# CHARACTERIZATION AND PREDICTION OF TROPICAL PEATLAND FOR THE WISE USE

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## ABSTRACT

*Utilization of peatland for agriculture in Indonesia since the early 70's has almost ended up in a failure box. Some national peatland reclamation projects, such as P3MT, P4S, and Mega Rice Project has resulted in degraded and abandoned peatland of more than 2 million ha. Reclaimed peatland for transmigration now is dominated by unproductive lands, some are abandoned. An outstanding reason of the failure was the lack of proper characterization as well as precise prediction of the characteristical changes of the peatland components when its natural condition is disturbed. This paper show incorrect characterization of tropical peatland and certainly to draw necessary corrections.*

***Keywords:*** *Tropical peatland, peat characteristic, land evaluation*

## INTRODUCTION

Peatland has been regarded as a potential land resource in Indonesia for agricultural use based on its flat topography and considerable expanse. The use of peatland in Indonesia, especially coastal peatland, for agriculture has been initiated by traditional farmers, living in the circumstances, since the early 1960's. Their success has inspired Indonesian government to start expansively using the coastal peatland in Sumatra and Kalimantan through a national transmigration program for developing especially annual crops.

Soil survey and land evaluation had always been made prior to land utilization for such purpose. Despite the intensive surveys, most of the reclamation projects of the coastal peatland, such in Pulau Petak in Kalimantan, Sugihan, Saleh and Pulau Rimau in South Sumatra and Rantau Rasau in Jambi, were ended up at a failure and a destruction of the ecosystem. The most distinct destruction is the disappearance of the peat layers regardless the original thickness, that depend on underlain sediment type might have caused subsequence serious problems.

There are some reasons of the failure, but our great concern has led us to firmly realize that the failure is greatly attributable to our miss in treating the land. Among others, is that the tropical peatland was always characterized by all means developed for temperate peatland and even by those for mineral soils. Principle differences between these two distinct peatland were not taken into consideration very well. Peats of tropical region mainly are woody that quite different from the sphagnous peat of colder region.

This paper review and discuss characteristics of tropical peatland as well as method of characterization to show incompatible characterization approaches and methods and certainly to draw necessary corrections.

### Genesis, Characteristics, and Changes of Tropical Peatland

Genesis of peat in wet tropical region was firstly reported by, among others, Polak (1933). The report shows clear evidence that peat of wet tropical region were derived from woods of tropical rain forest. Recent reports (Darmawan *et al.,* 2002) show that parts of dead trees (branches and trunks) are not necessarily completely decayed. The partly decayed branches and trunks could be found within the peat sediment at around the middle between the surface and the bottom as loose stacks. Spaces between individual woody materials of the stack are not necessarily filled with a dense mass of finer organic decay (Figure 1). Interlayer blank parts which are common in boring column taken in the tropical peat reflect the presence of the voids (Figure 2). At a natural condition the spaces as well as pores of the finer organic decay bulk are saturated with water since the land is always waterlogged. The saturating water to some extent gives a floating effect to whole mass of the peat especially the incompletely decayed woody parts. Thickness of the peat sediment at natural condition should therefore be considered as the thickness of the floated peat sediment.

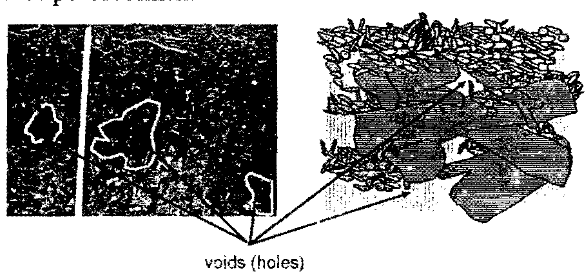


**Figure 1.** Profile of tropical peat showing woody materials and voids.

The present of incompletely decayed woody parts distinguish tropical peat from that of temperate peat. Peat of temperate region are in general originated from easily decayed vegetation such as sphagnum, so it composed of entirely fine organic decay that forming a homogeneous and compact peat mass. Some parameters to describe peat in natural and disturbed or changed conditions are related to this origin. Consequently, technique to describe the parameters for tropical peat may not necessarily be similar to that for temperate peat.

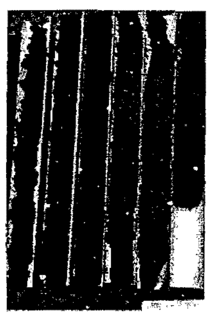

**Figure 2.** Boring column of tropical peat with blank parts.

In general, the utilizations of peatland for agriculture will change the land from anaerobic to aerobic condition. Aerobic condition will immediately occurs following the forest cut and the construction of drainage canals. Field experiences show that characteristics of peatland rapidly change under such utilization practices. One of significance changes is that the thickness of peat layer will decrease significantly, especially when the land is use for cultivation of annual crops.

