

Study of the Critical Limits of the Ground Water for Peatland Fire Prevention

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ABSTRACT

Indonesian Government Regulation No. 71/2014 requires all parties to maintain the groundwater level less than 40 cm below the ground level to prevent land fires in peatlands. This regulation is quite burdensome as it will be tough to do during the dry season. The research results on peat, which has a hemic maturity level, show that the soil water content is still in the range of 200% at a distance of 50 cm above the groundwater level. The purpose of this study was to study whether the same thing would happen to peatlands with different humification levels and water table depth. Research has carried out using survey and monitoring methods on the peatlands of PT. Mendahara Agrojaya Industri, located in Lagan Tengah village, Geragai sub-district, Tanjung Jabung Timur Regency, for six months to achieve this objective. Data collected includes peat depth determined by drilling using a peat drill. Peat maturity is determined using the van Post method; groundwater depth carried out using steel tape. The soil water content determines the gravimetric method. The C-organic content was determined using the loss on ignition method. The results showed that 1) there was a difference in soil water content between the water level depth (40 cm, 50 cm, and 60 cm) below the peat surface and the different humification levels of peat (sapric and hemic), 2) the farther from the groundwater level, the faster the peat burns, and 3) peat fires begin to occur at a groundwater level of 50 cm

Keywords: *Groundwater level, Land fire, Peatland, Water content.*

1. INTRODUCTION

Peatland ecosystems are one of the options for developing oil palm plantations as of their potential in Indonesia, which is still quite broad, namely 14.9 million ha [1], of which 29.5% consists of degraded forest overgrown with shrubs. Thickets but the potential for agriculture. Besides, 15.1% of peatland has been cultivated as agricultural land in food crops, plantations, and industrial crops [2], with good results. However, there are still many that show the need for improvement in management.

Although the peatlands' potential is quite significant, they are one of the ecosystems most prone to land fires. Almost every year, forest and land fires occur, especially during the long dry season, which results in social, economic, environmental, and ecological problems.

In the last 15 years (2000 - 2015), hot spot peaks of more than 15,000 occurred in 2002, 2004, 2006, 2009,

2014, and 2015. On average, hot spots occurred both outside the concession area (55%) and inside concession areas (45%), of which 16% occur on oil palm plantations. The fires' peak occurred in 2015, which think to have burned 2.61 million ha of land and forest. Even though La Nina hit Indonesia in 2016, land and forest fires continued, where fires covered an area of 14,605ha.

There are three leading causes of forest and land fires: humans, climate, and land conditions [3][4]. Peatland fires occur due to triggering and supporting factors. Trigger factors include human negligence, intentional or unintentional, land preparation, fishing, and hunting [5]. Meanwhile, the supporting elements are the long dry season, reduced land cover, and uncontrolled drainage channels. The massive clearing of peat swampland followed by the construction of drainage channels without following water management practices resulted in a rapid decrease in the peatlands' water table.

To prevent peatland fires, the government issued Government Regulation No. 71/2014, Article 23

paragraph 3, which states that the peatlands' groundwater level must maintain no deeper than 40 cm below the ground surface. A decrease in the water level in the land to more than 40 cm below the soil's surface. According to the government, it will impact the peat's nature in holding water to be lost, which will cause the peat to dry out and eventually lead to a fire. Most oil palm plantation owners object to this government regulation as, based on several studies, the growth and production of oil palm are highest at groundwater depths of 50-70 cm.

Decreasing the groundwater level's depth causes water flow to the upper layer through capillary flows to be small. Some research results indicate that the increase in capillary flow in peatlands only occurs to a depth of 40 - 60 cm from the groundwater level. That shows that up to 60 cm below the ground surface, the peat is still moist even though there is no additional water from rainfall. The research results show that the groundwater content is still in the range of 200% at a distance or height of 50 cm above the groundwater level [6]. When referring to the critical limit of water content (125%) stated by [7], peat will not burn if the water table is less than or equal to 50 cm above the ground. However, there is no information on the level of maturity and depth of peat in the study [7]. Simultaneously, [6] Researched a peat depth of 6 m and maturity level of hemic peat with five-year-old oil palm vegetation. It is interesting to research whether peat's different depths and maturities will also produce the same water content. This research expects to provide input that whether the minimum groundwater level in peatlands of 40 cm that the government has set through Government Regulation No. 71/2014 can be reviewed, considering that based on several research results. It shows that the highest growth and production of oil palm at water level soil 50-70 cm. The purpose of this study was to assess the minimum groundwater level to prevent fires on peatland planted with oil palm at various peat depths and maturities.

