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Spatial analysis of Wildfire in the South Sumatra Peat area during 2019 Drought Season

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ABSTRACT

South Sumatra's peatland is the largest on the Sumatra island after Riau province. In the 2019 dry season, wildfires take place in most of the South Sumatra peatlands which generated a haze disaster in the South Sumatra region and beyond. This study aims to identify the characteristics of the wildfires in the South Sumatra peat area during the 2019 dry season. Remote sensing data and GIS techniques are applied in this study to realize the research purposes. Wildfires were analyzed using hotspot data and burned areas were obtained from spatial buffer analysis of hotspot data. For peatland distribution data, this study uses data from the Indonesian Ministry of Environment and Forestry in 2017. The results showed that in the 2019 dry season, wildfires took place on approximately 20% of South Sumatra's peatlands. Characteristics of the peat fires distribution are concentrated in Ogan KomeringIlir and Musi Rawas Utara Districts. On the other hand, the lowest peat fire rate during the observation period was in Musi Rawas District. The wildfires during the observation period increased from June until October and decreased in November, with the peak of fires in October. Based on the results, fire prevention and management need to be improved. The priority for preventing and managing peat fires is focused on areas with massive fires during the dry season.

***Key words**: Peat fires, Hotspot, Land cover, Dry season*

Introduction

The largest tropical peatlands in Southeast Asia are located in Indonesia (Miettinen *et al.*, 2016; Susan E. Page *et al.*, 2011). The latest data from the Indonesia Ministry of Environment and Forestry states that 24 million hectares of peatlands are distributed over the large islands in Indonesia. Some research indicates that Indonesia's peatlands are currently degraded due to deforestation, land-use change, fires, etc (Miettinen *et al.*, 2012, 2010). The Degradation of peatlands due to fire results in loss of surface vegetation and also harm to the peat material (Cole *et al.*, 2015; Page *et al.*, 2016). The Peat fire events in Indonesia predominantly occur in the dry season during the June-November period.

Peat fire in Indonesia, particularly in South Sumatra is very harmful to humans as well as the environment. In 2015, the severe peat fire generated a haze disaster in most of Sumatra, Kalimantan, and other countries around Indonesia (Singapore, Malaysia, etc.). The haze disaster is very dangerous to human health, it was recorded that the haze disaster in 1997, 2006, and 2015 caused human deaths and

respiratory diseases across Indonesia (Koplitz *et al.*, 2016; Marlier *et al.*, 2015). On the other hand, peat fire emits carbon into the atmosphere which contributes to global warming and climate change. During the 2015 fires, carbon emissions averaged is about 11.3 Tg CO_2 per day during the September-October period (Huijnen *et al.*, 2016).

The last haze disaster in Indonesia due to peat fires occurred in the 2019 dry season. One of the regions in Indonesia with the highest peat fires in 2019 is South Sumatra province (BNPB,2020). Putra *et al.* (2019a) mention that some parts of South Sumatra's peatlands have burned repeatedly between 1995 to 2016. This study aims to identify the characteristics of the distribution of peat fires in 2019 in South Sumatra Province. This research provides information related to the characteristics of peat fires which is useful in developing strategies to maintain and prevent future peat fires in the study area.

Methods

Study Area

The research area is the peatlands of South Sumatra with an area of about 2,1 million hectares based on the Indonesian Ministry of Environment and Forestry data in 2017. South Sumatra's peatland is the second largest peat ecosystem on the Sumatra island (the first is Riau Province). South Sumatra's peatland is distributed in seven districts/cities (Figure 1). Half of the South Sumatra peatland area is located in the Ogan KomeringIlir district. Several studies state the peat fires in the study area occurred during the dry season in the June-November period.

Wildfires

In this study, the wildfire analyses by hotspot data were sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS) sensors.This study uses hotspot data with a confidence level above 80% for MODIS data, while for VIIRS data in normal and high confidence classes. The resolution of the hotspot data obtained from the two sensors is 1 kilometer (MODIS) and 0.375 kilometers (VIIRS). Hotspot data is collected from the FIRMS website (*firm.modaps.eosdis.nasa.gov*).

