



Distribution of Hotspots and Forest and Land Fire Control Efforts

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Article Info

Article history:

Received 18 October 2024

Received in revised form 3 December 2024

Accepted 30 December 2024

Keywords:

Forest Fires

Land Fires

Hotspots

Control Efforts

Prevention Efforts

Abstract

Forest fires are a common ecosystem disturbance globally and have a significant impact on the environment and human life. Ecologically, fires result in decreased land productivity, loss of forest economic value, and threats to biodiversity. The study was conducted quantitatively and qualitatively with secondary and primary data. The data shows fluctuations in the number of hotspots and the area of burned land from 2019 to 2024. Major fires occurred in 2019 and 2023, while a significant decline was seen in 2020 and 2024. This decline reflects the effectiveness of fire mitigation involving the government and the community. Efforts that have been made to reduce the risk of forest and land fires in OKI Regency include peatland rewetting, community education, peatland-based economic empowerment, joint patrols, and the active role of the Fire Aware Community (MAPI) group. The use of satellite-based monitoring technology is also an important step in fire monitoring and mitigation. Preventing forest and land fires in the future requires a comprehensive and sustainable approach, including law enforcement against illegal land burning, increasing patrols, and strengthening community education. Collaboration between stakeholders such as BPBD, local governments, communities, and the private sector is very important to maintain the stability of forest and land fire reduction in the OKI region.

Introduction

Forest fires are a common ecosystem disturbance globally and have significant impacts on the environment and human life (Lecina-Diaz et al., 2023; D'Evelyn et al., 2022). This phenomenon can occur naturally or as a result of human activities (Chechin & Nedikova, 2020; Budiningsih, 2017). In tropical regions such as Indonesia, forest fires are becoming an increasingly prominent mechanism for land clearing (Edwards et al., 2020). Prolonged dry seasons exacerbate the risk of fires because they cause land conditions to become drier and more flammable (Collins et al., 2022; Littell et al., 2016). Peatland fires are at higher risk due to their high organic matter content, which can trigger fires when temperatures rise (Shofiyati & Kuncoro, 2007).

Indonesia, as an archipelagic country consisting of more than 17,508 islands (Wijoyo & Prihatiningtyas, 2019), has faced repeated major fires throughout its history. The major fires in East Kalimantan in 1982/1983 were reported to have burned around 3.5 million hectares of

forest (Rasyid, 2014), while the fires in 1997/1998 affected around 11.7 million hectares of forest area. The fires during 2014–2015 caused damage to more than 2.6 million hectares of forest. The impact of these fires was not only felt domestically, but also spread internationally with the emergence of transboundary haze (Aiken, 2004; Bellard et al., 2012; Parmesan, 2006; Wulandari et al., 2022).

Forest and land fires that occur in Indonesia are almost entirely caused by human activities, either due to negligence or intention (Suhardono et al., 2024). Activities such as land conversion, land clearing for agriculture, and land preparation are the main factors of fires (Budinarsih, 2017). Although fires on mineral land are wider (67%) than peat (33%) (KLHK, 2021), the impact of peatland degradation is much more serious (Kospa & Praja, 2023). These fires pose a threat to various aspects of people's lives, including health, education, economy, as well as disruption of mobility and transportation (Faradiba, 2024). Ecologically, fires result in decreased land productivity, loss of forest economic value, and threats to biodiversity (Shlisky et al., 2007).

Methods

The research was conducted in Ogan Komering Ilir (OKI) Regency, South Sumatra Province, which has a peat ecosystem that is vulnerable to forest and land fires. The focus of the research includes areas with high fire potential identified from hotspot data. Mapping was carried out to determine the distribution and pattern of fire incidents in the research area. The mapping steps are: a) Using satellite imagery from monitoring platforms such as MODIS and VIIRS (Xiong et al., 2020); b) Processing spatial data using GIS software to visualize the distribution of hotspot points by year and location (Afolayan et al., 2022); c) Identification of priority mitigation areas based on the severity and area affected by the fire (Sakti et al., 2022). Secondary data collection was carried out with the following sources: a) Hotspot data from LAPAN and the forest and land fire monitoring site (sipongi.menlhk.go.id); b) Rainfall and soil moisture data from BMKG; c) Historical data on the area of burned land from the Forestry Service and the Regional Disaster Management Agency (BPBD).

Qualitative Research Design

The appropriate research design to explain the results of this study is a triangulation qualitative descriptive design. This design is used to describe and analyze the phenomenon of peatland management and forest fire mitigation efforts in OKI Regency. This approach allows for in-depth exploration of the roles of the government, community groups, and related parties in maintaining peatlands and preventing forest fires.

Key informants include the Peat Restoration Agency (BRG), BPBD South Sumatra, and Manggala Agni related to peatland management and handling forest and land fires. The Sirah Pulau Padang Police and SP Padang play a role in law enforcement. Community groups such as the Fire Awareness Community (MAPI) and local farmers provide perspectives on economic empowerment and fire prevention. Experts, environmental researchers, and industry representatives are also important in evaluating the program and its impacts.

