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Highly grass fine fuel in contributing peat fire in South Sumatra

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Abstract. Grass density and moisture content in peatlands are important factors in fire management and for the protection of fire prone areas. If relevant data is available, it can be used as an early warning system. In this study, a replicated trial that includes vegetation analysis of understorey species and measurement of moisture content have undertaken in 1x1 m plots, and it is used to obtain a representative image of field condition of six grasslands in Riding village and Kayulabu village, Ogan Komering Ilir, South Sumatra. Base on this study, the average grass moisture content in the wet season is 70.2%, a non-flammable condition. The grass will decrease continuously in dry season to extreme dry conditions and become highly flammable. The average grass fresh biomass in Riding village, Ogan Komering Ilir, South Sumatra is 8.6 ton/ha, equivalent to 1.3 ton/ha dry biomass which is potentially a highly flammable fine fuel. This is associated with a positively reinforcing feedback loop between burning and grazing. In dry condition, that conditions is stimulated for forest peat fire.

1. Introduction

Forest and land fires are still disasters that almost every year affects several places in Indonesia (1–3). Fire is used in Indonesia as a tool to clear tropical forest and to convert peat land for agricultural purposes (1,4). Agricultural activities and the dry season, especially El Nino, have a significant influence on the increase in fire incidents in Indonesia(5,6). The year 2015 was the biggest forest fire event, especially the peatland that have ever happened in Indonesia, which caused an extraordinary smog disaster. The emissions released by fires caused a regional air pollution episode with tremendous impacts on human health, visibility, economy, and influenced regional to possibly global climates (1,5,7) and major cause of peatland degradation and leads to loss of biodiversity and carbon stocks (3).

Forest and peat fires occur because of fuel in flammable conditions. Fuels that are often as the trigger of fires are fine fuels and they are widely available on the peatland floor. Grass is categorized as highly flammable fine fuel in dry conditions (Applegate et al. 2017). Grass is typically the first fuel type to become flammable as drying progresses over the landscape because the lack of an overstory
canopy promotes faster drying due to greater solar radiation and wind that is reaching the fuels (Groot et al. 2005). Grasslands in Riding Village, Ogan Komering Ilir Regency, South Sumatra have many vulnerable peatland areas where fire can cause significant damage based on the mapping of fire-prone areas by the South Sumatra Regional Peat Restoration Team (RPRT). The existence of this grassland in Riding village is very important for the community for grazing swamp buffalo. The condition of grass in the grasslands in the dry season will become very dry and become the cause of fire.

In the tropic area, grass is the most common dominant vegetation in various types of land and is important as surface fuel in savanna ecosystem. Fire is very common in these grass-dominated fuel complexes with tropical savannas being the most fire-prone biome on earth (8,9). Grass is often considered a universal fuel type because of its extensive global distribution and common occurrence in many different vegetation biomes (10). The 40% of global carbon emissions are from fires in grasslands and savannas (11). Groot et al. (10) in Sumatra find that grass fuel loads averaged around 420-722 g/m2 with a highly significant decrease in dead grass moisture content and a highly flammable fine fuel. (12,13). Grass is very easy to dry during the dry season, especially in the peat area. The grass becomes very dry because the heating process. The heating is not only because of the sun's rays but also the decrease in the surface of peat water, very dry gusts of wind and the process of releasing heat emissions from dry peat materials. In Indonesia, fire has been used as a tool in traditional farming as is the easiest way to clear an area of land and of how to get green grass shoots with dead grass blooms(14). The community use grassland at peatland area for grazing their livestock i.e. buffalos. Pastoralists use fire to stimulate grass growth for livestock (15)

Information on grass density and moisture content in peatlands is important for fire management as a means of protecting fire prone areas that are more difficult to control than other environments. Grass density and moisture content determine the occurrence of the size of the fire event and the damage caused thereafter. Managing fires on peatlands is more difficult because peat fires are often not visible on the surface; it is only smoke coming out from inside the peat which is visible.