Burned Area

The burned area is an area that has a possibility of burning during the observation period. This area was identified by the spatial buffer analysis of hotspot data. The buffer interval is applied according to the hotspot data resolution (MODIS hotspot: 1 kilometer; VIIRS hotspot: 0.375 kilometers).

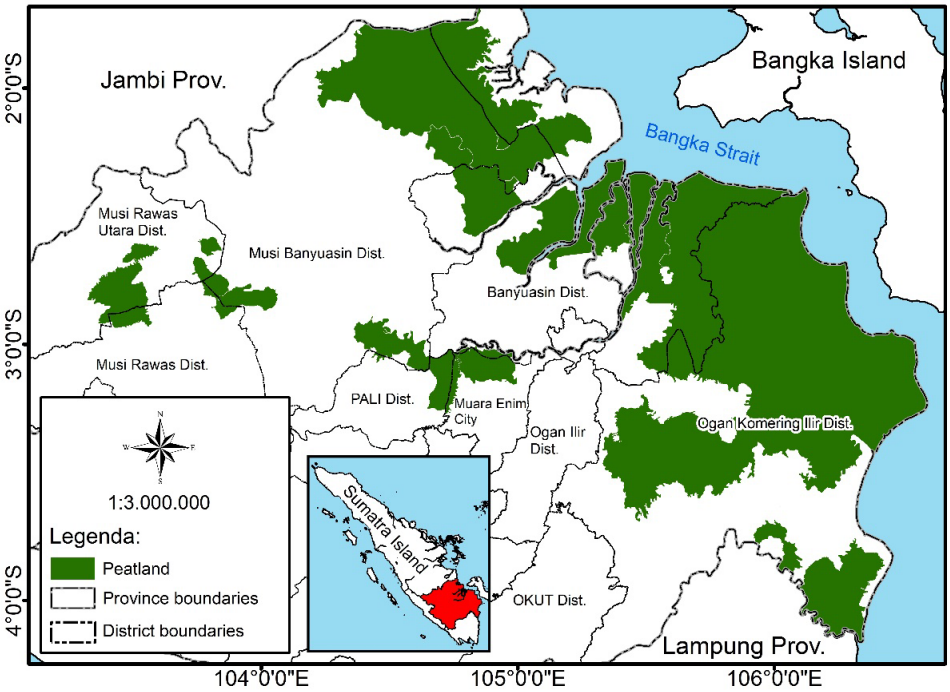

Fig. 1. Peat distribution in South Sumatra Province

Data Analysis

This study applies Geographic Information System (GIS) techniques for data analysis using spatial overlay and buffer methods. The spatial analysis method was carried out with ArcGIS software version 10.4. The Hotspot data during the observation period were identified in the South Sumatra peat area using the spatial overlay method. Furthermore, hotspots in the study area were analyzed with spatial buffers to obtain burnt areas. The results of the analysis for hotspots and burnt areas were evaluated to attain information and characteristics of wildfires in the study area during the observation period.

Result and Discussion

During the 2019 dry season, 32,950 hotspots were identified in the study area. Hotspots appeared in June and increased until October, then decreased in November (Table 1). The results of the observations are consistent with the previous study (Putra *et al.*, 2019a; Putra *et al.*, 2019b), where the peak of fire took place in October, which was marked by the highest number of hotspots (12,862 hotspots). From August to September 2019, wildfires in the observed area increased rapidly coincide with a decrease in the intensity of the rain. According to Golden Gate Weather Services (*https://ggweather.com*), at the end of 2019 most of Indonesia's climate, especially Sumatra was affected by the weak El Niño phenomenon which caused drought.

