Physical and Chemical Analysis of Land in Forest Peat Swamp in Resort Pondok soar, Tanjung Puting National Park, Central Kalimantan

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Abstract. Peatlands are ecosystems with the particular characteristic that is high organic matter content. On the other hand, these features lead to the peat soil vulnerable to decreasing the quality of the land. This study aimed to analyze the physical and chemical properties of peat soil in the peat swamp forest in the Resort Pondok soar, Tanjung Puting National Park in Central Kalimantan. The method used in this research is systematic sampling with a set of five points as soil sampling with twice replications within the plot measuring 100 m × 100 m. Peat soil at the site of research has added to peat ranged from 20 - > 400 cm. Tests showed there are different levels of maturity of peat from fibric until saprik, and the peat is likely to have the same maturity level or more raw than the maturity level of peat with field tests. The results of color identification are very dusky red, dark reddish-brown, reddish-black, and black. Peat soil has a pH ranging from 3.7 - 5.2 with an average pH of 4.5 (acidic), does not contain pyrite, ash around 1:13% - 43.88%, and the content of organic C ranges from 32.55% - 57.35%.

1. Introduction
Tanjung Puting National Park has various types of biodiversity typical of such jelutung swamp (Dyera lowii), ramin (Gonystylus bancanus), and pitcher plants (Nepenthes spp.). The presence of peat influences the conservation of biodiversity as the area is likely to grow. However, the lack of information on wet peatland and the high human activity around the area of the National Park has implications for increasing physical disturbance caused by human land. Greenpeace International [1] stated that there are some threats to the Tanjung Puting National Park on its current mining activities around the area of Tanjung Puting National Park, illegal logging, and palm oil concessions. Such conditions threaten the physical condition, and the availability of peatland in Tanjung Puting National Park to remember more than 50% of the total area of the National Park area is a critical area [2]. The decline in physical quality and availability of peatlands will have implications on the quality and peatland area as a place to grow plants in order to enrich biodiversity.

Based on this, the characteristics of peatland research is needed in the form of physical and chemical properties of peat in Tanjung Puting National Park. The results of this study are expected to provide general information about the characteristics of peatland in Tanjung Puting National Park in particular in Pondok soar, so the general public can get to know and know the role of peatlands in supporting the
growth of plants and preserve biodiversity in Indonesia. This study aimed to analyze the physical and chemical properties of peat soil in the peat swamp forest in Pondok soar, Tanjung Puting National Park in Central Kalimantan.

2. Method

2.1 Materials
The tools used in this study include drill ground, drill peat, pH digital meters, bottles films, ruler, meter sewing, syringe volume of 10 ml, filter ground 150 mesh, plastic bags, digital scales, saucer porcelain, oven, furnace, desiccator, stationery, labels, laptops, books Munsell soil color chart, Microsoft Excel 2016 software and software Microsoft Word 2016. Materials used in the study include peat soil in peat swamp forest at Pondok soar Tanjung Puting National Park in Central Kalimantan, mineral water, and a pH buffer value of 4.

2.2 Procedure
Soil sampling is done in a systematic sampling in a plot size of 100 × 100 m. The number of data collection points in a plot size of 100 × 100 m are five points with the details of the four points taken at each end of the plot and a point located at the center of the plot. Each point of data collection was made two replications so that the total amount of soil sampling point that is ten points. Soil sampling point first repeat is 15 m with soil sampling point repeat second. Layout point soil sampling locations presented in Figure 1.

Disturbed soil samples were taken at each depth of 20 cm and a span of 1 m if the soil has a depth > 1 m. When carried out soil sampling, for each point of sampling sites also is recording the depth of the peat layer. The soil samples that have been obtained are then put into plastic and labeled contains a description of the point number, number of replications, and sampling depth. Besides, the type of mineral substratum is recording (at the base of peat/peat below) at any point of soil sampling locations. The soil samples were analyzed then performed physical and chemical properties of the soil.

