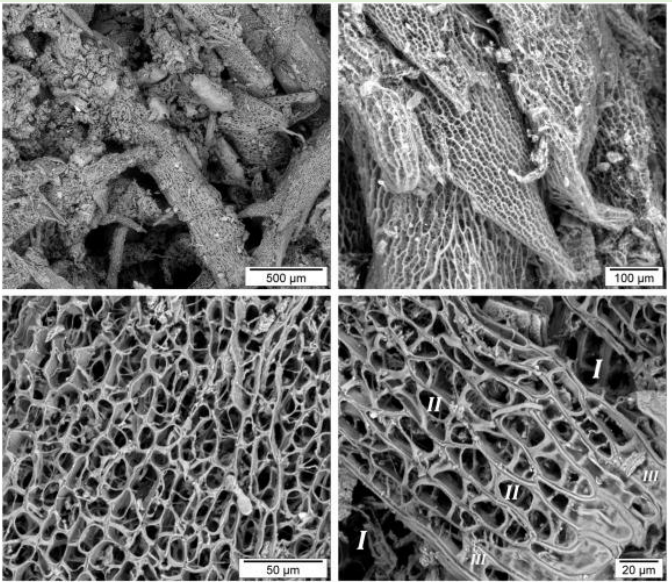
	Type of organic soil horizon		
	Fibric	Mesic/hemic	Sapric
Maximum moisture holding capacity (%)	1,057	374	289
Moisture equivalent (%)	166	112	110
Water required to saturate 100 cm of dry material (g)	101	91	99
Water required for moisture equivalent of 100 cm^3 of dry material (g)	16	27	38
Weight of 100 cm^3 of dry material (g)	11	27	39

4. Characteristics of peat soils/peatlands

Characteristics of organic materials in peat soils according to their degree of decomposition (Soil Classification in FAO)

	Fibric	Hemic	Sapric
Wet bulk density (gcm^{-3})	< 0.1	0.07 – 0.18	> 0.2
Fibre content	2/3 volume before rubbing; ¾ % volume after rubbing	1/3 – 2/3 % volume before rubbing	< 1/3 volume before rubbing
Saturated water content as percent of oven-dry material	850 – > 3,000	450 – > 850	< 450
Colour	Light yellowish brown or reddish brown	Dark greyish brown to dark reddish brown	Very dark grey to black