2. METHODS

The research was conducted in peatland on oil palm plantations at PT. Mendahara Agrojaya Industri, Lagan Tengah Village, Tanjung Jabung Timur District, Jambi Province of Indonesia. The research conduct by surveying and monitoring methods on 3,105 ha of peatland at a semi-detailed level with a 1: 50,000 scale working map. The observation points of 25 points were determined using the Grid Method with a grid size of 750 m x 500 m. The observation points are made perpendicular to the river. The research flow chart as follows:

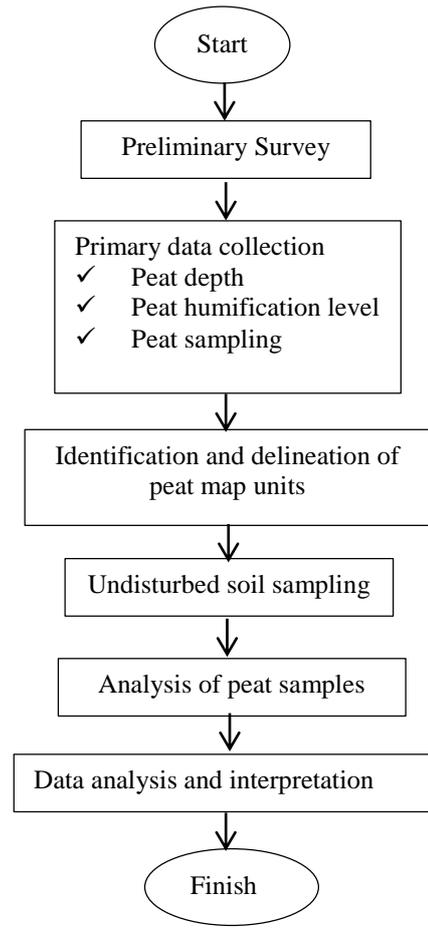


Figure 1. Research flow chart

Table 1. Data types and collection method

Types of data	Methods
Peat depth	Direct measurement
Peat humification level	Von Post
Groundwater level	Direct measurement
Water content	Gravimetric
Bulk density	Box sample
C-organic	Loss on ignition

3. RESULTS

3.1. Homogeneous Land Unit

Observations show that the depth of peat in the research area ranges from more than 50 cm to less than 400 cm, dominated by peat depths of 201-300 cm. There are two levels of peat humification in the research area: the sapric peat level and the hemic peat level. Meanwhile, the groundwater level group's depth into three depths, namely the center of the groundwater level, namely 50 cm, 60 cm, and 70 cm. Homogeneous land units were

created by overlaying the peat humification level and groundwater level data: WL50S, WL50H, WL60S, WL60H, WL70S, and WL70H (Table 2).

Table 2. Description of the factors that differentiate homogeneous land units

Distinguishing Factors	
Water Level (cm)	Types of Peat
1. 50	1. Sapric peat 2. Hemic peat
2. 60	1. Sapric peat 2. Hemic peat
2. 70	1. Sapric peat 2. Hemic peat

3.2. Peat Water Content

Made observations in the dry season at three depths of the groundwater level (50 cm, 60 cm, 70 cm) below the ground's surface. There is no rain for an extended period, indicating that the farther from the groundwater level or the closer to the soil surface, moisture land is getting lower.

The results show that the farther from the groundwater level, the water content decreases. The peat water content differs from the difference in peat humification level, as seen in Figure 1 (sapric peat) and Figure 2 (hemic peat). The peat's water content was higher than the peat's water content at the sapric humification level.

