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Analysis of Forest and Land Fire with Hotspot Modis on Various Types of Land Cover in Central Kalimantan Province

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Large forest and land fires occurring each year have severely detrimental impacts. Forest and land fires affect different types of land cover, the reason being that land cover indicates how fuel is available when a fire spreads. Information on the distribution of points hotspot on various land covers is still difficult to find. Therefore, this research is carried out to provide an overview to stakeholders who have an interest in forest and land issues as to where points of hotspot fire can be used as indicators of fire, and when integrated with land cover data, it is expected that information on the tendency of forest and land fire hazard in various land covers can guide policy in order for forest and land fire disaster to be anticipated as early as possible. The study was conducted in April until June 2019 with the context of the research set in the Central Kalimantan Province. The stages of the current research on forest and land fire vulnerability class analysis based on the types of land cover starts with the identification and collection of data, followed by data analysis, to build a distribution map model hotspot on various covers. Parameters observed were hotspots that were vulnerable during the last 10 years from 2009 to 2018. The results of calculations of the forest and land fire hazard class on forest land cover that are often included in the vulnerable category are secondary swamp forest (Hrs). Whereas the non-forest land cover which is often included at the dangerous level is the Shrub Shrubs (Br).

Key words: Forest Fire, Hotspot, Land Cover Type.

1. INTRODUCTION

Humans and the wider natural ecosystem have much to benefit from forests, which make them an important natural resource. Wood and fuel, tourism, watershed protection and carbon storage are just a few of the multiple benefits it provides to mankind. Increasing forest fire activity, on the other hand, is a major source of concern since it endangers the environment, the economy, and the lives of humans. We know that fire plays a significant role in the Earth's natural ecosystems . Because of this, fire is an important factor in forest disturbances (Mulyanto et al., 2020). At the global scale, forest fires have a significant impact on vegetation dynamics, carbon stocks, land use change, and are a significant source of greenhouse gases and aerosols (Aminudin et al., 2020; Elliott et al., 2019). However, there is a great deal of uncertainty about the distribution, extent, and intensity of fire occurrence on a global scale, as well as the amount of biomass that is burned as a result (Handoko et al., 2021; Yin et al., 2019). As the only source of global information on fire incidence, satellite products are the only available source since they give a complete geographical and temporal coverage of fire-affected areas. Fire hotspots and burned area patches are two types of satellite data products that have been used to map the occurrence of wildfires. Warm spots are formed by temperature anomalies recorded by middle and thermal infrared sensors, whilst burned area patches are formed by the reflecting contrast between unburned and recently burned areas detected by the middle and thermal infrared sensors (mostly associated to the presence of char, ashes, and scorched leaves). In contrast, satellite overpasses only detect fires at the time of satellite overpass, implying that the detection of hotspots is merely a representative sample of the total fire occurrence (Jiang et al., 2017; Kadir et al., 2019), whereas reflectance alterations of burned patches persist for a longer period of time (from several weeks to years, depending on the ecosystem's response to fire). Furthermore, when fire incidents occur under dense cloud cover, it is possible that they will not be identified, resulting in additional fire omissions (Kumari et al., 2020).

Central Kalimantan Province has experienced forest and land fires which were subsequently briefed on forest and land fires since decades ago (Mulyanto et al., 2020; Van der Laan et al., 2018). First recorded in 1997, there have been large forest and land fires which have caused significant negative impacts in terms of ecological damage, decreased biodiversity, declining economic value of forests and soil productivity, micro and global climate change, as well as the smoke which affects the health of humans (Magdalena et al., 2020). Statistics pertaining to forest and land fires indicate the increasing level of forest degradation from year to year, with one of the causes being forest and land fire, both naturally and due to human intervention. Therefore, human intevention can actually add fuel to problems resulting from forest and land fire during the dry season which is exacerbated by climate anomaly phenomena *El Nino* which causes a worsening of the situation when the dry season arrives. As a resulr, forest and land fires are often difficult to deal with either through prevention or direct blackout (Marlina et al., 2021).

