Study of Changes in Physical Properties of Burnt Peat: *A Case Study in Jati Mulyo Village, Jambi Province, Indonesia*

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Abstract. Jambi Province is a province that has a peatland area of 716,838 ha, which is vulnerable to peat fires. One of the villages where fires often occur is Jati Mulyo village, Dendang sub-district, East Tanjung Jabung district. Several researchers reported that there were differences in the characteristics of burned and unburned peatlands. The burned peatland ecosystem undergoes a succession where litter is produced from shrubs that grow after the peat land is burned which is able to cover the soil surface. The condition of land burned in 2015 is expected to have different characteristics from peatland that burned in 2015 and burned again in 2019. The study aims to analyze the physical characteristics of peatlands that were burned in 2015 and peatlands that were burned in 2015 and burned back in 2019 in Jati Mulyo Village. The research method uses survey and observation methods. Representative sampling was carried out using purposive sampling method on burnt peatland areas in different years from May to September 2020. The data collected are peat depth, peat maturity (van Post method), groundwater table depth (using a float ruler), soil moisture content (gravimetric method), organic matter content (loss of ignition method), bulk density (ring sample method). The results showed that there were differences in peat depth, peat organic matter content, and peat bulk density between peatlands that burned in 2015 and burned back in 2019.

Keywords: Characteristics · Fire · Peatland · Succession

1 Introduction

Peat with a very vital function, is still not managed and utilized properly. Damage to the peat environment occurs due to human negligence in land use. The occurrence of peatland fires in Jati Mulyo Village in 2015 and most of them burning again in 2019 is an environmental disaster that has a negative impact on the community. As a result of peatland fires, the community's economy is disrupted, the level of public health decreases, the habitat of flora and fauna is disturbed and the function of the peat ecosystem itself is reduced.

After the fire, the peat ecosystem becomes the main focus of ecosystem restoration as peat has 2 main functions, namely ecological (environmental) functions and economic

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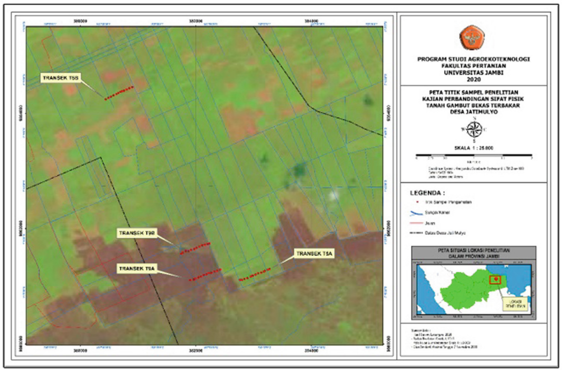

Fig. 1. Study Site

functions. The ecological function of peat is as a regulator of the global climate, hydrological cycle and biodiversity of flora and fauna. While economically, peat is land for cultivation activities to meet the needs of people's lives, such as agriculture, fisheries and forestry [1].

The physical condition of degraded peat is very difficult to restore as the peat formation process takes a very long time. After the fire, the peatland ecosystem undergoes a succession starting with the growth of wild plants into shrubs. During the succession process, the litter produced from shrubs was able to cover the surface of the peatland burned in 2015. The condition of the burnt peatland covered with shrubs is thought to have different characteristics from the peatland burned in 2019. Based on the description above, it is necessary to a study was conducted to determine the differences in the physical characteristics of peatlands that were burned in 2015 and burned in 2015 then re-burned in 2019. It is important to identify and analyze the differences and development of post-burned peatland.

2 Material and Methods

2.1 Study Site

The research was conducted on peat land that was burned in 2015 and burned in 2015 then burned again in 2019. The research location is in Jati Mulyo Village, Dendang District, Tanjung Jabung Timur Regency, Jambi Province, Indonesia, located between 1°12′06.2" to 1°18′50.2" South and 103°53′26.6" to 104°01′22.1" East. The research locations are presented in Fig. 1.

2.2 Methods

The study used survey and observation methods and representative sampling was carried out by purposive sampling method on peatland areas burned in 2015 and peatlands burned in 2015 and burned again in 2019. Sampling was carried out by transect lines were perpendicular to the channel. drainage. The use of the transect method perpendicular to the drainage channel aims to obtain different data variations based on the distance from the channel. The starting point of the sample is taken 25 m from the edge of the channel which is then 50 m from the previous sample point.