5. Identification of peat soil/Peatland



Large amount of porosity in peat soils

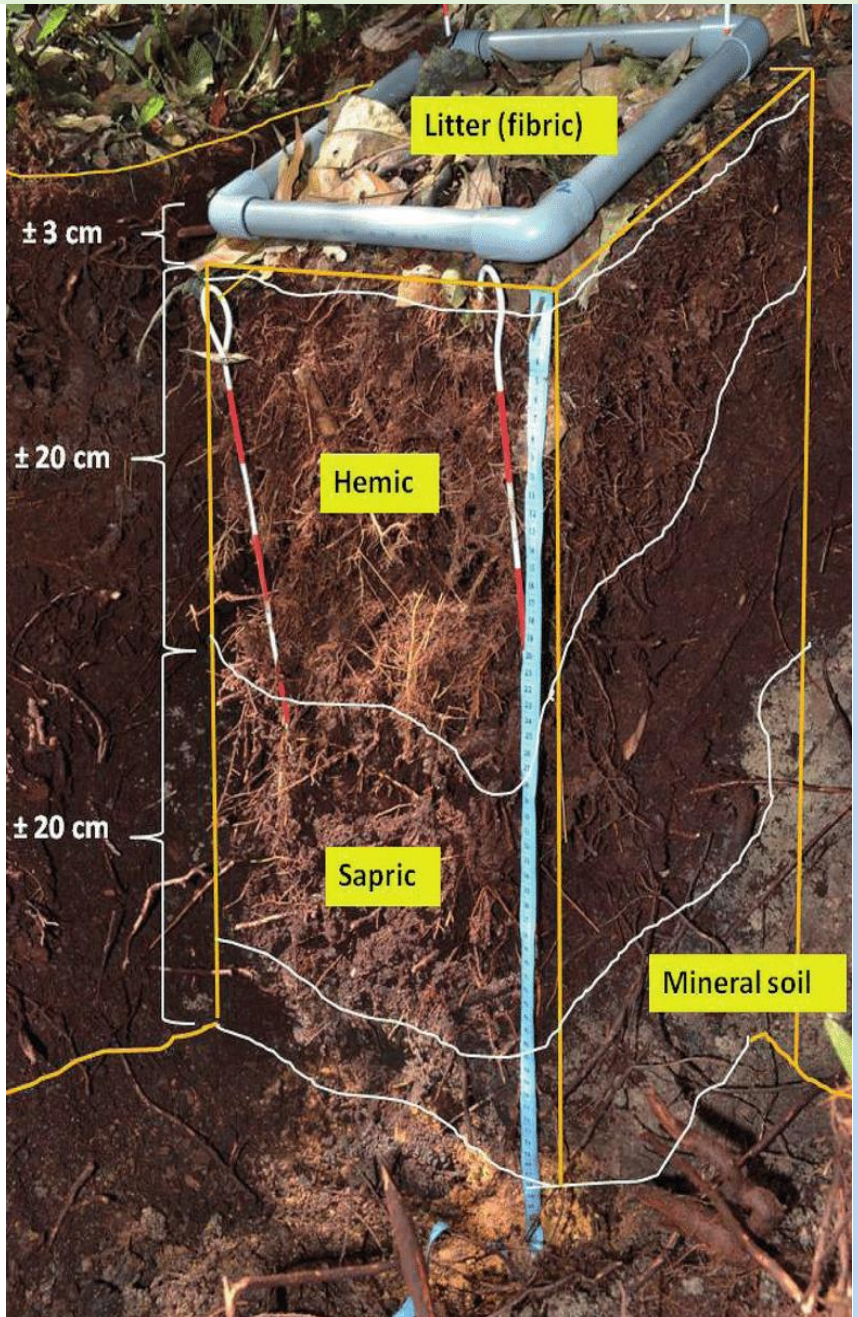
Dark colour of peat soils

How do you identify peat soil ?

The special characteristics of peat soils are indicators for peatland identification.

- Peat soil contains a large amount of **porosity** resulting in its quite spongy texture.
- Peat soil contains a high amount of **organic carbon** and decomposed plant residues within so it has a dark color.
- However, the plant remains in peat soil can be found at various degrees of decomposition (ranging from undecomposed to highly decomposed stages). Therefore, peat soil often exhibits a dark brown to black color.
- A high amount of pore space causes peat soil with low bulk density and bearing capacity, soft spongy substratum.

5. Identification of peat soil/Peatland



Decomposition of peat materials

- The plant remains in peat can be found at various degrees of decomposition (*ranging from undecomposed to highly decomposed stages*);
- Therefore the peat soil often exhibits a dark brown to black color and spongy consistency with a distinctive odor.
- Based on the degree of decomposition and fiber content, the peat can be categorized into three types:
  1) *Fibrous peat,*
  2) *Hemic or semi-fibrous peat, and*
  3) *Sapric or amorphous peat*

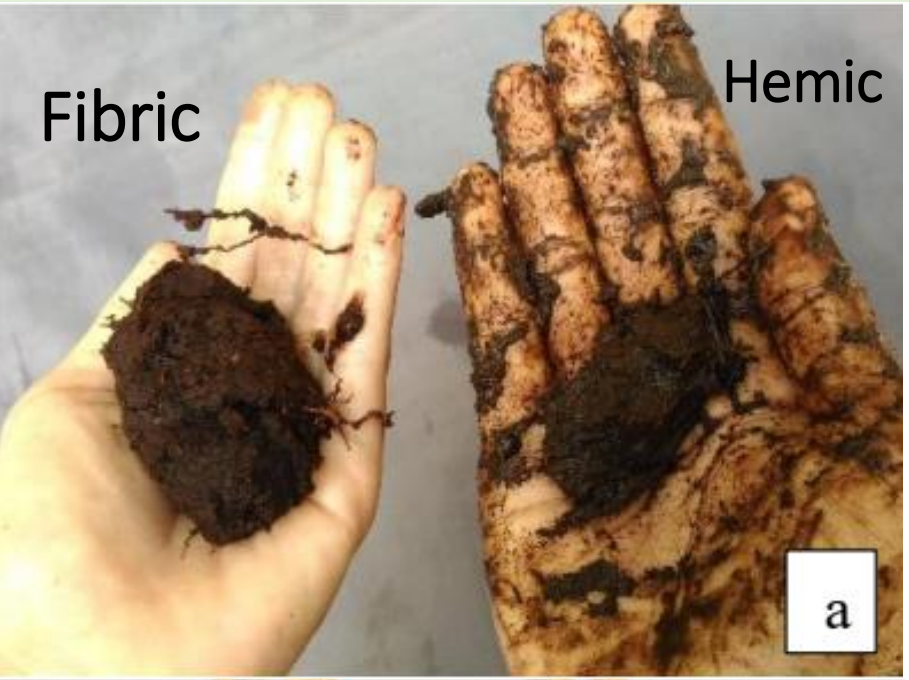
  (Zulkifley et al., 2014).

