The Determinant Of Forest Fires In Sumatera Island, Indonesia

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Abstract: Sumatra Island is one of Indonesia's regions which has a high risk of forest fires. Even though many scientists have studied forest fires using various perspectives, little research analyzed the determinants of forest fires quantitatively. This article aims to analyze the influence of village topography (X1), geographical position of villages with forests area (X_2), forest functions (X_3), sources of population income (X_4), resident agricultural commodities (X_5), slush and burn traditions (X_6), residents dependency upon forest area (X_7), cooking fuel for most families (X_8), the number of civil defense (*pertahanan sipil* or *hansip*) or community protection (*perlindungan masyarakat* or *linmas*) office at village level (X_9) against forest fires on Sumatra Island using logistic regression. The research data came from the 2018 Village Potential survey produced by the Central Bureau of Statistic of the Republic of Indonesia. Data analysis focused on three provinces (South Sumatra, Riau and Jambi) which had a high risk of forest fires compared to other provinces on Sumatra Island. The results showed that of the nine independent variables identified as predictors of forest fires, only four independent variables (X_6, X_3, X_5, X_9) significantly affected Y (forest fires incident). The final logistic regression model can explain Y by 5 percent significantly, X^2 (4) = 110.95, p <0.01. All independent variables have a positive relationship with Y and contribute as 202.4% (X_6), 25.2% (X_3), 86% (X_9), and 19.6% (X_5). This article recommends that the government should focus on the effort of forest fire prevention on villages that have slush and burn agriculture practices. The government must allow conditional burning for small farmers and regulate the standardization of management and technology for preventing and combating forest fires for private corporations. This article encourages government and private corporations to strengthen institutions at the village level as an entry point for citizen participation in forest fire prevention.

Index Terms:forest fires, Indonesia, Jambi, Riau, slush-and-burn agriculture, South Sumatera, PODES 2018, transboundary haze, Indonesia.

1 INTRODUCTION

THE phenomenon of forest fires in Indonesia has occurred since 1998. The last forest fires event occurred in 2015 in several provinces on the island of Sumatra and Kalimantan. After this event, the government paid serious attention to the prevention of forest fires in the country. Seriousness and collaboration of many parties, as well as a supportive climate, succeeded in reducing hotspots in Indonesia during 2016 – 2018 period. The forest fires are referred to the event of burning trees in forest areas or land that is difficult to control by humans, so it tends to spread quickly and destructively [1], [2].

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Forest and land in the above definition have two different meanings. First, the term forest refers to an ecosystem unit in the form of a stretch of land containing biological natural resources dominated by trees in the natural community where the environment cannot be separated from one another (Law No. 18/2013 on Prevention and Eradication of Forest Destruction). Second, the term land refers to peatlands. Peatlands are unique ecosystems because they can function as tropical forests and created from the accumulation of imperfect decomposition of various organic materials that occurred 10,000 - 12,000 years ago [3, pp. 95–106], [4, pp. 557–566]. Forest fires are a global public problem because it occurs in many countries, has global and complex impacts, ranging from ecology, human health, the economy, and the global climate [5, pp. 156–163]. Forest fires can threaten the security, health and productive activities of people (for example, the education sector, transportation sector, tourism sector, and trade sector), both in the country of origin and in the neighboring countries. Forest fires release large amounts of CO2 so that it can threaten the atmosphere and trigger global climate change [6, pp. 3–36], [7, pp. 61–65]. Forest fires also destroy biodiversity [8, pp. 49–57], scorch carbon stocks [9, pp. 109–138], and biomass [10, pp. 301–309], and affect soil systems [11, pp. 1–10]. Like other environmental problems, scientists see the phenomenon of forest fires using a variety of perspectives: ecological [12], disaster management [13], international cooperation [14], [15, pp. 65–81], and socio-cultural [16]. Forest fires are a part of natural disasters and human-made disasters. As a natural disaster, forest fires are caused by the El Nino effect that triggers a long drought [17], [18, pp. 98–115]. As an artificial disaster, forest fires are triggered due to various government policies to change the use of land for example, transmigration programs [19, pp. 185–188] and plantation concession permits [20, p. 41] which convert forest areas into monoculture forests [21, pp. 208–219]. The slash and burn agricultural traditions among the population [22, pp. 157–169], and land clearing, both by plantation and mining corporations [23, pp. 447–456], [24, pp. 37–48], could also produce uncontrolled forest fires. Some researchers had explained that the causes of forest fires in Indonesia are very varied, either in the level of farmers, corporate corporations, or district/central governments [25, pp.