Data collected in the field are peat depth (Eijkelkamp peat auger with a 50 cm barrel and 10 m extension), groundwater level (piezometer), water level in channels (pieschal), peat decomposition (van Post), bulk density (ring sample), soil sampling disturbed (Eijkelkamp peat auger with a 50 cm barrel). Physical soil analyses were carried out on selected soil samples, which are analysis of bulk density and soil water content (gravimetric method) as well as soil organic contents (loss of ignation). All soil samples were analyzed in accordance to Technical Manual Guidelines for Soil, Water, Plant and Fertilizer Analysis [2].

3 Result and Discussion

3.1 Research Site

Administratively, Jati Mulyo Village is located in the Dendang District, East Tanjung Jabung Regency, Jambi Province. The area of Jati Mulyo Village with the research area is about ± 9764.66 ha. Geographically, Jati Mulyo Village is located at the coordinates of 1°12′06.2"LS to 1°18′50.2"LS and 103°53′26.6" East Longitude to 104°01′22.1" East Longitude.

Two types of land use were studied, namely the first, land that was burned in 2015 with a mixed land cover of oil palm and areca nut plantations. The second land is land that burned in 2015 and burned again in 2019 with bushland cover.

3.2 Channels Dimension and Water Level

The research lands that burned in 2015 and burned in 2015 and burned again in 2019 have slightly different dimensions of drainage channels (Table 1). The drainage system was built by the oil palm plantation company which borders the research area. The construction of drainage channels aims to reduce excess water from a land so that the groundwater level on the land can be lowered so that the land can be used optimally for plant growth.

Table 1 shows that the dimensions of the channel affect the water level in the channel. It does not compare all the channel cross-sectional areas as they are located on different block of land, so that only canals located on the same block of land can be compared, namely channels 1, 2, and 3 (burned land in 2015 transect 1); channels 4 and 5 (land burned in 2015 transect 2); and channel 6 and channel 7 (land burned in 2015 and burned again in 2019).

In general, channels that have the same cross-sectional area on the same block show the water level in the channel which is relatively the same. The wider the cross-sectional area of a channel, the deeper the water level in the channel. This can be seen on channels 1, 2, and 3 as well as channels 6 and 7.

Water loss in peatlands comes from evapotranspiration and drainage [3]. According to [4], rapid water level decline in peatlands as peat has high hydraulic conductivity and

Tabel 1. The relationship between channels dimension and water level

Lokasi	Channel	Width (cm)	Depth (cm)	Cross-sectional area(cm^2)	Water level (cm)
Transect 1, burned in 2015	1	400	240	96.000	−55
	2	400	185	7 74.000	−50
	3	400	225	90.000	−53
Transect 2, burned in 2015	4	400	185	74.000	−40
	5	400	185	74.000	−45
Transect 1, burned in 2015 and 2019	6	600	235	141.000	−50
Transect 2, burned in 2015 and 2019	7	600	80	48.000	−40

porosity. The decreasing in ground water level will cause the top layer of soil to dry out due to the release of a certain volume of water [5]. Excessive and long-term drainage of peat soil causes a number of impacts on the soil layer above the groundwater table such as a decrease in the groundwater table and soil surface, and increased aeration [6].

3.3 Relationship Between Water Table and Peat Depth

The results of the peat depth measurement show that the water level and the distance from the channel affect the peat depth. The shallower the water table, the deeper the peat and the closer to the channel, the lower the peat depth (Table 2).

There are 3 drainage channels on the burned land in 2015 transect 1, namely drainage channels 1, 2, and 3. Drainage channel 1 is located near observation point 1, drainage channel 2 is located between observation points 4 and 5, and drainage channel 3 is located between observation points 9 and 10. For land burned in 2015 transect 1 there are 2 drainage channels, namely drainage channel 4 located close to observation point 1 and drainage channel 5 located between observation points 5 and 6.

The closer the observation point to the channel, the deeper the groundwater table and the thinner the peat depth (observation points 1, 4, 5, 9, 10 on transect 1 and observation points 1, 5, and 6 on transect 2). This happens as the deeper the water table, the thicker the oxidized layer, which will reduce the depth of the peat. For peatlands that burned in 2015 and burned again in 2019 for both transect 1 and transect 2, there is only one drainage channel. Similar to the land that burned in 2015, the farther from the channel the shallower the water level on the land and the higher the peat depth.

The results show the same thing as stated by [7], that the distance from the drainage channel will affect the depth of the peat water table. The closer to the drainage channel, the deeper the groundwater level and the farther from the drainage, the shallower the water table.