Different types of land cover will affect forest and land fires. This is because land cover indicates the availability of fuel where fire spreads. From observations, it is found that land cover in the form of shrubs tends to have a high number of hotspot findings. This condition shows that land cover consisting of shrubs has the highest forest and land fire risk (*extremely high*). This is because the type of fuel in shrubs is smoother and more flammable compared to forest vegetation (Adrianto et al., 2020; Khairani et al., 2020; Venkatesh et al., 2020).

Within the experience of forest and land fires in Central Kalimantan in the last decade, there have been several times of forest and land fires that are large enough and have had a highly detrimental impact (Minarni et al., 2020). This experience means that learning about effective prevention efforts needs to be carried out in an integrated manner in the future. One of these efforts must be towards utilizing information on the distribution of *hotspots* and other supporting data to be used as a basis for policies on how to deal with forest and land fires in Central Kalimantan. Information about the level of fire vulnerability based on the distribution of points identified *hotspots* on various land cover is difficult to find. Therefore not many people can understand how technology using remote sensing (sensing *remote*) and geographic information systems (GIS) can support policy makers to deal with forest and land fires in Central Kalimantan (Kumari et al., 2020; Purnomo et al., 2018; Purnomo et al., 2019). Therefore, this research is carried out to provide an overview to *stakeholders* who have an interest in the issue of forest and land fires as to when and how points *hotspot* can be used as indicators of fire, and this information when integrated with land cover data it is expected to yield new and useful information on fire vulnerability in various types of land cover. Therefore, this study aims to map the class of forest and land fire vulnerability in various types of land cover in Central Kalimantan province. The present research is expected to provide a new source of information for the community and local government or policy makers to help ensure that forest and land fire disasters can be anticipated as early as possible based on information regarding forest land and forest vulnerability .

2. METHODOLOGY

A. Time and Place

The current research on the classes of forest and land fire vulnerability in types of land cover was carried out over a period of 3 months starting from data collection to data analysis, from April to June 2019. The scope of the research is specified to the Central Kalimantan Province.

B. Tools and Materials

The tools needed in this research consist of hardware in the form of *personal computers*, *printers* and stationery as well as software in the form of software packages *ArcMap* 10.5 and *Microsoft Excel* 2013 and *Mozzila Firefox Quantum* version 66.0.5.

The materials used in this study are:

a. Spatial Data (*Shapefile*) distribution of *fashionable hotspots* in Central Kalimantan Province for the past 10 years from 2009 to 2018 on the basis of the results of NASA's Terra and Aqua satellite monitoring

b. Spatial Data (*Shapefile*) of Central Kalimantan Province land cover types from the Directorate of Forest Resources Inventory and Monitoring (IPSDH), Directorate General of Forestry Planning and Environmental Management, Ministry of Environment and Forestry

c. Spatial Data (*Shapefile*) administration area in Central Kalimantan Province, Spatial Data ((*ShapefileAdpum*) sources from the Central Kalimantan Public Administration) Bureau of Spatial Data (*Shapefile*) 2016 Indonesian Earth Map in the form of toponimi of village capital, district / city capital, road network, river sources from the Geospatial Information Agency (BIG).

C. Parameters Observed

The parameters observed in this study are the *hotspots* that are indicated to cause forest and land fires. Thee scope of the study covers types of land cover in Central Kalimantan Province by observing the distribution of *hotspots* during the last 10 years from 2009 to 2018 .

Central Kalimantan has 22 types of land cover types in which 7 species are the types of land cover in the form of forest and 15 species are the types of land cover in the form of non-forest, with details as follows:

a. Types of land cover in the form of forest: Primary Dry Land Forest, Secondary Dry Land Forest, Primary Mangrove Forest, Primary Swamp Forest, Secondary Mangrove Forest, Secondary Swamp Forest, Plantation Forest

b. Types of land cover in the form of non-forest: shrubs, plantations, settlements, open land, Savanna / prairie, water bodies, swamp shrubs, dry land agriculture, mixed dry land agriculture, rice fields, ponds, airports / ports, transmigration, mining, wwamp.