55–79], [26, pp. 205–219], [27, pp. 750–752], [28, pp. 13–17], [29, pp. 465–504], [30, pp. 227–233], [31, pp. 1109–1126], [32, pp. 1–13], [33, pp. 1–4], [34, pp. 679–690], [35, pp. 200–217]. However, other than the extreme weather factors, the causes of forest fires originating from humans are still very controversial [36, pp. 1–4], [37, pp. 159–171]. CIFOR [38, pp. 1–4], for example, consider the plantation corporation as the villain of forest fires. However, Varma [37, pp. 159–171] argue that the community is the villain of forest fires because they have slush and burn tradition to agriculture land opening. This research will contribute to this scientific debate by giving special attention to the causes of forest fires originating from the village areas and villagers who also have the potential to influence the occurrence of forest fires. Previous research has shown that topography dramatically influences the resistance of trees to burn [39, pp. 209–216], [40, pp. 446–455], the severity of fires [41, pp. 237–245], [42, pp. 1–33], [43, pp. 62–79], and the potential for a fire [44, pp. 317–324]. Because the topography will affect the type of plant vegetation in the forest area and affect the agricultural activities of the population that uses fire, this study includes village topography variables as a predictor of forest and land fires. In addition to village topography, another variable to consider is the geographical position of the village with the area and function of the forest. In Indonesia, if it is associated with forest areas, villages in Indonesia can be divided into three categories: inside the forest area, at the edge of the forest area, and outside the forest area. The position of villages with forested areas also needs to be included as a predictor of forest fires. Because, as indicated by Cattau et al., [26, pp. 205–219], the majority (68-71%) of forest fires are within a 5-kilometer radius from residential areas. The study of Cattau et al. [26, pp. 205–219] rejects the claim that forest fires originated from oil palm plantation concessions and confirm that the origins of most fires originated from residential settlements. Cattau et al. [26, pp. 205–219] confirm that there is a relationship between the location of residential settlements and plantation corporations with forest fires. The function of the forest area and the dependence of the population on forest areas adjacent to human settlements also need to be considered as independent variables that affect forest and land fires. In general, the function of forests in Indonesia is divided into two categories, namely: conservation forest and production forest. For the Indonesian inhabitant, the forest area is not only a source of the family income but also a source of local tradition. As part of Eastern culture that emphasizes harmonious relations with the environment [45, pp. 273–290], some regions have unique local traditions related to forest areas, for example the concept of prohibited forests on the island of Sumatra [46, pp. 152–173], customary law on the island of Maluku [47, pp. 1079–1122], taboo attitudes in Banten [48, pp. 296–301], Dayak attitudes toward rattan commodities [49, pp. S77–S87], [50, pp. 58–68], *lende ura* philosophy in East Nusa Tenggara [51, pp. 97–110] and the relations of residents around the Lore Lindu National Park, Sulawesi, with *Macaca tonkeana* (a type of orangutan) [52, pp. 235–240]. However, the harmonious relationship between people and the natural environment can be disrupted due to the conversion of the forest area into the production forests managed by the plantation's corporation. As shown by the previous research, large areas of production forests and plantations tend to be more vulnerable to fire because private corporations adopt the method of burning in a phase of land clearing due to economic considerations [25, pp. 55–79], [53, pp. 28–38]. Conversely, villagers only burn a limited amount of agricultural land. The change of land-use also tends to give rise to conflicts between residents and corporations [54, pp. 22–30], [55, pp. 165–176], [56, pp. 1009–1024] which triggers burning [57, pp. 1–4]. This finding confirms the close relationship between land functions and forest fires. In addition to the attributes of rural areas, other variables that influence forest fires are the source of income of the population, agricultural commodities of the