5. Identification of peat soil/Peatland

The degrees of decomposition of peat:

- Fibrists consist largely of plant remains so slightly decomposed that rubbing does not destroy them and their botanical origin can be determined easily ((fiber content over 67%). [*low stage of decomposition]*
- Hemists consist of organic materials that are decomposed that the botanic origin of as much as two-thirds of the materials cannot be readily discerned or the fibers can be largely destroyed by rubbing between the fingers (iber content can range from 33% to 67%.) [*moderate stage of decomposition*]
- Saprists consist of almost completely decomposed plant remains and their botanic origin cannot be determined (fiber content less than 33%). [*very high stage of decomposition*]

5. Identification of peat soil/Peatland



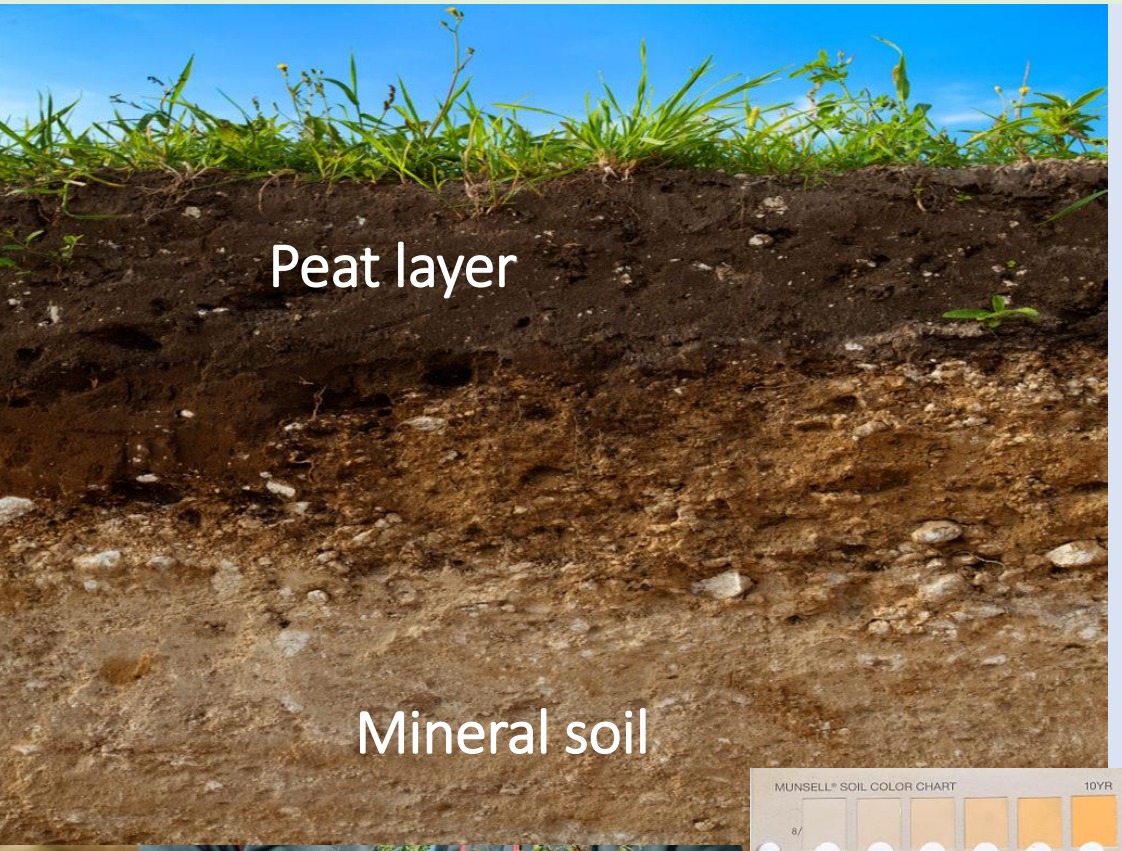
Comparison of peat at maturity by hand feeling test:

- **Fibric (left) and hemic (right)**

- **Fibric (left) and sapric (right)**

- **The peat fiber remaining after kneading has some fiber residues after squeezing more than the number of fibers remaining on peat soil with hemic and sapric.**

5. Identification of peat soil/Peatland

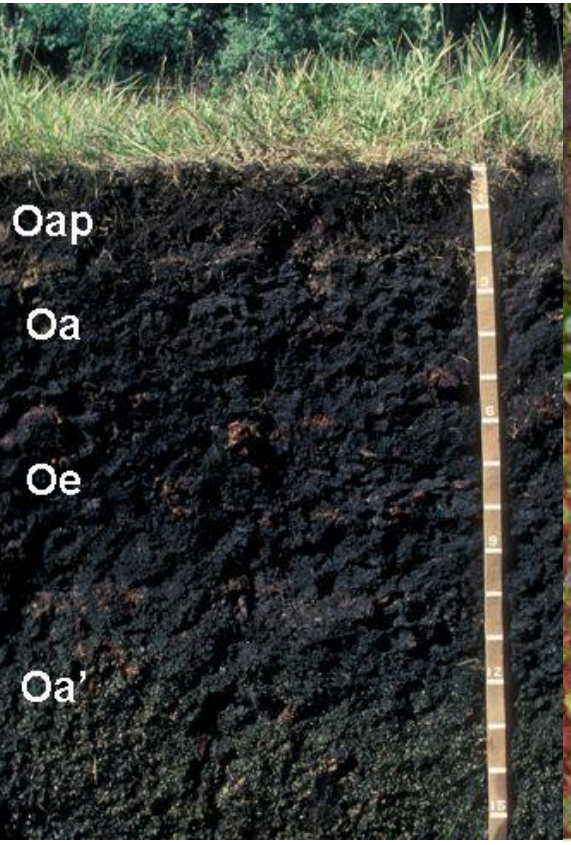


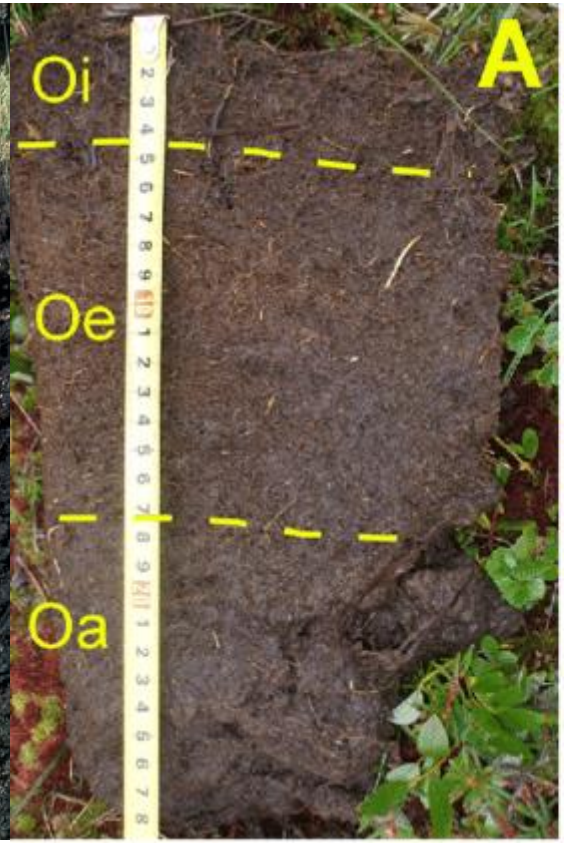
Peat colour

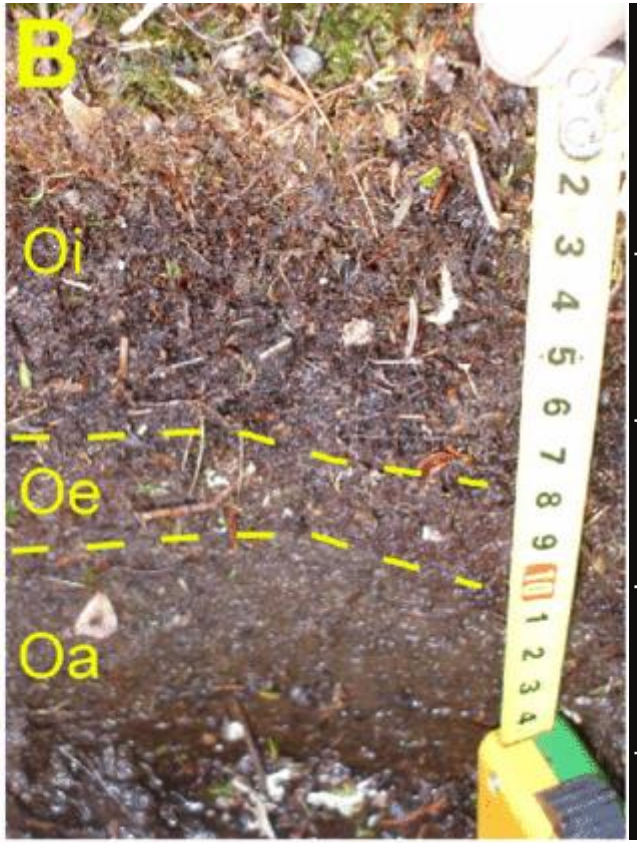
- Peat is heterogeneous because it is made up of different types of vegetation, and of the various different components (*wood, leaves, seeds, etc.*) of the plants.