D. Data Analysis

In this study, data analysis is used to determine the class of forest and land fires in the types of land cover. This analysis is divided into 2 parts, namely 1) Analysis of forest and land forest vulnerability in the types of land cover in the form of forests and; 2) Analysis forest and land fire vulnerability analysis on land cover types in the form of non-forest. This is done with a view to makea map of the forest and land fire vulnerability class and distribution of *hotspot* per year from 2009 to 2018. The following are the stages of the analysis of forest and land fire vulnerability classes:

1. Determine the Number of forest and land fire Hazard Classes. After collecting primary and secondary data, the number of karnutla vulnerability classes (KKN) is calculated using the formula according to Purbowaseso (2004):

KKN = 1 + 3,3 *Log* N

Where N = Number of types of land cover types, namely 7 types for land cover types in the form of forests and 15 types for land cover types in the form of non-forest 2. Calculating Score forest and land fire Vulnerability Interval Classes. After obtaining the number of forest and land fire vulnerability classes, we calculate the intervals of each hazard class drawn in the form of scores on the basis of the number of distributions that occur. The following is used to calculate the class interval:

$$\text{Class Interval} = \frac{\text{Number of Highest Score} - \text{Number of Lowest Score}}{\text{Number of Classes}}$$

3. Classifying Hotspots into Fire Hazard Classes. After the number of hazard class and interval scores of each class is known, it is then tabulated by classifying or grouping land cover types into classes the vulnerability in accordance with the total score of the *hotspots* that occur in each type of land cover.

4. Mapping the Fire Hazard Class. Mapping the distribution of *hotspots* annually from 2009 to 2018 in various types of land cover is done using class data based on calculations and analysis with *hazard* GIS software.

3. RESULT & DISCUSSION

A. Hotspots on Forest and Non-Forest Land Cover

Based on the accumulation of distribution of *hotspot* between 10 years from 2009 to 2018 on the development of land cover in Central Kalimantan which has 22 types of land cover where there are 7 types of land cover in the form of forest and 15 types of land cover types in the form of non-forest. A list of distribution of *hotspots* in various land covers is presented in Table 1 below

Table 1: Data Recap of Distribution Hotspot in Various Land Cover 2009-2018

No	Land Cover Type	Hostspot Distribution (Year)										Number
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
	A. Forest Land Cover											
1.	Primary dry land forest	6	4	5	10	10	7	13	-	1	7	63
2.	Secondary dryland forest	2.121	191	1.050	1.076	1.036	1.395	1.895	209	95	337	9.405
3.	Primary mangrove forest	-	-	-	-	-	-	-	-	-	-	-
4.	Secondary mangrove forest	2	-	6	-	-	1	13	-	-	-	22
5.	Primary swamp forest	36	-	1	-	-	2	4	1	-	-	44
6.	Secondary swamp forest	4.464	34	724	535	527	1.879	8.413	50	13	157	16.796
7.	Plantations	71	5	53	80	31	57	240	13	19	29	598
	Number of forest land cover	6.700	234	1.839	1.701	1.604	3.341	10.578	273	128	530	26.928
	B. Non forest land cover											
1.	Shrubs	2.081	194	1.053	1.194	934	2.106	2.288	119	66	221	10.256
2.	Swamp shrub	7.843	68	3.684	3.538	1.294	7.724	19.426	143	118	1.959	45.797
3.	Plantation	747	72	548	597	274	1.308	1.655	50	26	256	5.533
4.	Dry land agriculture	143	18	72	53	49	92	201	37	35	406	1.106
5.	Agricultural land mixed dry	900	126	510	546	398	805	1.429	212	119	432	5.477
6.	Settlement	124	7	69	38	30	82	181	12	8	12	563
7.	Open land	713	13	177	174	97	791	1.098	54	34	248	3.399
8.	Transmigration	70	5	16	13	16	25	20	1	-	-	166
9.	Mining	50	1	22	19	25	52	72	18	12	28	299
10.	Pond	1	-	2	-	-	2	1	-	-	-	6
11.	Rice fields	815	5	447	238	181	663	894	19	3	33	3.298
12.	Body of Water	24	3	27	21	15	23	45	5	3	9	175
13.	Swamp	1.542	18	425	519	161	792	1.792	19	9	81	5.358
14.	Savanna	-	-	-	-	-	3	-	-	-	-	3
15.	Airport/harbor	-	-	-	-	-	-	-	-	-	-	-
	Number of non forest land cover	15.053	530	7.052	6.950	3.474	14.465	29.102	689	433	3.685	81.433
	Total Number	21.753	764	8.891	8.651	5.078	17.806	39.680	962	561	4.215	108.361