villagers, the tradition of slash and burn agriculture, cooking fuel, and the number of *hansip/linmas* officers. These six independent variables are the attributes of the villagers. The sources of income of the population, the agricultural commodities of the villagers, the tradition of slash and burn agriculture, and the dependence of the population on forest areas together illustrate the village's agricultural economy. In South Sumatra, Jambi, and Riau, population agriculture systems rely on non-irrigated or sub-optimal land where productivity is low due to internal factors (for example, parent material, physical, chemical, and biological properties) and external factors (for example, rainfall rain and extreme temperatures). In Indonesia, there are at least five sub-optimal types of land, namely: acid dry land, dry climate land, swampland, tidal swampland, and peatland [58, pp. 47–55]. For the residents of South Sumatra, Riau and Jambi, sub-optimal land is a source of family economics, precisely a place to fishing and grow swamp rice. In South Sumatra and Lampung, swamp rice is called *sonor* rice which does require land burning before seeding [59, pp. 786–799], [60, pp. 65–87]. In Kalimantan, sub-optimal land is also used as a place for fishing, hunting animals, and growing rice in shifting fields using slash and burn techniques [61]. Conversely, the state utilizes sub-optimal land by converting the area into production forest, especially oil palm plantations, which is managed by the private corporation. Because the villagers use fire for land clearing, the potential for fire could be explained using the source of income of the villagers and the primary agricultural commodities they plant in the sub-optimal land. In general, slash and burn agriculture or shifting cultivation systems are very closely related to rice commodities [62, pp. 77–87]. In addition to rice, slash and burn agriculture are also used by the villagers to open new oil palm, rubber plantations and planting annual crops, such as upland rice, corn, watermelons, etc. [22, pp. 37–48]. However, the previous research has not revealed the agricultural commodities which provide the most significant contribution to forest fires incident. Therefore, the study included sources of population income and agricultural commodities produced by villagers as predictors of forest fire events. As mentioned above, researchers tend to agree that slash and burn agriculture in the community contributes to the cause of forest fires in Indonesia. However, how much its contribution is still a big question. This tradition is also related to swidden agriculture or cultivation agriculture [16] or specific farming techniques that are very typical because they apply in certain areas, such as *sonor* rice in South Sumatra and Lampung [59, pp. 786–799], [60, pp. 65–87]. This research also included energy sources for cooking used by the villager's household and the number of *hansip* officers as predictors of forest fires. Energy sources for cooking are additional indicators of population dependence on forest areas. Logically, when most people use firewood for cooking, it is impossible for them to burn the forest and vice versa. Finally, the number of *hansip* officers was included as a predictor to see the readiness of villagers in anticipating forest fires. If a forest fire occurs in a village where there are a small number of *hansip* officers, this indicates the low readiness of the residents in facing potential forest fires and vice versa. This study examined the factors that cause forest fires originating from the villagers and the village area (village topography/X_1, village geographical position with forests/X_2), forest function/X_3, source of villagers income/X_4), agricultural commodities of villagers/X_5, slush and burn agriculture/X_6, dependence of villagers with forest area/X_7, source of cooking fuel/X_8, number of *hansip* officers/X_9) that have not received the attention of forestry researchers in Indonesia. To the best of researchers' knowledge, the focus of forest fires research in Indonesia is more on the issue of impact [63, pp. 293–308], [64, pp. 14875–14885], [65, pp. 28–38], [66, pp. 137–144], [67, pp. 109–129], [5, pp. 156–163], [68, pp. 186–198], [69, pp. 75–85], [7, pp. 61–65], [70, pp. 1098–1103], [71, pp. 1–23] and prevention of forest fires [72, pp. 4–17], [73, pp. 129–134], [74, pp. 21–31].