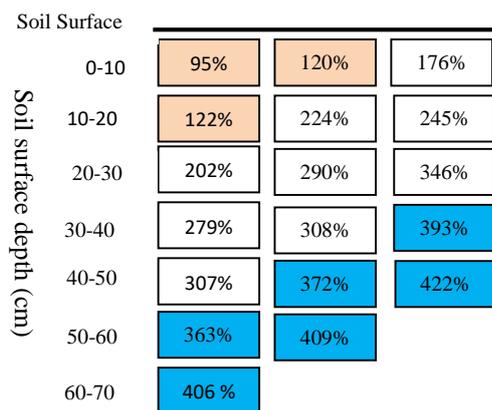


Figure 1 Peat water content (%) each layer of 10 cm on different water level in Sapric peat

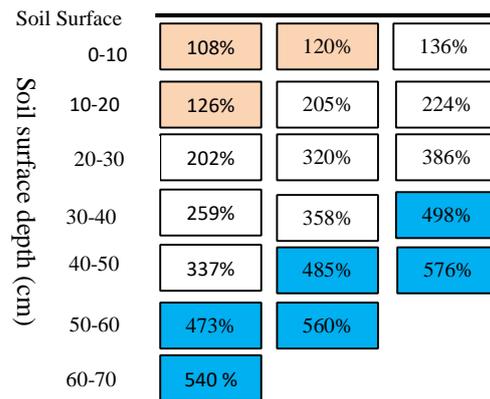


Figure 2. Peat water content (%) each layer of 10 cm on the various water level in Hemic peat

3.3. Bulk Density and C-organic

The results showed that different levels of humification showed additional organic matter content and bulk density. The organic matter content at the hemic peat's humification level is higher than the organic matter content at the sapric peat. On the other hand, the bulk density at the hemic peat is lower than the bulk density at the sapric peat level (Table 3).

Table 3. Bulk density and C- organic at different humification levels

Peat Humification Level	Bulk Density (g cm ⁻³)	C-Organic (%)
Hemic peat	0,13	53,36
Sapric peat	0,20	51,04

4. DISCUSSION

The level of peat humification affects the bulk density and C-organic content. The bulk density at the hemic peat's humification level is 0.13 g cm⁻³, and the bulk density at the Sapric peat is 0.20 g cm⁻³. These two levels of humification indicate that the bulk density is in the same range, namely 0.1-0.2 g cm⁻³, which is relatively the same as the previous researchers [8-9].

The peat's water content at the sapric humification level is lower than that of the peat at the hemic humification level. That occurs because, at the sapric peat, there has been a decrease in the organic matter content and increased bulk density. The increase in bulk density results in a reduction of peat porosity. The

removal of organic matter and porosity will decrease the water content retained in peat.

The peat's water content at all groundwater levels of 50 cm, 60 cm, and 70 cm is still above 125%. Referring to the research results by [8] that the critical limit for peat fires is 125%, then at 50 cm of groundwater level, there will not be peat fires. Peat fires will occur at a water table depth of more than 50 cm. This study's results are in line with the opinion of previous researchers who stated that capillary water would be able to rise from the groundwater level as high as 40-50 cm [10][11], 40-60 cm [12]. This study is somewhat different from that of [13], which stated that at a drainage depth of up to 70 cm, capillary water could still reach the root zone of plants.

A decrease in the groundwater level's depth results in little water flows to the upper layer through the capillary flow and reduced soil moisture. What happens as several groundwater volumes will release from the layer above it [14]. The release of groundwater is faster due to the high porosity and hydraulic conductivity of peat soils [15]. [11] state that the increase in capillary flow in peatlands only occurs up to a depth of 50 cm from the groundwater level. It further argues that an increase in the value of bulk density will increase capillary flow due to more micropores.

5. CONCLUSIONS

The following conclusions obtain from this study:

1. Organic matter content, bulk density, and water content of peat at Sapric are lower than at Hemic humification level.
2. The peat's critical limit will burn at a water table depth of more than 50 cm at both the Sapric and Hemic humification levels.

AUTHORS' CONTRIBUTIONS

H Junedi and A.K. Mastur were involved in planning and supervised the work. A.K. Mastur performed the measurements. H Junedi and Arsyad AR processed the experimental data, performed the analysis, drafted the manuscript. All authors discussed the results and commented on the document. H Junedi wrote the manuscript with support from Arsyad AR.

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