- Moreover, the vegetation forming the peat varies with time, depending on the predominance of either tree communities or herbaceous plants, and this will be reflected as layers in the beds of peat soils.
- Peat soils contain a high amount of organic matter, and high water absorption.
- Variable peat colours: Variable peat colours: Dark brown to black

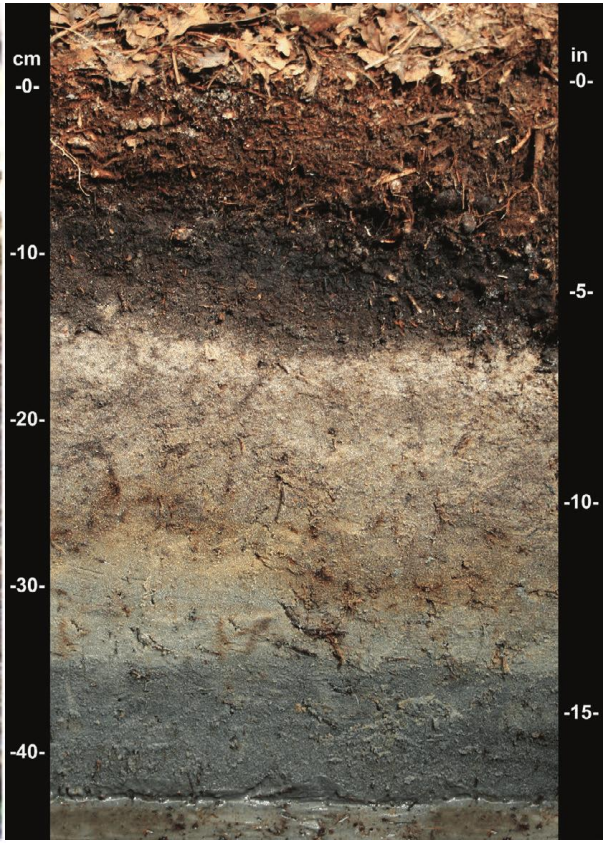
5. Identification of peat soil/Peatland

- Identification and description of peat layers are indispensable for peatland classification.
- Peat soil horizons (layer). Identify, separate and describe different soil layers based on characterisctis of peat materials in soil profile.