2 METHODS

This study uses a quantitative approach that seeks the strength of the relationship between independent variables and dependent variables. The cross-section data of the study came from the results of the Village Potential Survey (*Survey Potensi Desa* or *Podes*) conducted by the Central Statistics Bureau (*Badan Pusat Statistik* or *BPS*) in 2018. The Village Potential Survey (Podes) 2018 conducted by the BPS involved all villages in Indonesia, which reached 82,000 villages. Of this total, the number of villages experiencing forest fires reached 4,394 villages spread throughout Indonesia [75]. This study will only analyze Podes 2018 population data from three provinces on the island of Sumatra: South Sumatra, Jambi, Riau. They have the most hotspots in Indonesia during 2014-2016 periods. The total number of villages in these provinces reached 6,677 villages (South Sumatra: 3,239 villages; Jambi: 1,562 villages; Riau: 1,876 village). This study consisted of one dependent variable and nine independent variables. Table 1 illustrates the operationalization of the research variables.

Table 1 Research variable

Dependent variable	**Operational definition**
The incident of forest fires (Y)	1 = yes; 0 = no
Independent variable	
Village topography (X_1)	1 = peak/slope; 2 = valley; 3 = plains
Village geographical position with forests (X_2)	1 = within the forest area; 2 = around the forest area; 3 = outside the forest area
Forest function (X_3)	1 = conservation forest; 2 = protected forest; 3 = production forest
Source of villagers' income (X_4)	1 = agriculture; 2 = mining and quarrying; 3 = manufacturing industry; 4 = wholesale/retail trade and restaurants; 5 = transportation, warehousing and communication; 6 = services. Data recoded into dummy variable (1 = agriculture and 0 = non-agriculture)
Agricultural commodities of villagers (X_5)	1 = rice; 2 = crops; 3 = horticulture; 4 = plantations; 5 = livestock; 6 = capture fisheries; 7 = aquaculture; 8 = forestry; 9 = agricultural services
Slush and burn agriculture practice (X_6)	1 = yes; 0 = no
Dependence of villagers with forest area (X_7)	1 = high; 2 = medium; 3 = low; and 4 = independent
Source of cooking fuel (X_8)	1 = gas; 2 = kerosene; 3 = firewood; 4 = others
Number of *hansip* officers (X_9)	1 = 21 – 40 peoples; 2 = 41-60 peoples; 3 = > 61 peoples

The data is analyzed using the logistic regression which consists of several stages [76], namely: data transformation, partial regression analysis to select variables by the Forward method, multivariate analysis using the logistic regression method, and the goodness of fittest. Researchers use STATA 15 to processing and analyzing data.

3 RESULT

3.1 The Respondent

The respondents of this study were all villages in Jambi, Riau, and South Sumatra that experienced forest fires in their area in 2017. Of the entire villages in these provinces (6,699 villages), only 275 (5%) villages experienced forest fires. The remaining 6,424 villages (95%) did not experience any forest fires. These villages consist of 87.80% rural villages (*desa*) and 12.20% urban villages (*kelurahan*). There are 55.14% of villages that already have legal administrative maps. The remaining 44.86% do not yet have a legal map of village areas. The number of villages bordering the sea reached 4.58% and not bordering the sea reaching 95.42%. The majority (97.70%) of the village already has a Village Representative Body (*Badan Perwakilan Desa* or BPD for the rural village; *Lembaga Musyawarah Kelurahan* or LMK for the urban village). Only 2.40% of villages have no BPD/LMK. The number of BPD/LMK members is quite varied. The dominant are villages that have five members (38.27%), seven people (25.71%), and nine people (16%). However, there is 2.30 percent of villages that do not have BPD/LMK members. The existence of the BPD/LMK indicates that village government institutions are operating fit with the principle of checks and balances. Most of the sample villages already have representative village offices (88.74%). There are only 11.26% of villages that do not have village offices. The village office has a village asset status (72.25%), not a village asset (16.49%), and the undefined status (11.26%). The village office is in decent condition (78.62%) to be the center of village government activities, and the rest (10.12%) is the opposite. Even though the village head's office is available, most village governments in South Sumatra continue to carry out government activities at the village head's house (84.59%). In contrast, the village head's office has functioned as a place to carry out government activities in Jambi (26.17%) and Riau (34.42%). This situation indicates that the process of village governance mostly takes place informally without going through a complicated bureaucratic process.

3.2 Bivariate analysis

Of the nine independent variables identified as predictors of forest fires in South Sumatra, Jambi and Bengkulu, only eight variables passed through the multivariate analysis stage with binary logistic regression. Six variables passed to the multivariate analysis stage because they did have a significant relationship with Y. Two variables passed to the multivariate analysis stage because of $p < 0.25$. Only one variable did not qualify for the analysis stage because it did not have a statistical relationship with Y and the value of $p > 0.25$. Table 2 shows the results of bivariate analysis which has been sorted by the size of X^2 score. The arrangement of the independent variables in Table 2 is the basis for researchers to enter the independent variables in sequence to the logistic regression.