Table 2. Groundwater level and peat depth

Observation point	Burned in 2015				Burned in 2015 and 2019			
	Transect 1		Transect 2		Transect 1		Transect 2	
	GWL (cm)	PD (cm)	GWL (cm)	PD (cm)	GWL (cm)	PD (cm)	GWL (cm)	PD (cm)
1	−47	415	−33	395	−42	470	−34	480
2	−43	462	−30	440	−41	500	−32	535
3	−42	455	−26	460	−42	510	−30	625
4	−45	415	−29	439	−41	560	−28	610
5	−47	375	−32	396	−39	600	−27	700
6	−43	390	−37	400	−35	640	−26	660
7	−40	403	−35	460	−34	660	−25	680
8	−43	387	−36	528	−30	670	−30	698
9	−44	362	−34	549	−27	680	−27	720
10	−42	370	−33	589	−24	710	−23	747
11	−30	400	−32	615	−21	760	−21	750
12	–	–	−28	628	–	–	–	–

Note: GWL = groundwater level; PD = Peat Depth

3.4 Relationship Between Peat Maturity and Peat Depth

Peat maturity is defined as the level of weathering of organic matter which is the main component of peat soil, one of which is influenced by the water level on the land. The deeper the water table, the thicker the aeration zone so that the activity of aerobic microorganisms is much more active than the activity of anaerobic microorganisms that are below the surface of the groundwater, resulting in increased decomposition of organic matter [8]. Maturity level affects other physical properties as illustrated in Table 3.

The maturity level of land burned in 2015 includes the level of fibric maturity (64.83%) and hemic (35.17%), while the maturity level of land that was burned in 2015 and burned again in 2019 is included in the level of fibric maturity (28.48%), hemic (70.85%), and sapric (0.67%) maturity levels. According to Syaufina et al. (2004), maturity level affects the ease of burning, where fibric (H1-H3) and hemic (H4-H7) peat is more flammable than sapric peat (H8-H10).

Table 3 shows that the maturity level is directly proportional to the bulk density and inversely proportional to the organic matter content and water content of the peat. The more mature the peat, the higher the bulk density value and the lower the organic matter content and water content. Peat decomposition has a positive relationship with water holding capacity, and ash content and negatively correlates with organic matter and fiber content [9].

Tabel 3. Effect of peat maturity level on bulk density, organic matter, and water content

Location	Maturity Level	BD ($g\ cm^{-3}$)	OM (%)	WC (%)
Transect 1, burned in 2015	H3	0,10	89,4	845
	H4	0,14	89,1	761
	H5	0,15	85,1	580
	H6	0,19	80,8	479
Transect 2, burned in 2015	H2	0,08	95,1	920
	H3	0,11	92,7	885
	H4	0,15	89,5	613
	H5	0,16	84,2	556
Transect 1, burned in 2015 and 2019	H3	0,10	92,5	970
	H4	0,13	89,3	760
	H5	0,16	88,1	610
	H6	0,18	84,2	554
	H7	0,19	80,5	471
	H8	0,22	75,4	289
Transect 2, burned in 2015 and 2019	H2	0,09	93,7	963
	H3	0,10	90,5	870
	H4	0,12	88,3	693
	H5	0,15	87,0	553
	H6	0,17	83,4	476

Note: BD = bulk density; OM = organic matter; WC = water content

The bulk density on land that burned in 2015 was in the range of 0.08–0.19 g cm^{-3} while on land that burned in 2015 and burned again in 2019 was in the range of 0.09–0.22 g cm^{-3}. This range of bulk density values is related to the level of peat maturity. Bulk density are in the same relative range as previous researchers (Prayitno et al., 2013; Susandi et al., 2015; Tonks et al., 2017).

Table 3 also shows that the more mature or higher the level of maturity of the peat, the lower the moisture content of the peat. Moisture content at the fibric maturity level was 845%–963%, the hemic maturity level was 471%–761%, and the sapric maturity level was 289%. Increasing the maturity of peat results in a decrease in the content of organic matter, a reduced percentage of pore space so that its ability to absorb water and bind water will also decrease. The ability of peat soil to absorb and bind water in fibric peat is greater than hemic and sapric peat, while hemic peat is greater than sapric peat (Suwondo et al., 2012). According to Andriesse (1988), the maximum water-holding capacity for fibric peat is 850–3000%, for hemic peat 450–850% and for sapric peat $<$ 450%.

4 Conclusion

The conclusions from the results of this study are:

1. The cross-sectional area of the channel affects the water level in the channel and on the land which affects the thickness of the peat and the level of peat maturity
2. Land that burned in 2015 and re-burned in 2019 had a higher level of maturity, higher bulk density, lower organic matter content and water content compared to land that only burned in 2015

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