Table 1. Total of hotspots per month in 2019

Month	Hotspot	Percentage
June	13	0.04
July	97	0.29
August	2,103	6.38
September	12,156	36.89
October	12,862	39.03
November	5,719	17.35
TOTAL	32,950	100.00

The distribution of wildfires in 2019 is spread over seven districts/cities (Figure 2). The largest wildfires during the observation period occurred in the Ogan KomeringIlir (OKI) district, where half of the total hotspots in 2019 (16,492 hotspots) were located in this district. The highest number of hotspots is in line with the largest peat area distribution for the research area located in OKI District according to the Indonesian Ministry of Environment and Forestry data (2017). On the other hand, the lowest distribution of wildfires in 2019 took place in the Musi Rawas District with a total of 46 hotspots along the observation period. The characteristics of the hotspot distribution in the study area have a strong correlation with the distribution of peatland in the South Sumatra region.

Hotspot density is the ratio of the total hotspots in each district/city and the area of peatland in that area. In Table 2, hotspot density is presented for every 1,000 ha of peatland. The highest hotspot density

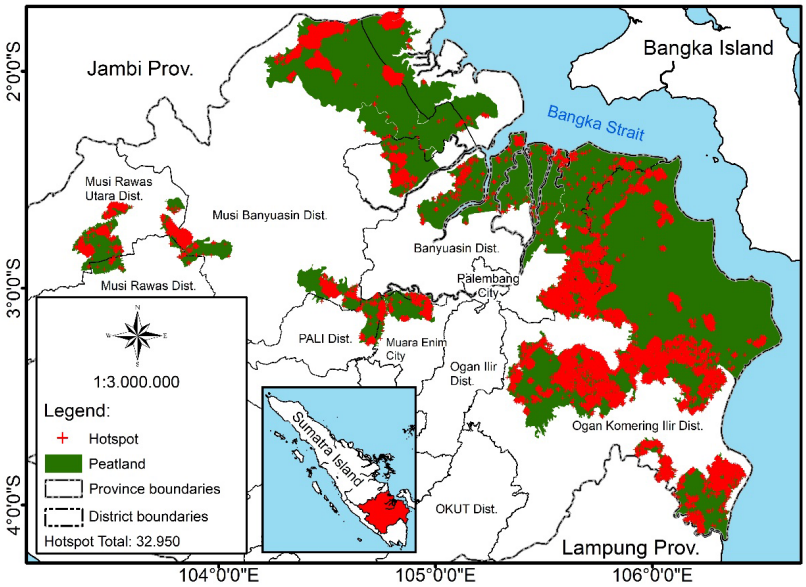

Fig. 2. Hotspot distribution map of South Sumatra peat area in 2019

Table 2. Hotspot distribution and density of South Sumatra peat area in 2019(hotspot density /per 1.000 Ha)

District/City	Total Hotspot	Percentage (%)	Hotspot Density
Banyuasin	5,627	17	10
Muara Enim	608	2	17
Musi Banyuasin	8,217	25	23
Musi Rawas	46	0	2
Musi Rawas Utara	1,764	5	30
Ogan KomeringIlir	16,492	50	16
PALI	196	1	8
TOTAL	32,950	100	16

in 2019 was located in Musi Rawas Utara District with 30 hotspots per 1,000 hectares of peatland. Meanwhile, OKI District with the largest peatlands and the highest hotspot distribution in 2019, has a density of 16 hotspots per 1,000 hectares. The characteristics of hotspot density indicate the possibility of the area to burn (high density indicates a high possibility to burn and conversely) (Giglio *et al.*, 2003). Thus, Musi Rawas Utara District is the area with the highest fire susceptibility level during the observation period. Meanwhile, the lowest fire susceptibility level is Musi Rawas District with a density of 2 hotspots in every 1,000 hectares of peatland.

Next, the buffer analysis is applied to identify the burnt area of each hotspot data. The results are presented in Figure 3 and Table 3. During the observation period, more than 20% of South Sumatra's peatlands burned. The wildfires in 2019 took place in seven districts/cities with varying burned areas. The total area burned was analyzed to the area of peatland in South Sumatra and also the area of peatland in each district/city.