According to the recapitulation of distribution data of *hotspots* from 2009 to 2018, the total number of distribution *hotspot* at most on the cover. forest land is secondary swamp forest (Hrs) and secondary dry land forest (Hs) while in non-forest land cover the most concentrated distribution of hotspots is found in swamp shrubs (Br) and shrubs (B).

Figure 1 shows the distribution of hotspots for 10 years from 2009 to 2018 on forest land cover in Central Kalimantan:

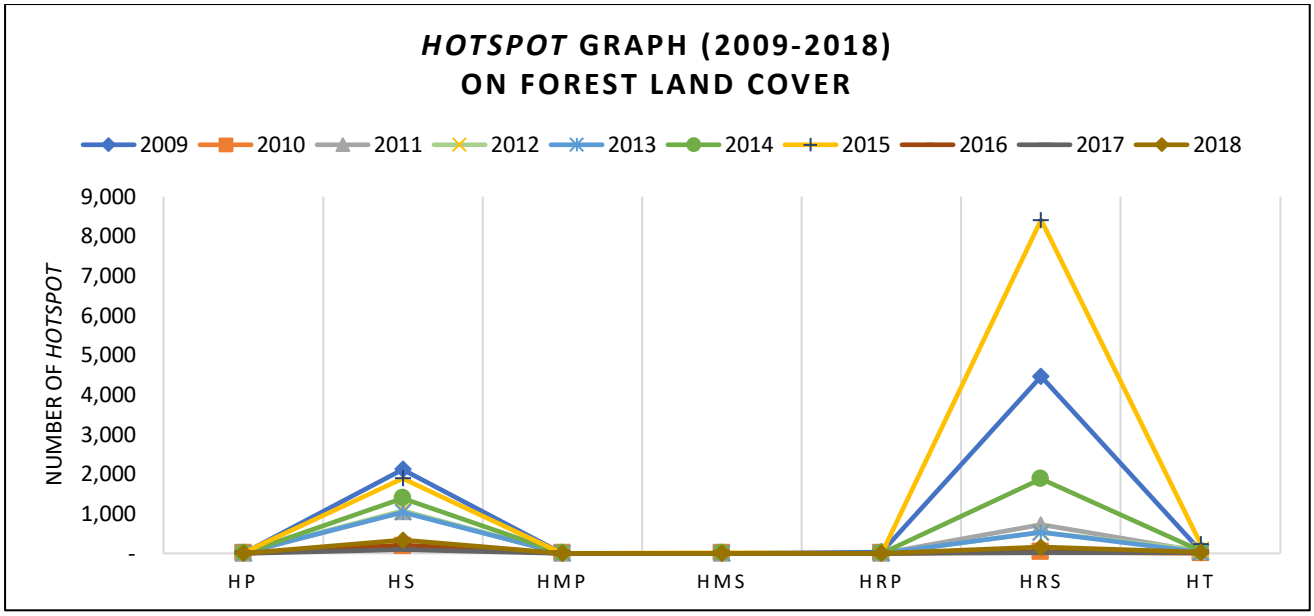

Fig 1. Hotspot Graph (2009-2018) on Forest Land Cover

Table 2. Recap Class Insecurity in Forest Land Cover on 2009-2018

Livelihood Assets	(A) Descriptive Statistics Explanatory Variables	Mean (SD)	(B) Multiple Linear Regression B (Std. Error) [t-value]	Collinearity Statistics VIF Values
	Constant		0.125 (0.080) [1.554]	
Natural Capital	*LSIZE : own land size*	5.3495 (8.0036)	-0.007* (0.004) [-1.697	1.330
Human Capital	*FEDU : farmer's level of education*	5.59 (4.620)	-0.011* (0.006) [-1.741]	1.137
	FPTPN : farmer's level of participation in livestock rearing activities	1.60 (1.826)	0.043*** (0.015) [2.797]	1.061
Physical Capital	*HSIZE : herd size*	5.61 (4.538)	0.019*** (0.006) [2.995]	1.109
Financial Capital	*ICROP : the total (gross) annual income derived from crops*	1.2003 (2.0342)	0.224*** (0.015) [15.334]	1.211
	INONF : the total (gross) annual income derived from nonfarm sources	0.6407 (0.8075)	0.116*** (0.036) [3.242]	1.149
Management	*MGTC : no. of managerial constraints*	1.22 (0.761)	-0.009^{NS} (0.038) [-0.237]	1.138
Dependent Variable	*ILSTOCK: the total (gross) annual income derived from livestock*	0.5353 (0.6809)		

Model Diagnostics	
F-value	*42.105***
R Square	*0.465*
Adjusted R Square	*0.454*
Std. Error of the Estimate	*0.5031*
Durbin Watson	*1.594*

Note: Standard Error is written in ( ) parenthesis and t-stats value is written in [ ] brackets.
*significance at 10% level, **significance at 5% level, and ***significance at 1% level