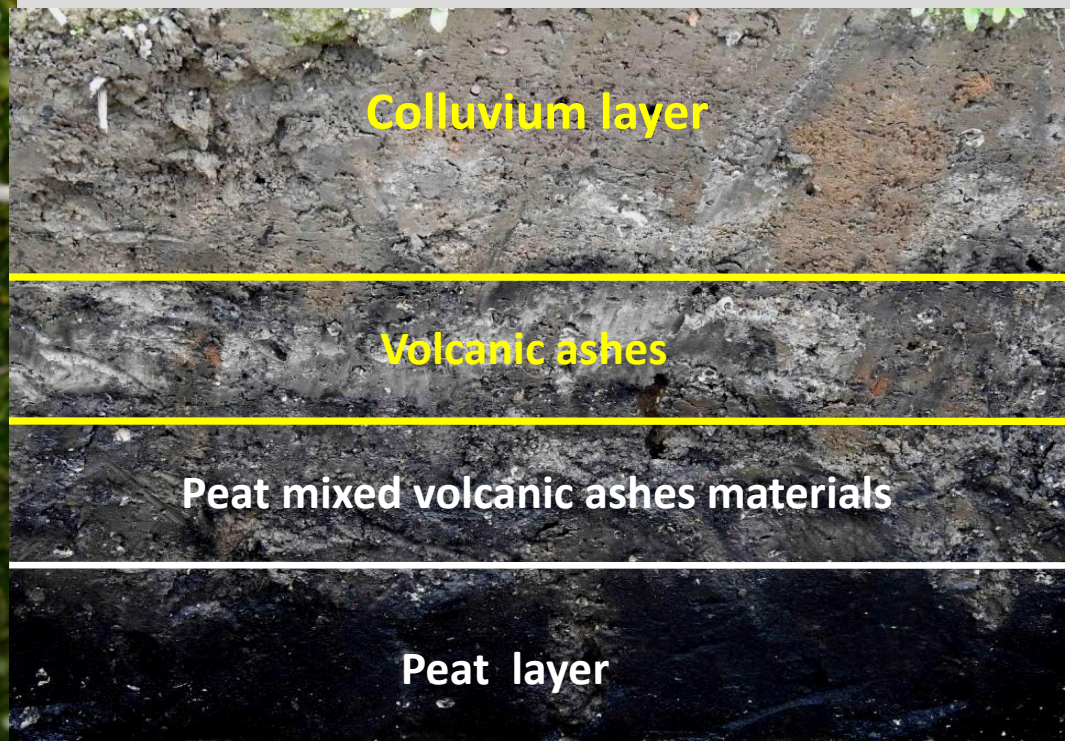




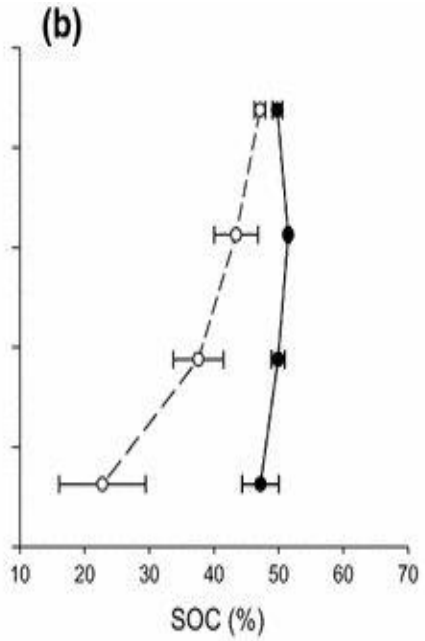


5. Identification of peat soil/Peatland

- It is necessary to identify other materials intermingled (or mixed) within the peat layer in the soil profile.
- The soil profile of peatlands in He Ho (Myanmar) shows erosion materials (colluvium) on top of peat layers and volcanic ash intermingled within the peat layers.