2.3 Analysis of soil properties
There are two properties of soil analyzed in this study is the physical and chemical properties of soil. Physical soil properties analyzed include the level of maturity and color of peat, while the chemical properties of soil analyzed include the pH, an indication of the content of pyrite, ash, and organic C in peat.
3. Result and discussion

3.1 Peat maturity

Peat is weathering maturity level of organic material becomes a major component of peat [3]. Peat maturity analysis on each soil sample in Table 1 and Table 2 shows each depth at the point of sampling has a different maturity level peat. The maturity level of peat found in the five plots is fibric until sapric (field tests) and hemic to sapric (laboratory testing). Maturity level turf field test results presented in Table 1.

| Maturity Level | Percentage (%) |
|----------------|----------------|
| Fibric         | 20             |
| Hemic          | 20             |
| Sapric         | 60             |

Table 1. Maturity level turf by field test

| Maturity Level | Percentage (%) |
|----------------|----------------|
| Hemic          | 20             |
| Sapric         | 80             |

Table 2. Maturity level turf by laboratory testing

Figure 2 shows the peat fiber remaining after kneaded. Fibric peat maturity (Figure 2a and Figure 2b left) has some fiber residues after squeezing more (<1/3 of the original amount) than the number of fibers remaining on peat soil with hemic maturity level (Figure 2a right) and sapric (Figure right 2b). The maturity level of peat mixed with testing in the field and laboratory tests showed different results. Testing the maturity of peat with field trials (Table 1) indicates the presence of peat, which has a maturity level fibric. On the other hand, testing the maturity of peat by laboratory tests (Table 2) showed no peat has fibric maturity level.

Differences in the level of maturity of peat in field trials and laboratory tests thought to be caused by differences in the volume of soil samples were analyzed. Table 1 and Table 2 indicate the deeper layers of peat, the more mature the peat layer. However, this is not consistent with the statement [4], which states the upper peat layer is higher than the water surface layer of peat below the water because the level of decomposition of the peat layer is higher than the part of the peat layer below the groundwater level. The higher level of maturity on the part of peat in the peat layer in the layer previously suspected to be the top layer of decomposition and has experienced well before heaped with new organic material and into the layer beneath the groundwater table. This is consistent with the statement Dariah [3], a layer of peat that has matured in the inner layer had been in the surface layers and decomposed well. The discovery of the peat layer to the maturity level is not more mature than the previous layer (5 replicates the first point of 80-100 cm depth) indicates the layer does not decompose completely before eventually
covered by new organic materials and under groundwater level. Likewise, the discovery of a layer with a layer of peat is more mature than before, and afterward (Point 3 replicates both a depth of 20-60 cm) indicates the layer of decomposed organic matter best when located in the surface layer.

In general, differences in the level of maturity of peat at any depth caused by the decomposition rate (weathering) of different organic materials. This difference is affected by the anaerobic nature of the peat soil, high acidity, lack of nutrients that occurs with slow decomposition process [5]. The presence of multiple point sampling sites that have maturity fabric peat at the level needs to be maintained its natural state because, according to Haryono et al. [6], immature peat (fabric) are more prone to subsidence or land subsidence. If the surface of the soil decreases, then the plants that live on the surface of the peat will not stand upright and comfortable to collapse due to a decrease in the volume of soil that can not sustain the optimal plant. Maturity peat is also one of the determinants of fertility and carbon content of peat. According to Agus et al.[7], more mature peat generally more fertile, although other factors determine the fertility of peat or a mixture of clay and ash.

3.2 Color peat
Results peat color identification at every point, and every depth sampling is presented in Appendix 1. The Appendix shows that each of the depth of the peat layer has a different color. Appendix 1 shows a layer of peat at a depth of 0-20 cm is dominated by the color 2.5YR 2.5 / 2 (very dusky red) (Figure 3a) except point 2 first repeat that color 10R 2.5 / 1 (reddish-black) (Figure 3c) and points 3 replicates first color 5YR 2.5 / 2 (dark reddish-brown) (Figure 3b). Peat in the surface (0-20 cm) has a lighter color than the peat on the bottom layer. This is indicated by the color of the upper layer of peat, which tends to have a reddish color.