The decrease of peat thickness is partly attributable to the lost of the peat due to the increasing decomposition rate that occur under an aerobic condition. The loss of peat is, to some extent, also caused by fire. Sometimes peat at the upper parts could be accidentally burn during dry season because dry peat materials are very vulnerable to fire. Peat burning is also frequently used for land clearing during land preparation. The lost of peat layer is therefore accelerated by these fire.

One think that seems to be incorrectly figured for many years is the decrease of the peat thickness that is caused by the so-called subsidence. Basically the subsidence of peatland is attributed to the shrinkage of the peat volume following the water loss after drainage is applied. By draining the land, the water level of the peatland would decrease significantly leaving upper parts of peat layers lack of water. As the consequence, the floating effect of water to the peat materials disappears. This situation would cause the peat to collapse resulting in a great subsidence of the land.

When peat layers completely disappeared, then the land will have mineral sediment on the surface. Thereafter characteristics of the land, therefore, depend on the type of mineral sediment underline the peat layers. The type of mineral sediment underlain the peat layers depend on their depositional environment. Sumawinata (1998). Peatland that developed in a riverine swamp environment, for example, would has underlain mineral sediment that differ with that of peatland that developed in brackish swamp environment. The mineral sediment of the riverine swamp would not contain sulfidic materials. In the contrary, the mineral sediment of the brackish swamp environment generally contain significant amount of sulfidic materials.

### Inappropriate characterization methods and its alternative

Prediction of to what extent the subsidence would happen is, among other, use bulk density (BD) value, such as in a prediction model of Sageberg (Sageberg, 1999). The prediction will give reliable figure if the BD value is also reliable for each condition. Regarding peat material size and composition of tropical peat as described above, BD measurement of the tropical peat, therefore, definitely must consider the heterogeneity.

BD measurement of the tropical peat in Indonesia that has been taken in the past was done using the technique set for mineral soils, in that undisturbed samples were taken using a ring sampler of 10 cm in diameter and 6-7 cm in height or smaller (Figure 3). This technique would result reliable data when used for the temperate peat but for the tropical peat a larger sampler (Figure 4) should be used to cover the heterogeneity.

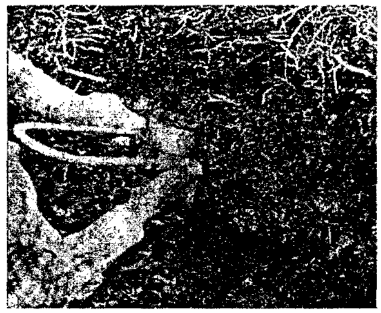

**Figure 3.** Small ring sampler being used for tropical peat soil.

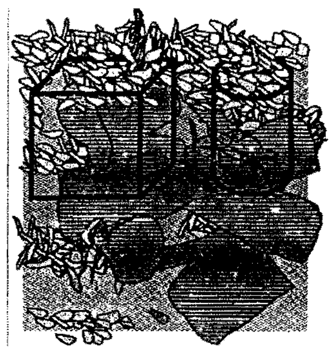

**Figure 4.** Larger measurement unit for bulk density.

Regarding laboratory analysis of tropical peat samples that have been carried out in Indonesia during the past, there is an incorrect approach in sample preparation. The peat samples for chemical analysis used to be crushed and sieved with 2 mm sieve prior to analysis. This sieving step is a standard for analyzing samples of mineral soils. Definition of mineral soils says that the soil components are the entire fraction sized 2 mm or less. Size of peat materials is an importance characteristic of peat in relation to the degree of decomposition that naturally determines chemical characteristics of the materials.Based on size and degree of decomposition peat material are by definition fragmented into: 1) fibric for the coarsest and slightly decomposed organic material, 2) sapric for the finest and most decomposed, and 3) hemic for the middle. It is important to bear in mind that sediment of peat in tropical region contains not only this fragmentation but include coarser incompletely decayed woody materials. Sieving the sample will exclude the fibric or woody materials from analysis. When fibric-categorized peat samples that may contain coarser materials are sieved with 2 mm sieve and then analyzed for cation exchange capacity (CEC), for example, the value would be much higher than it's actual. The high CEC values of fibric materials shown in Table 1 are examples of unrealistic peat chemical data obtained by an incorrect method of analysis.

Another mistake happen in the past in taking inventory of the tropical peatland in Indonesia is that what so-called land evaluation. Concept of land evaluation developed and used for years in the past is to map the peatland into mapping units showing each suitability for certain crop(s) cultivation, such as $S_1$ for the most suitable map units, $S_2$ for those of moderately suitable, $S_3$ for those of marginally suitable, $N_1$ for those of not suitable at present and $N_2$ for those of permanently not suitable. Technique of classifying map units into the suitability classes was done using sets of criteria of land suitability for certain crop(s) where the parameters in the criteria were based on merely "the soil" characteristics. Say that the criteria are correct but the soils of the tropical peatland will not stay with static characteristics as will the mineral soils. Then noting peatland into separate map units with static suitability prediction is contradictory to the fact that the peatland will change drastically upon utilization.