5. Identification of peat soil/Peatland



- Because organic materials accumulate for a long time to form peat soil, the organic matter (and organic carbon) content and their layer thickness are used as soil diagnosis for identifying and classifying peatland/peat soils.
- Definitions of peat vary across disciplines and between authorities for different purposes and there is no universal agreement that is applicable in all circumstances.

  This is unfortunate because it affects estimates of the area of peatland and the determination of important attributes of peat, especially volume, and carbon content.

  There is disagreement on the minimum thickness of the soil surface organic layer and the minimum percentage of organic matter in it between different definitions of peat.

  For example, according to the U.S.D.A Soil Classification peat is an organic soil (Histosol) that contains a minimum of 20% organic matter increasing to 30% if as much as 60% of the mineral matter is clay.
- Other authorities have adopted definitions of peat with organic matter content higher than 30% and thickness greater than 30 cm.

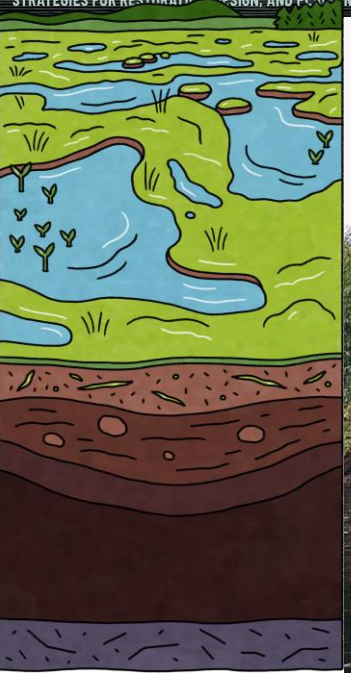
5. Identification of peat soil/Peatland

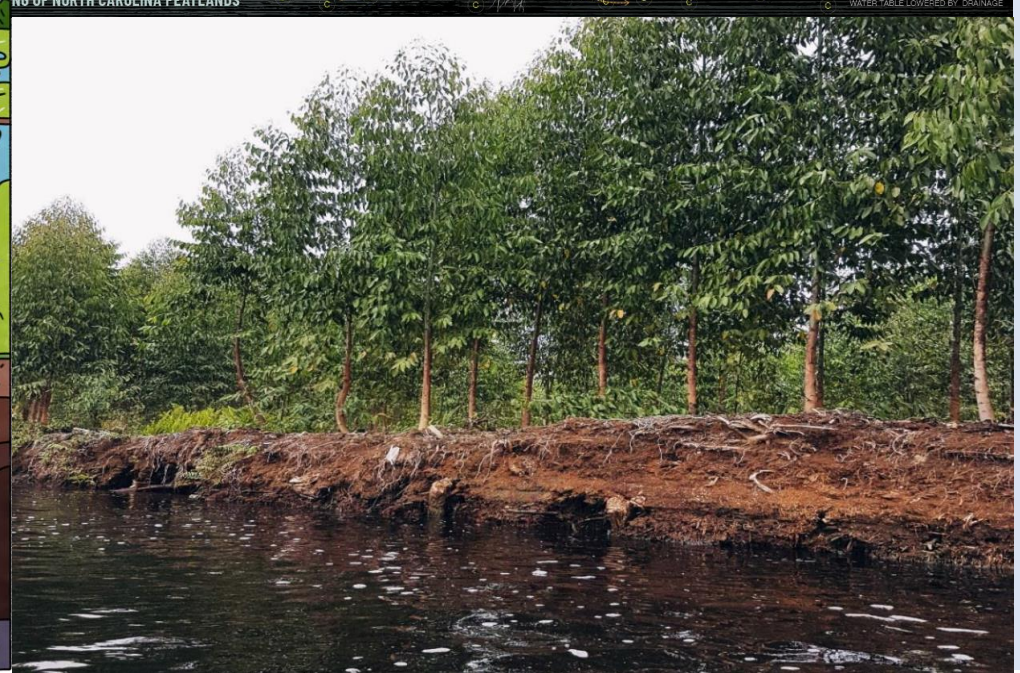
- According to the U.S.D.A Soil Taxonomy and FAO Soil Classification, peat soil is an organic soil classified as soil order of Histosols.
- Classified peatlands must have a Histic epipedon.
  - > 30 % OC if >60 clay
  - > 20 % if no clay
  - from 20 to 60 cm thick

Peat soil (Histosol)

- ***that contains a minimum of 20% organic matter increasing to 30% if as much as 60% of the mineral matter is clay.***
- Thickness of peat layer: > 40 cm.