![Figure 3. Colors peat](image)

The level of maturity of influences peat soil color. According to [4], the more stable, the older the organic material in color, while getting fresh organic ingredients than the brighter the color. The discovery of the color difference in the maturity level of the same peat (Point 3 replicates both the depth of 60-80 cm and 80-100 cm maturity hemic) suspected to be caused by differences in the maturity of peat in the range of the smallest and the most extensive range of indicators fiber. This is because the peat maturity indicator hemic levels are the lowest residual fiber volume range is 1/3 (field tests) or 15% (laboratory testing), and the highest residual fiber volume is 2/3 (field tests) or 75% (of laboratory tests). Peat at a certain depth does not warrant having the same color with peat at depths similar but located in different locations. This is shown in three replicates the first point and point 4 replicates both the color 5YR 2.5 / 1 (black) at a depth of 20-60 cm, while the same depth at different locations has color 10R 2.5 / 1 (reddish-black) (Figure 3c) or 2.5YR 2.5 / 2 (very dusky red).

The color differences are also influenced by the level of maturity of peat and organic matter content difference, according to the statement Suswati et al.[8], the higher the soil organic matter, then color may become darker. whereas the same depth at different locations have color 10R 2.5 / 1 (reddish-black) (Figure 3c) or 2.5YR 2.5 / 2 (very dusky red). The color differences are also influenced by the level of maturity of peat and organic matter content difference, according to the statement [8], the higher the soil organic matter, then color may become darker. whereas the same depth at different locations have color 10R 2.5 / 1 (reddish-black) (Figure 3c) or 2.5YR 2.5 / 2 (very dusky red). The color differences are also
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3.3 pH and indications of pyrite content in peat

The result of peat soil pH measurement provided in Appendix 2 shows the location of each point of the data, and each depth has a degree of acidity (pH) are different. pH owned by peat Pondok soar, Tanjung Puting National Park ranged between 3.7-5.2 (very sour to sour) with an average pH of the whole point is 4.5 (acidic). Additionally, Dariyah et al. [3] suggests the tropical peat soil acidity generally high ranging from 3 to 5. Based on this, the peat soil pH Pondok soar Tanjung Puting National Park following the general peat soil pH. Surly nature on peat soil caused by poor hydrolysis of organic acids resulting from the decomposition of organic materials. According to Charman [9], organic acids contribute significantly to low pH soils. The average pH at any point are presented in Table 3.

| Point | moist peat soil pH | peat soil pH after drying |
|-------|-------------------|---------------------------|
| 1     | 4.8               | 4.2                       |
| 2     | 4.6               | 4.0                       |
| 3     | 4.2               | 4.0                       |
| 4     | 4.6               | 4.1                       |
| 5     | 4.4               | 3.8                       |
| Average| 4.5             | 4.0                       |

Differences in soil pH at any point in Table 3 is influenced by the level of decomposition (decay) of organic material, and the depth of the peat. [10] states the chemical characteristics of peatland in Indonesia is largely determined by the mineral content, thickness, type of minerals in the substratum (at the base of peat), and the degree of decomposition of peat. The comparison pH value between the maturity level of peat (Appendix 2) shows the pH peat fibric generally has a pH value lower than pH with maturity hemic or sapric, it is consistent with the statement Kurnain [11], peatland in the maturity level fibric have higher levels of organic acids, while the peat soil in the maturity level sapric higher ash as a source base. Besides, based on the comparison of peat soil pH at any depth (Appendix 2) shows the soil pH increases with increasing soil depth.

Table 3 shows that the content of the ash content increases with increasing soil depth. Peat soil pH measurements after dried soil samples showed no decrease in pH drastically, and there are examples of soil that has a pH value of <2.5. Soil pH is not decreased drastically due partly to sulfidic material on the ground that has been oxidized. Dried peat soil has an average pH of 4.0 (Table 3) or only decreased 5 degrees overall average pH of peat in wet conditions.