Let follow this example. Peat layers of Terric Tropohemists soil having depth of pyritic mineral layer of 100 cm from the surface will completely loss after some years of cultivation and the pyritic material is oxidized resulting strong acid. In this case, at the beginning the map unit will be classified suitable ($S_1$), for example, for paddy field (see used criteria in Table 2) will then found not suitable ($N_1$ or $N_2$) after some years (Figure 5). This story is a fact and easily found in any coastal peatland utilized since about 20 years ago for transmigration area. This story tells us that such land evaluation approach is completely meaningless.

In addition, figuring out peatland area into detil differences of each individual characteristic is not practical. For example, two adjacent map units has a different soil depth of pyritic mineral layer should not be separately considered in deciding if both may be utilized or only one of them. Changes to an area will affect the adjacent as well. It is because hydrologic pattern of the peatland is continuous regardless the soils boarder.

**Tabel 2.** Range of depth of pyrite and peat for each respective land suitability class (in Hardjowigeno and Widiatmaka, 2001)

| Project | Crop | Parameter | $S_1$ | $S_2$ | $S_3$ | $N_1$ | $N_2$ |
|---|---|---|---|---|---|---|---|
| PPT (1983) | Rice | Sulfidic layer depth | >100 cm | >75 cm | >50 cm | >25 cm | td |
| | | Peat depth | <50 cm | <75 cm | <100 cm | <150 cm | td |
| | Upland crops | Sulfidic layer depth | >100 cm | >75 cm | >50 cm | >25 cm | td |
| | | Peat depth | <30 cm | <50 cm | <100 cm | <150 cm | td |
| | Perennial crops | Sulfidic layer depth | td | td | td | td | td |
| | | Peat depth | <50 cm | <75 cm | <100 cm | <150 cm | td |
| LREP II (1984) | Rice | Sulfidic layer depth | >75 cm | 60 - 75 cm | 40 - 60 cm | 30 -40 cm | <30 cm |
| | | Peat depth | td | <100 cm | 100 - 150 cm | 150 - 200 cm | >200 cm |
| | Maize | Sulfidic layer depth | >100 cm | 75 - 100 cm | 50 -75 cm | 40 - 50 cm | <40 cm |
| | | Peat depth | td | <100 cm | 100 - 150 cm | 150 - 200 cm | >200 cm |
| | Oil Palm | Sulfidic layer depth | >125 cm | 95 -125 cm | 80 -95 cm | 70 -80 cm | < 70 cm |
| | | Peat depth | td | <100 cm | 100 - 150 cm | 150 - 200 cm | >200 cm |
| | Rubber | Sulfidic layer depth | >200 cm | 130 - 200 cm | 80 -130 cm | 80 cm | < 80 cm |
| | | Peat depth | td | <100 cm | 100 - 150 cm | 150 - 200 cm | >200 cm |

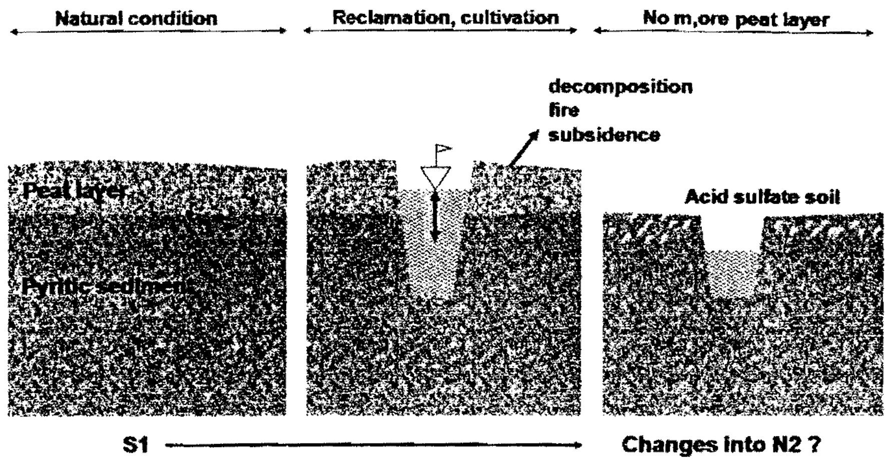


**Figure 5.** Soil characteristical changes in relation to land suitability class

## CONCLUDING REMARK

All incorrect and meaningless characterizations of tropical peatland are untenable. Characterization approach should be based on good insight of the nature of the ecosystem and all possible changes that would take place upon utilization of the land. Correct anticipation should be drawn carefully and appropriate technologies must be invented for higher and sustainable benefit.

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