6. Peatland Values and Functions

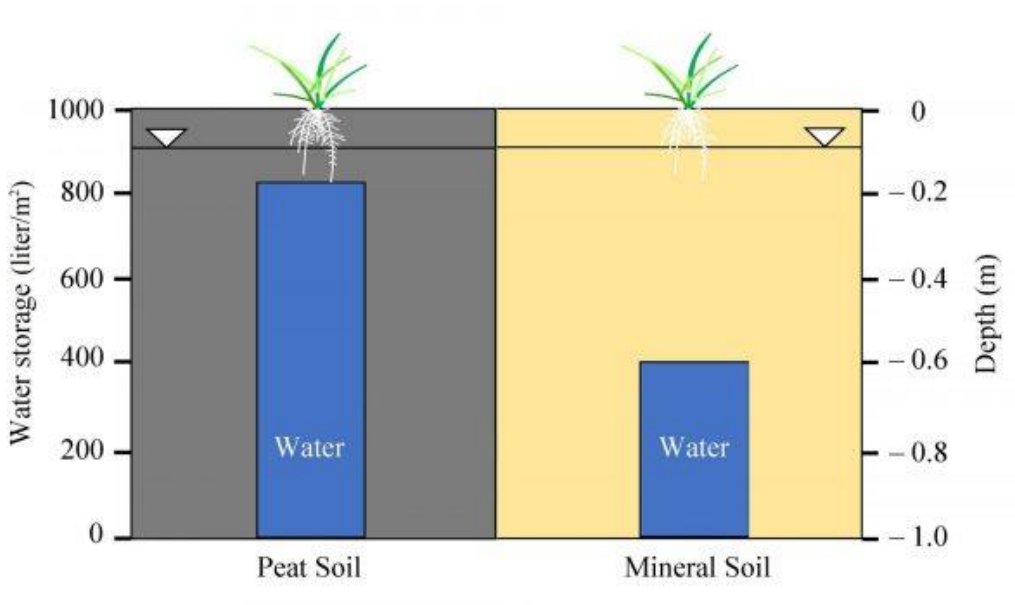




Peatlands and carbon

- Peatlands are the largest natural terrestrial carbon store.
- Peatlands have accumulated and stored this carbon over thousands of years, and since the last ice age peatlands have played an important role in global greenhouse gas balances by sequestering an enormous amount of atmospheric CO_2.
- Peatland restoration is an effective way to maintain the carbon storage of peatlands and to re-initiate carbon sequestration.

6. Peatland Values and Functions



Storing and providing water supply

- **Regulation of catchment hydrology and hydrochemistry.**
- **Regulation of regional and local climates.**

  Large peatland bodies may regulate the surface- and groundwater regime and mitigate droughts and floods.

- **Coastal peat swamps act as a buffer between salt- and freshwater systems, preventing saline intrusion into coastal lands.**

6. Peatland Values and Functions


Peat dome in Hopon

- **Peatlands hold water inside their bodies and provide water for domestic use and production during the dry season.**

Peat dome in Inle, Myanmar

6. Peatland Values and Functions

Peatland habitat for biodiversity

- Many peatland species have restricted distributions and are not found in other habitats. These highly adapted species can only survive if their habitat is conserved
- The natural landscapes that cover the peatlands are inhabited by specific types of plants including sphagnum moss, shrubs, sedges, and woody plants.
- Some species of plant-cover on peatlands is considered as an indicator used for detecting the potential areas of peatlands.
- Healthy, wet-state peatlands are not only critical habitats for a wide range of biodiversity, including endemic species, but they provide vital ecosystem services.

THANK YOU

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ASEAN Haze Portal (https://hazeportal.asean.org/programmes/mahfsa/)


Thanks for attention