Table 2 Summary of bivariate analysis

No.	Independent variable	X^2	*df*	*p*	*ϕ*
1.	Slush and burn agriculture practice (X_6)	95.25	1	0.01	-0.12
2.	Forest function (X_3)	29.97	3	0.01	0.07
3.	Dependence of villagers with forest area (X_7)	27.89	4	0.01	0.06
4.	Village geographical position with forests (X_2)	25.96	2	0.01	0.06
5.	Source of cooking fuel (X_8)	17.13	3	0.01	0.05
6.	Agricultural commodities of villagers (X_5)	11.89	5	0.03	0.04
7.	Number of *hansip* officers (X_9)	7.58	3	0.05	0.03
8.	Source of villagers' income (X_4)	3.48	1	0.06	-0.02
9.	Village topography (X_1)	0.40	2	0.82	0.01

3.3 Multivariate analysis

The logistic regression process at the variable level or without involving the categories of the independent variables from stage 1 to stage 8 can be simplified into Table 3. The final logistic regression model produced in this study can explain Y by 5 percent significantly, X^2 (4) = 110.95, p <0.01. At the variable level, the significant independent variables at the level of p <0.01 are X_6, X_3, and X_9 with contributions of 202.4%, 25.2%, and 86%, respectively. Only X_5 was significant at the level of p <0.1 with a contribution of 19.6%. All these variables have a positive relationship with Y. At the level of the category of independent variables, only the categories at X_6 and X_3 are significant at the level of p <0.01. The category of X9 variable is only significant at the level of p < 0.05 and p <0.1. It means that the risk for forest fires will be more likely in villages that have the slash and burn agriculture, adjacent to production forest areas, and having '21-40 people' and '> 61 people' *hansip* officers.

Table 3 The final model of logistic regression

Independent variables	The incident of the forest fires (Y)	
	Category level	Variable level
Slush and burn agriculture practice (X_6)		
Yes	1.130***	
	(-0.127)	
Forest function (X_3)		
Forest Conservations	0.431	
	(-0.404)	
Protected forest	0.262	
	(-0.272)	
Production forest	0.725***	
	(-0.179)	
Agricultural commodities of villagers (X_5)		
Agriculture	-0.278	
	(-0.294)	
Plantation	0.114	
	(-0.258)	
Fishery	0.603	
	(-0.498)	
Number of *hansip* officers (X_9)		
21-40 people	0.623*	
	(-0.339)	
41-60 people	1.13	
	(-1.063)	
>61 people	1.709**	
	(-0.812)	
Slush and burn agriculture practice (X_6)		1.106***
		(-0.126)
Forest function (X_3)		0.225***
		(-0.0565)
Agricultural commodities of villagers (X_5)		0.179*
		(-0.0955)
Number of *hansip* officers (X_9)		0.621***
		(-0.197)
Constant	-3.759***	-4.813***
	(-0.245)	(-0.352)
Observations	6,689	6,699