The largest area of burnt peatland takes place in the OKI district, where the largest peatland distribution in South Sumatra was located. More than half of the peat area burned in 2019 locate in OKI District. The percentage of burned peatlands in each district/city shows the level of accuracy of fire management and prevention carried out by each district/city government. Although the largest fires take place in OKI District, the 2019 wildfires only burned 23% of the peatlands in this district. The highest percentage

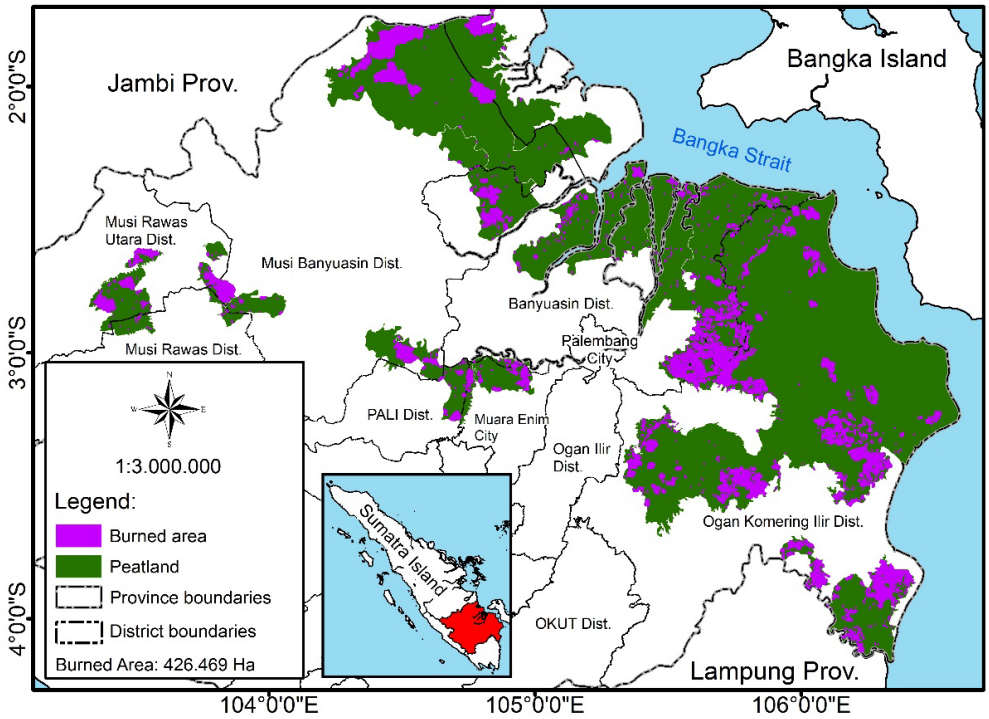

Fig. 3. Burned area map of South Sumatra peat area in 2019

Table 3. Burned area of South Sumatra peat area in 2019 (a: comparison to the total of the burned area; b: comparison to the total of peat area in each district/city)

District/City	Area (Ha)	Percentage (%)	
		(a)	(b)
Banyuasin	91,214.37	21.39	16.18
Muara Enim	8,428.94	1.98	23.02
Musi Banyuasin	57,318.95	13.44	15.77
Musi Rawas	1,300.16	0.30	6.27
Musi Rawas Utara	16,944.81	3.97	28.80
Ogan KomeringIlir	24,7134.00	57.95	23.90
PALI	4,128.47	0.97	17.02
Total	426,469.70	100.00	20.29

of wildfires in each region is detectedin Musi Rawas Utara District (28% of peatland burned in 2019). Meanwhile, the district/city peatlands with the lowest burned were located in MusiRawas District.

Conclusion

During the 2019 dry season (June-November), 32,950 hotspots were detected in at least 20% (426,469 hectares)of South Sumatra's peatlands. The peak of peat fires occurs in September-October and decreases in November. OKI District is the largest contributor to wildfires, where more than half of the total hotspot and burned areas in 2019 are located in this district. Meanwhile, the highest hotspot density and the largest area of burned peatland in each district take place in MusiRawas Utara District. This study showed that the current management practices of South Sumatra's peatlands, especially fire prevention and management, need to be improved. The prevention and management practices of fires are prioritized in OKI and MusiRawas Utara Districts because these two areas have the largest distribution of peatland with the highest number of wildfires in The South Sumatra region.

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