The purpose this study is to observe the grass fine fuel loads in peatland and the volume and moisture content that could be used in fire management planning and swamp buffalo feed management planning.

2. Methods
Data of live fresh grass was collected at six grasslands in six villages (Sungai Rasau, Rengas Merah, Rengas Potong, Sungai Setanjung, Sungai Damping and Penyajab) on July 2017 and in that time, the dry grass was collected at three plot in Kayulabu. Volume vegetation analysis of understorey species and measurement of moisture content of fresh grass are conducted using 1x1 meter plot. 3 replications in each grassland and 3 plots in Kayulabu to obtain a representative image of field condition of many grasslands in Riding village, Ogan Komering Ilir (OKI) District, South Sumatra. Samples (300 – 600 g each 3 replicates) are collected and sealed in airtight metal tins, weighed (Ww), oven-dried for 4 x 24 hours at a nominal temperature of 105 °C and then they are reweighed every day until constant(Wd) (16). The meadow area is calculated using GPS and it is processed using GIS. The moisture content (mc) formula bases on wet basis (Wb) where the result of the calculation is presented below:

\[
mc = \frac{Ww - Wd}{Ww}
\]

Where \(mc\) is moisture content, \(Ww\) is wet grass weight and \(Wd\) is dry grass weight after oven-dried.

3. Result
The sum of biomass data collection in six grassland area are below.
Table 1. Volume fresh grass biomass at six grasslands, Riding Village, Ogan Komering Ilir District, South Sumatra, Indonesia

| Nu. | Name of Grassland | Area | Fresh biomass (ton/ha) | Dry biomass (ton/ha) |
|-----|-------------------|------|------------------------|---------------------|
|     |                   | Total| Other land use/HP (Production Forest area) |                      |
| 1   | Sungai Rasau      | 334.99 | 246.97 | 88.02 | 7.48 | 1.75 |
| 2   | Rengas Merah      | 233.36 | 129.15 | 104.21 | 9.6 | 1.14 |
| 3   | Rengas Potong     | 179.51 | 179.51 | 0 | 4.28 | 1.46 |
| 4   | S. Setanjung      | 799.81 | 432.92 | 366.89 | 16.2 | 1.31 |
| 5   | S. Damping        | 545.96 | 287.51 | 258.45 | 7.63 | 1.09 |
| 6   | Penyajab          | 317.01 | 117.96 | 199.05 | 6.38 | 1.10 |
|     | **Total**         | **2410.64** | **1394.02** | **1016.62** | **51.57** | **7.85** |

Average: 8.60, 1.31

The sum of moisture content data collection in grassland area are presented below.

Table 2. The fresh grass moisture content (mc) at six grassland village in Riding village, Ogan Komering Ilir District, South Sumatra, Indonesia

| Nu. | Name of Grassland | n. subsample | Fresh subsamples weight (g) | Dried weight (g) | mc (%) |
|-----|-------------------|--------------|------------------------------|------------------|--------|
| 1   | Sungai Rasau      | 1            | 472                          | 104              | 77.97  |
|     |                   | 2            | 646                          | 181              | 71.98  |
|     |                   | 3            | 610                          | 186              | 69.51  |
| 2   | Rengas Merah      | 1            | 351                          | 99               | 71.79  |
|     |                   | 2            | 463                          | 120              | 74.08  |
|     |                   | 3            | 364                          | 125              | 65.66  |
| 3   | Rengas Potong     | 1            | 387                          | 110              | 71.58  |
|     |                   | 2            | 438                          | 122              | 72.15  |
|     |                   | 3            | 458                          | 206              | 55.02  |
| 4   | S. Setanjung      | 1            | 0                            | -                | -      |
|     |                   | 2            | 0                            | -                | -      |
|     |                   | 3            | 0                            | -                | -      |
| 5   | S. Damping        | 1            | 430                          | 99               | 76.98  |
|     |                   | 2            | 336                          | 94               | 72.02  |
|     |                   | 3            | 312                          | 135              | 56.73  |
| 6   | Penyajab          | 1            | 408                          | 84               | 79.41  |
|     |                   | 2            | 336                          | 77               | 77.08  |
|     |                   | 3            | 405                          | 169              | 58.27  |