The results from the graph above show that swamp shrubs (Br), shrubs (B) in the last 10 years have seen distribution of *hotspot* much more than other non-forest land cover. This is due to the extent of the spread of land cover of swamps and shrubs in Central Kalimantan where each reaches 1,998,580 Ha for swamp shrubs (13% of the area of Central Kalimantan) and 1,093,943 Ha for shrubs (7%

of Kalimantan area Middle). Large area of non-forest land cover is also proportional to the distribution of *hotspots* captured by satellite. This may be attriibutable to the many types of organic material that are small and smooth and derived from leaf litter and twigs which denote dry conditions and are therefore, more flammable; similar results are also reached by other researchers (Ardila et al., 2017; Rahman et al., 2019; Sevinc et al., 2020).

Shrubs both on dry land and on wetlands (swamps) are degraded or critical areas that have land cover conditions that are always exposed to sunlight because the vegetation that grows is dominated by low vegetation (succession plants) that do not have canopy. The condition of the vegetation can also, among other reason, occur due to repeated fire incidents over a period of several years at the same location with the result that the growth of high-level plants (trees) is hampered.

Climatic conditions also affect the distribution of *hotspots*. As seen in the graph above, in 2009, 2014 and 2015 the highest number of *hotspots occurred* because in these year the climate event occurred, that is, *EL Nino* namely the phenomenon of sea level warming in the central to eastern Pacific Ocean, in general the impact of *El Nino* is to cause dry conditions and reduced rainfall (Aprilia et al., 2021; Isna, 2018). Low rainfall in September (2014 and 2015) correlated with the high number of *hotspots* during the month and the incidence of forest fires. The same observation has been reported by other researchers (Budiningsih et al., 2020). The effect of this incident is a long drought making it easier the formation of fuel in various land in Central Kalimantan covers in 2015.