The absence of pyrite content in the soil indicates that peatland has no such plot sulfidic material layer (layer rich in pyrite) that is toxic to plants when the soil is oxidized. When oxidized, pyrite would cause toxicity in plants, such as impaired absorption of nutrients [12]. Pyrite is a microscopic mineral soil contained in the soils that evolved from marine sediment material [12]. Based on this, there is the discovery of pyrite content in the peat soil caused by the type of minerals that are below the peat layers is quartz sand and not precipitate marine. Although not found in the pyrite content of peat soil, this land still has a low nutrient content, as expressed by Wahyunto et al. [12], quartz sand soil layer in the form of an impact that the peat above have low fertility. This is indicated by the pH value of the soil very acidic. According to Wahyunto et al. [12], a layer of mineral soil below the peat soil affects the level of natural fertility soils.

3.4 The ash content and a C-organic peat soil

The results of calculations on the fifth ash content of soil samples in Table 4 show the different ash content in each soil depth. Peat soil at depths of <100cm has an average ash content of 7.17%. Peat at a depth of 100-200 cm has an average ash content of 7.00%, and peat at a depth of 300-400 cm has an...
average ash content of 8.60%. The average ash content is generally shallow peat soil (<1 m) has an ash content of about 15%, peat soil to a depth of 1-3 m has ash content of about 10%, and the peat soil to a depth of >3 m has ash content <10% or <5%. The presence of ash on peat soil indicates the level of natural fertility because ashes to be an indicator of peat mineral material content (Ca and Mg) and can reduce soil acidity properties. The ash content and organic C in all five sample points are presented in Table 4.

| Point | Depth (cm) | The ash content (%) | C-organic (%) |
|-------|------------|---------------------|---------------|
| 1     | 0-20       | 1.80                | 56.96         |
| 2     | 0-20       | 2.00                | 56.84         |
| 3     | 0-20       | 0.80                | 57.54         |
| 4     | 0-20       | 5.40                | 54.87         |
| 5     | 0-20       | 2.60                | 56.50         |
| 1     | 40-60      | 32.80               | 38.98         |
| 2     | 80-100     | 4.80                | 55.22         |
| 5     | 100-196    | 7.00                | 53.94         |
| 3     | 300-381    | 8.60                | 53.02         |

The ash content in peat soils affected the groundwater conditions and the decomposition of organic matter, according to the statement Suwondo et al. [13], the condition of the groundwater level will change into aerobic, anaerobic decomposition, so that the rate of organic matter will be an accelerated overhaul. This affects the moisture content, ash content, pH, C-organic peat soil. A different relationship indicated by the content of the C-organic peat layer. Peat soil at a depth <100 cm has an average content of organic C amounted to 53.84%, at a depth of 100-196 cm has an average content of organic C amounted to 53.94%, and at a depth of 300-381 cm has an average content of organic C amounted to 53.02%.

Table 4 shows the organic C content results in decreases with increasing depth of the peat. The content of C-organic peat soil is influenced by the level of maturity of decomposition or peat. The decomposition process causes a reduction in the carbon content of soils. Peat soil in the maturity level hemic and sapric contains organic C lower than the peat in the maturity level fibric [14]. Table 4 also shows that the ash and the C-organic relationships inversely. This is consistent with the statement Suwondo et al. [13], organic-C levels correlate negatively with ash content, the higher levels of C-organic, the lower the ash content.

3.5 Peat soil as a place to grow

The physical and chemical properties of peat are related to one another. The main factors that affect the characteristics of the peat are peat depth. The depth of peat determines the maturity level, color, pH, ash, and organic C in the soil. Indicating the depth of soil fertility, as stated by Suswati et al.[8], the thick layer of peat soil fertility decreases. Soil fertility is characterized by the low value of the degree of acidity (pH) and the decrease of ash content in the soil. Peat soil properties inundated and has a very acidic pH to sour a significant limiting factor to support plant growth. By karenat it, there are only certain types of plants that can grow and adapt well in this soil type.
Conclusion
Peat soil at 1 Ha sample plots in the peat swamp forest Pondok soar, Tanjung Puting National Park has a depth of peat ranges from 20-> 400 cm with the maturity level to hemic fibric peat and peat soil color that encompasses the very dusky red, reddish-black, dark brown, dark reddish-brown, and black. Peat soil in this plot has a pH ranging between 3.7-5.2 with an average pH of 4.5, did not have a pyrite content, ash content ranging from 0.8% -32.80%, and organic-C content ranging between 38.98% -57.54%.

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