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4 Discussion

The research findings state that slash and burn agriculture practice has a positive relationship and contributes 202.4% to the incidence of the forest fires. Villages that maintain this practice are likely to trigger forest fires as much as 202.4%. Conversely, villages that do not have this practice will reduce the opportunities by 202.4% for the occurrence of forest fires. This finding does not explicitly state that slash and burn agriculture practice at the community level is one of the causes of forest fires, because the causes of forest fires are very complex. However, the contribution of slash and burn agriculture practiced by 202.4% to the event of forest fire became a new evidence to support the arguments of previous researchers who considered slash-and-burn agriculture as one of the causes of forest fires [77, pp. 75–100], [65, pp. 913–919], [59, pp. 786–799], [22, pp. 157–169], [71, pp. 1–23], [36, pp. 1–4]. Because the odds of forest fire are higher in the villages that have the slash and burn agriculture practice, various policy interventions (for example, land burning arrangements, farmer empowerment, prevention forest fires, disaster preparedness training, etc.) must be focused on these villages. However, what happened today is that the Provincial Government of South Sumatra, the Provincial Government of Jambi, and the Provincial Government of Riau tended to provide the same treatment to all villages. For example, the Regional Regulation of the Jambi Province Number 2 of 2016 concerning Prevention and Control of Forest and Land Fires explicitly states that "every person and legal entity is prohibited from clearing forests and land by burning" (Article 5 Paragraph 1). The same provisions can also be found in the Regional Regulation of the South Sumatra Province Number 8 of 2016 concerning Forest/Land Fire Control, particularly Article 3 Paragraph 1, state that "every person or legal entity is prohibited from burning forests and land area." As a result, the attention of the government becomes unfocused because it must pay attention to all existing villages. Statistically, as the results of this study show, each village has a different contribution to the likelihood of forest fires. Since the highest chance of a forest fire is only owned by villages that have the slash and burn agriculture practice, the government's priority should be directed to these villages. As mentioned above, there are only 1,816 villages under this category and spread across South Sumatra (1,059 villages or 32% of the total villages in South Sumatra), Jambi (379 villages or 24.26% of the total villages in Jambi) and Riau (378 villages or 20.16 of the total villages in Riau). The government should continue to allow land clearing by burning as long as the climate and weather continue to support [36, pp. 1–4], and pay attention to the area of land to be burned and institutional mechanisms at the community level to manage the burning process. For example, several villages in Province South Sumatra still refers to the procedure set out in *Kitab Simbur Cahya* as the source of customary law, when using fires for land clearing. Furthermore, the 2018 Village Potential survey classifies three functions of forest area (X_3): conservation forest, protected forest, and production forest. By ignoring these categories, the forest function has a positive relationship and contributes 25.2% to Y. It suggests that villages adjacent to protected forest areas, conservation forests, and production forests have a 25.2% chance of the occurrence of forest fire. However, if analyzed at the category level, only production forest areas contribute significantly to Y by 106.4%. It implies that villages bordering with the production forest area have a 106.4% chance for the occurrence of forest fires. Of the 275 villages that experienced forest fires in 2017, 7 villages (2.55%) bordered the conservation forest, 16 villages (5.82%) bordered the protected forest, and 43 villages (15.64%) bordered the production forest. This data indicates that villages bordering production forest areas have more frequency of forest events compared to villages bordering conservation forest areas and protected forests. Although the area around the production forest area is more vulnerable to forest fires, this finding cannot be used as a basis to generalize that the perpetrators of forest fires are corporations. Because it is more vulnerable, it is very natural that many forest fires happened in the production forest. This research has no further data to support or reject the arguments of some researchers who state that the corporation is the perpetrator of forest burning because land clearing activities that adopt burning techniques [27, pp. 750–752], [5, pp. 156–163], [78, pp. 429–441], [37, pp. 159–171]. Because villages adjacent to production forest concessions are vulnerable to burning, efforts to prevent and combat forest fires must be prioritized in this area. Owners of production forest concession licenses must work with local communities to prevent and combat forest fires in their areas. Concession permit holders must also provide modern forest fire prevention and control equipment. The central government and regional governments must release regulations regarding minimum standards of management and technology for preventing forest fire prevention for private corporations that manage production forest areas. Meanwhile, the agricultural commodities of villagers (X_5) are only significant at the level of p <0.1 and has a positive relationship and contribute as much as 19.6% to the incidence of forest fires (Y). At the category level, only the agricultural, plantation and fisheries commodity categories each contributed -24.3, 12 and 82.8% to Y. However, this contribution was not statistically significant (see Table 3). This data confirms that whatever the main commodity of villagers, the opportunity to trigger forest fires is 19.6%. This data criticizes the previous research that argues that forest fires are caused by slush-and-burn agriculture at the community level [77, pp. 1–4], [65, pp. 28–38], [59, pp. 786–799], [22, pp. 157–169], [71, pp. 1–23], [33, pp. 55–66]. However, these findings are not statistically convincing because the significance is only at p <0.1. Conversely, the contribution of slush and burn agriculture practice is significance at p <0.01. It indicates that the odds of a forest fire event do not depend on the main commodity produced by the villagers. Agricultural villages, plantation villages or fishing villages have the same opportunities for forest fires. The practical implication is that efforts to prevent forest fire are irrelevant if they are based on the division of villages based on the main commodity types produced by the population. Finally, the number of *hansip* officers has a positive relationship and can explain Y by 86% (see Table 3). At the category level, villages that have 21 - 40 *hansip* officers contribute 86.4% (0.066, p <0.1) and villages with > 60 *hansip* officers contribute as much as 452.4% (0.035, p <0.05). This data does not mean that the greater the number of *hansip* officers at the village level will increase the odds of forest fires. On the contrary, the relation between '> 60 *hansip* officers' category and Y is the impact of strengthening community groups conducted by the government and private corporations in the context of preventing and controlling forest fires since 2015. For example, Fire-free and Prosperous Village (*Desa Makmur Peduli Api* or DMPA) by Asia Pulp & Paper Sinar Mas, Fire Concerned Community (*Masyarakat Peduli Api* or MPA) by Ministry of Environment and Forestry, Disaster Resilient Village (*Desa Tangguh Bencana* or Destana) by National Disaster Management Agency. Because the 2018 Village Potential data was collected in 2017, all villages that experienced forest fires already had *hansip* officers of > 60 people as integrated into the DMPA, the MPA, or the Destana. This finding shows that the efforts of government and private corporations to strengthen community institutions in preventing and combat forest fires are in the right location/village. The question is, what about the sustainability of these programs? Will the financing still be submitted to the state budget, regional budget, regional budget, and CSR funds of private corporations (plantations and industrial plantations)? The answer to this question is beyond the context of this study. However, an important message from the findings of this study is that conditioning the villagers to be better prepared, and their participation in the prevention and control of forest fires is a non-negotiable policy choice.