In 2015, the largest land and forest fires were estimated to be ± 39,680 $km^{2.}$ The burned land was then continued in 2009 with an area of ± 21,753 km^2 and in 2014 it was ± 17,806 $km^{2.}$ From the data above, it is clear that there has been a shift in the area of forest land cover to non-forest or an increase in the area of non-forest land cover; in this case it could have been triggered due to repeated forest fires over the past decade The distribution *hotspot* in the district / city administration area in Central Kalimantan is mmost concentrated in the Pisau district, Kapuas, Kotawaringin East, and Katingan. It ter call in harmony with districts that have the spread of fire-prone land cover as seen on the distribution map *hotspot*.

B. Forest Fire Vulnerability Based on Land Cover Type

From the results of the calculation of the forest and land fire, we determine the Hazard Class using the Formula Sturges. The Forest Fire Vulnerability Class on forest land cover has 4 levels of categories, namely not prone, less prone, prone, and very vulnerable. Meanwhile, the Forest Fire Vulnerability Class on forest land cover has 5 levels of categories, which are not vulnerable, less vulnerable, vulnerable, very vulnerable, and dangerous. Based on the calculation of Forest Fire Hazard Class for 10 hazard years, a distribution map was obtained hotspot on various land cover and interval class calculation, with the following results:

1. Hazard Class on Forest Land Cover

Data on Hazard class on forest land cover is shown in Table 2 below:

Table 3. Recapitulation of vulnerability classes on non-forest land cover in 2009-2018

Vulnerability Category	Tahun 2009	2010	2011	2012	2013
Not Vulnerable	Hmp, Ht, Hp, Hrp, Hms	Hmp, Hms, Hrp, Hp, Ht, Hrs	Hmp, Hrp, Hms, Hp, Ht	Hmp, Hms, Hrp, Hp, Ht	Hmp, Hms, Hrp, Hp, Ht
Less Vulnerable	Hs	-	-	Hrs	-
Vulnerable	-	-	Hrs	-	Hrs
Very Vulnerable	Hrs	Hs	Hs	Hs	Hs
Vulnerability Category	2014	2015	Tahun 2016	2017	2018
Not Vulnerable	Hmp, Hms, Hrp, Hp, Ht	Hmp, Hrp, Hp, Hms, Ht, Hs	Hmp, Hrp, Hp, Hms, Ht, Hrs	Hmp, Hms, Hrp, Hp, Hrs, Ht	Hmp, Hms, Hrp, Hp, Ht
Less Vulnerable	-	-	-	-	Hrs
Vulnerable	Hs	-	-	-	-
Very Vulnerable	Hrs	Hrs	Hs	Hs	Hs

Description :

Hp	: Primary dry land forest	Hrp	: Primary swamp forest
Hs	: Dry land secondary forest	Hrs	: Secondary swamp forest
Hmp	: Primary mangrove forest	Ht	: Plantation
Hms	: Secondary mangrove forest		

Based on the calculation of the annual forest and land fire vulnerability class using distribution data from 2009 to 2018, it appears that forest land cover that often enters at very vulnerable level for 10 years is secondary dry land forest (Hs), which is 7 times, and secondary swamp forest (Hrs), which is 3 times.

Secondary dry land forest (Hs) and Secondary swamp forest (Hrs) are types of forest cover that often enter at this

very vulnerable level because it is likely that in the secondary forest land cover there are many community activities in managing land or opening new land by burning forests. Besides that, in the secondary forest land cover there are many land accesses in the form of roads and water access in the form of rivers that can facilitate the community to carry out activities and interact directly with the forest. Similar conclusions have also been reported in past research which state that the high fire density around the river is related to people's habits in catching fish around the lebak and dam by burning the vegetation (rasau and pandan) around the lebak and dam (Budiningsih et al., 2020; Harrison et al., 2020; Tata et al., 2018). Whereas the primary forest cover always falls into the category of not vulnerable; this is due to the lack of access, so that community interaction with the forest is lower than in the case of secondary forest.