Average (mc) %: 70.02
Table 3. The dry grass moisture content (mc) in Kayulabu, Ogan Komering Ilir District, South Sumatra, Indonesia in peak dry season.

| Plot number | Weight (g) | mc (%)
|-------------|------------|--------|
|             | Fresh grass | Dried grass |
| 1           | 287,781     | 234,240  | 22.86  |
| 2           | 173,032     | 145,288  | 19.10  |
| 3           | 364,681     | 279,699  | 30.38  |
|             | Average     |          | 24.11  |

4. Discussion

Ogan Komering Ilir is dominated by peat land. OKI has 7,500 ha peatland and with some different land use (Figure 1). In 2015 almost all peat in OKI was caught by fire which caused tremendous damage to biodiversity, economy and health. The grass species are dominant under tree stand in peatland and the tropical grasses are fuel for the majority of fires on Earth. (17).

Figure 1. Forest Area in Ogan Komering Ilir District
Figure 2. Peatland grazing area at Riding, Ogan Komering Ilir in wet condition

Peat fires tend to occur repeatedly during the dry season because of the abundant amount of extreme dry fuel. In dry season, the high volume grass fine fuel loads in peat land is a big problem in fire management. Fires will not start in the live grass component of grassland because the moisture content of live is much higher.

The grass study result shows that the average moisture content of live grass at 6 grasslands Riding villages are 70.02% (Table 2) in wet season and continue to dry until 24.11% (Table 3) and this condition make the grass become flammable. The ignition threshold of live grass occurs at 27.8% moisture content (10) it means that live grass in Riding village is not flammable in this condition. On peatland along with the change of wet season to dry, generally, a decrease in water table level follows. The moisture content of the grass will decrease continuously in the dry months to extreme dry conditions. The fire can start and spread in grassland when the moisture content of the dead grass component is near or below the threshold value of 35.4% (10).

The important factors that affect to moisture content are air temperature, solar radiation, wind rate and species of grass. In peak dry season, the moisture content of grass in peatland is rapidly going to decrease because high solar radiation and other factors makes the leaf, stems and even grass roots quickly become dry and highly flammable. Grass has variation flammability among the grass species. Moisture content is the main influence on ignitability, where species with higher moisture content take longer time to ignite and once alight burnt at a slower rate (17).

Since 1990 the government has constructed thousands kilometers of canals in peatland area (18,19). Uncontrolled canals cause over drainage and the peatland becomes very dry and fire prone. One of the results of drying by canal is the drought of vegetation especially grass on peatland. One effort to prevent grass as a trigger for peat fires is to try the grass in a condition that is always wet. The effort to keep the grass always in wet condition is to keep the water table level always at a high level. The blocking of drainage canals by building dam has become one of the most important measures to restore the hydrology and the ecological function of the peatland (19) and one way to keep the water table level always at a high level (18).

The major activities of the community in grass peatlands are providers of the swamp buffalo. The application of fire control management and maintaining the functions of grassland ecosystems as providers of swamp buffalo to support community livelihoods is important to do. The role of the community in keeping peat from fires is very important. Several studies have shown that forest fires
are caused by human activities (20–23). One of control management for the community is giving awareness to the community to be wise in using fire.

5. Conclusion
The dry grass at peatland Riding village, Ogan Komering Ilir District is potential as the trigger of flammable fuel with moisture content 24.11%. The effort to keep the grass always in wet condition is to keep the water table level at a high level. Canal blocking is one way to keep the water table level always at a high level and giving awareness to the community to be wise in using fire.

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