5 CONCLUSION

In 2017, from a total of 6,699 villages sample, 275 villages (4.11%) experienced forest fires and spread in South Sumatra Province (72 villages or 2.21%), Riau Province (165 villages or 8.80%), and Jambi Province (38 villages or 2.43%). This study produces the final model of logistic regression contains four independent variables (slush and burn agriculture practice/X_6, forest functions/ X_3, agricultural commodity of villagers/X_5, number of *hansip* officers/X_9) and can explain the odds of forest fires incident (Y) by 5 percent significantly, X^2 (4) = 110.95, p <0.01. The slush and burn agriculture practice (X_6), forest functions (X3), and the number of *hansip* officers (X_9) contribute significantly at p < 0.01 level as much as 202.4%, 25.2%, and 86% respectively. Only the agricultural commodity of villager (X_5) is significant at the level of p <0.1 with a contribution of 19.6%. The final model can be formulated as follows: the forest fires incident (Y) = -4.8134 + X_3_forest_function * 0.1787 +

X_5_the_agricultural_commodity_of_villager * 0.1787 + X_6_slush_and_burn_agriculture practice * 1.1065 + X_9_number_of_hansip_officers * 0.6206. Independent variables that do not affect Y are the village topography (X_1), the geographical position of the village with the forest (X_2), the source of villagers' income (X_4), and source of cooking fuel (X_8), the dependence of the villagers with the forest area (X_7). The practical implications of this finding are: *first*, the efforts to prevent and combat forest fires must be focused on villages that have slush and burn agriculture practice because the odds of forest fires are very high in these villages. *Second*, the government must revise local regulations that prohibit people/business entities from burning land for any reason. Burning as a land clearing technique must still be permitted for small farmers if it is supported by weather and controlled. *Third*, the government must immediately issue technical regulations related to management standards and technology for preventing forest fires for a plantation corporation that holding production forest concession licenses. *Fourth*, the government and private corporations must continue to strengthen community institutions in the effort to prevent and deal with forest fires that are already in the right location/village. Because this study is only able to explain the incidence of forest fires (Y) by 5 percent significantly, X^2 (4) = 110.95, p <0.01, it is necessary to add an independent variable to improve the ability of the logistic regression model to explain and predict the occurrence of forest fires. From a methodological perspective, logistic regression techniques have a fundamental weakness, which is not able to show statistical interactions between independent variables. Therefore, the effect of eight independent variables in this study on the occurrence of forest fires can be re-tested with generalized structural equation modeling (GSEM) techniques that allow researchers to see statistical interactions between independent variables. In terms of data sources, this study uses 2018 Village Potential Data (PODES) which uses a territorial approach. The PODES data do not have several variables at the household level that might contribute to forest fires. Therefore, in the future, PODES data need to be combined with SUSENAS data, specifically the National Resilience Module, which have data at the household level. Integrated PODES and SUSENAS data can be analyzed with multilevel analysis techniques. Another raw data source is the Indonesian Family Life Survey (IFLS) data produced by Rand Corporation, United States. IFLS has been carried out five times (1992 - 2014) and allows researchers to apply the longitudinal data research method or panel data.

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