The category is very vulnerable for the worst fire years, such as in 2009 when the number of hotspots reached 3,551 points up to 4,467 points. In the year of the biggest fires, that is, in 2015, the number of hotspots ranged from 6,312 to 8,415 points. This means that seen from the magnitude of points, it can be illustrated that the area of land burned may affect forest land cover so that in the following year there will be a decrease in area, where in 2009 the total area of secondary dry land forest reached 4,767,836 Ha and decreased the following year ie 4,626,826 Ha. A similar decrease is notedin the case of secondary swamp forest cover in 2009 from 2,114,996 Ha to 2,041,775 Ha. However, for secondary dryland forests it increased in 2015 where 4,503,261 Ha became 4,503,597 Ha in the following year; this increaee could be attributed to the addition of changes in the condition of primary dryland forests that dwindled due to exploitation of secondary dryland forests. 2. Hazard Classes in Non-Forest Land Cover

Based on the calculation of annual forest and land use hazard data using distribution data of hotspots from 2009 to 2018, it appears that non-forest land cover that often enters dangerous levels for 10 years is Shrub Shrubs (Br), that is 8 times, and mixed dryland agriculture (Pc), that is, 2 times. The data pertaining to vulnerability classes on non-forest land cover is depicted in Table 3 below.

Table 3. Recapitulation of vulnerability classes on non-forest land cover in 2009-2018

Vulnerability Category	Years 2009	2010	2011	2012	2013
Not Vulnerable	Tm, Sv, Bdr/Plb, A, Tb, Tr, Pm, Pk, Pt, T, Sw, R, Pc	Tm, Sv, Bdr/Plb, Tb, A, Tr, Sw, Pm, T, Pt, R	Sv, Bdr/Plb, Tm, Tr, A, Tb, Pm, Pt, T, R, Sw, Pc, Pk	Tm, Sv, Bdr/Plb, Tr, A, Tb, Pm, Pt, T, Sw, R, Pc, Pk	Tm, Sv, Bdr/Plb, A, Tr, Tb, Pm, Pt, R, Sw, T
Less Vulnerable	B	Br, Pk	B	B	Pk, Pc
Vulnerable	-	-	-	-	-
Very Vulnerable	-	Pc	-	-	B
Dangerous	Br	B	Br	Br	Br

Vulnerability Category	Years 2014	2015	2016	2017	2018
Not Vulnerable	Bdr/Plb, Tm, Sv, Tr, A, Tb, Pm, Pt, Sw, R, T, Pc, Pk	Sv, Bdr/Plb, Tm, Tr, A, Tb, Pm, Pt, Sw, T, Pc, Pk, R, B	Sv, Bdr/Plb, Tm, Tr, A, Pm, Tb, Sw, R, Pt	Sv, Bdr/Plb, Tm, Tr, Sw, A, Pm, R, Tb	Sv, Bdr/Plb, Tm, Tr, A, Pm, Tb, Sw, R, B, T, Pk
Less Vulnerable	B	-	Pk, T	Pk, T, Pt	Pt, Pc
Vulnerable	-	-	B	B	-
Very Vulnerable	-	-	Br	-	-
Dangerous	Br	Br	Pc	Br, Pc	Br

Information:

B	: Shrubs	Tb	: Mining
Br	: Swamp Bush	Tm	: Pond
Pk	: Plantation	Sw	: Rice Fields
Pt	: Dryland Agriculture	A	: Water body
Pc	: Dryland Agriculture Mixed	R	: Swamp
Pm	: Settlement	Sv	: Savanna
T	: Open Land	Bdr/Plb	: Airport/Port
Tr	: Transmigration		

Swamp shrublands (Br) often fall into the category of hazardous hazard classes. This is because there are many swamps in Central Kalimantan found in peatlands where the management of the land has resulted in the construction of a lot of canals that make the condition of the swamp shrubs on the peatlands worse by reducing water absorption function as well as through long drought conditions so that the swamp shrubs that were originally wet, are nowdry and flammable.

As explained earlier, the hazard class on forest land cover consists of 4 classes where the worst conditions make land cover vulnerable to fire. Hazard class on non-forest land

cover consists of 5 hazard classes, where the worst conditions are categorized as dangerous. To illustrate hazardous categories in the non-forest class, the most extreme numbers are shown in 2015 data where the number of hotspot readings reached 15,544 points up to 19,429 points, then in 2009, for the dangerous category the number of readings of hotspot reached 6,280 points up to 7,849 points and in 2014 the number of readings of hotspot was recorded at 6,184 points up to 7,729 points in the hazardous category and the number of hotspots illustrated, signify that the impact of the fire is quite extensive. Starting from forest and land degradation due to burning land, environmental damage and pollution, damage to forest ecosystems and biodiversity, as well as on air quality pollution due to the heavy smoke causing health problems such as acute respiratory infections (ARI), bronchial asthma, bronchitis, pneumonia, and eye and skin irritations (Harrison et al., 2020; Subekti et al., 2020; Wasis et al., 2018).

Some Central Kalimantan traditional community activities such as shifting cultivation carried out in shrubs also affects forest and land fires, as reported by other researchers of the sonor rice cultivation system (where rice is planted on peatlands which are deliberately burned in the dry season) - allegedly a trigger source of forest and land fires. Likewise, land clearing by forest farmers aims to open new fields or expand their land whereby land preparation is carried out with a system of slash, cut and burn. Shrubs is an area with possible shifting cultivation activities (Ardila et al., 2017; Hurteau et al., 2019; Rahman et al., 2019).

Furthermore, in terms of the distribution and extent of land cover, swamps and shrubs each year show the largest area compared to other types of land cover with data showing the enriched distribution of hotspots in Central Kalimantan.

Other non-forest cover such as Plantation (Pk), Mixed upland agriculture (Pc), Open land (T), Paddy (Sw) and Swamp (R) also have distribution of hotspots although smaller compared to shrubs; this is due to community activities as land cover is controlled from negligence of burning activities in managing land. Likewise, the non-forest land cover in the form of the most developed land, namely Settlement (Pm), Trasmigation (Tr), Mining (Tb), Tambak (Tm), Airport / Port (Bdr / Plb) is non-land cover forest with the distribution of this hotspot being lowest due to community-led efforts to maintain and prevent forest and land fires.

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusions

This study attempts to identify the different types of land cover in Central Kalimantan province that are most vulnerable to forest and land fires. Based on land cover data, Central Kalimantan consists of 22 types of land cover further divided into 7 types of forest cover, resulting in 4 classes of forest and land fires while 15 non-forest cover types produce 5 classes of forest fire vulnerability. The distribution of hotspots during the decade of 2009-2018 which was was mostly on forest land cover was in secondary swamp forest (Hrs) and secondary dry land forest (Hs) while in non-forest land cover, it was mostly in swamp shrubs (Br) and Shrubs (B). Forest fire Hazard Classes often occur on secondary land cover.

4.2 Suggestions

A primary goal of this study was to equip policymakers in the community and local government with fresh data on forest and land fire risk so that they can more effectively prepare for a forest and land fire disaster in the future. In the light of findings of the study, we out forth the following suggestions:

1. Mapping of fores tclasses in various land covers should be carried out annually by stakeholders and land fire hazard in an effort to more effectively formulate and implement forest and land fire control measures as early as possible,. This is because land cover affects the availability of fuel and affects the location of fire spread.
2. The need to increase vigilance as early as possible, especially in the months and years of the occurrence of long drought conditions that greatly affect the occurrence of drought and cause increased fuel availability in the field.
3. In order to prevent forest and land fires from occurring, prevention efforts must be undertaken by installing information boards on the status of forest fire hazard, especially in areas of land cover that are often known as hazardous or highly vulnerable.

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