Quantitative Research Design

This study uses a descriptive quantitative method with a survey as the main data collection technique to determine the level of community preparedness for disasters. The study population is people living in disaster-prone areas, with a sample of 377 respondents selected using the Slovin formula with a margin of error of 5%. The sampling technique used is stratified random sampling to ensure representation from various strata of areas with different disaster risks. Data

were collected through a structured questionnaire covering aspects of disaster risk knowledge, evacuation planning, availability of emergency equipment, and experience of participating in disaster-related training or outreach. In addition, short interviews were conducted to clarify the survey findings. The collected data were analyzed quantitatively using descriptive statistics, which showed that 79% of respondents were in the "Ready" category, while the other 21% were in the "Not Ready" category. These results provide important insights for improving policies and programs to improve community preparedness for disasters.

Results and Discussion

Forest and land fires overview

OKI Regency is one of the areas in South Sumatra that has a large peatland and forest ecosystem, making it vulnerable to forest and land fires, especially during the dry season. Factors such as dry peatland conditions, accessibility, and human activities play a significant role in increasing the number of hotspots (Imron et al., 2022). Studies in Riau Province show that land clearing and canals can make peatlands more susceptible to fires, especially during the long dry season (Shlisky et al., 2007).

Fluctuations in the number of hotspots throughout the year can be influenced by climate variability, such as the El Niño phenomenon which causes a longer and more intense dry season, increasing the risk of forest and land fires (Aflahah et al., 2019). In addition, human activities such as land clearing for agriculture and plantations also contribute to the increase in the number of hotspots, especially in months with low rainfall. Implementation of effective forest and land fire management policies is crucial to reduce the number of hotspots and the negative impacts they cause (Saharjo & Velicia, 2018).

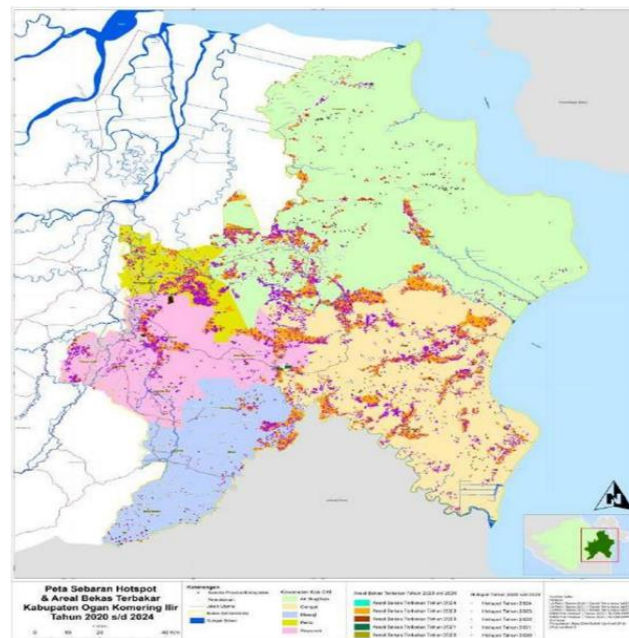


Figure 1. Distribution of Hotspots and Burned Areas in Ogan Komering Ilir (OKI) Regency from 2020 to 2024

Table 1. Hotspot Data in Ogan Komering Ilir (OKI) Regency from 2020 to 2024

Years	Subdistrict	Month Period												Total Hotspot
		1	2	3	4	5	6	7	8	9	10	11	12	
2020	Air Sugihan	3	5	12	9	4	7	1	12	2	6	4	0	65
	Cengal	2	2	0	0	0	0	0	6	3	2	7	0	22

	Jejawi	2	0	0	0	0	0	0	3	0	0	0	0	5
	Kayu Agung	3	4	33	13	5	0	1	1	1	2	1	1	65
	Lempuing	0	0	2	1	0	0	0	0	0	0	0	0	3
	Lempuing Jaya	1	2	2	2	0	2	1	2	0	5	3	0	20
	Mesuji	1	0	2	0	0	2	2	0	0	0	0	0	7
	Mesuji Makmur	2	0	1	5	0	2	0	4	5	1	4	0	24
	Mesuji Raya	0	2	5	0	0	0	0	7	1	0	0	0	15
	Pampangan	1	0	1	0	0	0		0	0	0	0	0	2
	Pangkalan Lampam	1	1	5	8	2	0	2	5	2	0	3	0	29
	Pedamaran	32	0	0	2	0	2	1	1	0	0	0	0	38
	Pedamaran Timur	1	3	6	0	0	1	4	1	2	0	0	0	18
	Sirah Pulau Padang	0	0	2	0	0	0	0	0	0	0	0	0	2
	Sungai Menang	1	2	1	0	0	2	5	13	8	3	3	0	38
	Tanjung Lubuk	10	0	0	2	0	1	0	5	0	0	0	0	18
	Teluk Gelam	2	0	0	1	0	0	0	1	0	0	0	0	4
	Tulung Selapan	11	7	24	30	6	1	5	3	2	7	8	0	104
	Total Hotspot	73	28	96	73	17	20	22	64	26	26	33	1	479
2021	Air Sugihan	0	1	1	4	6	3	10	13	3	2	0	1	44
	Cengal	2	2	1	2	6	2	20	17	8	16	3	0	79
	Jejawi	0	0	0	0	0	0	3	0	5	2	0	0	10
	Kayu Agung	0	0	3	0	1	1	1	0	3	0	0	0	9
	Lempuing	0	1	0	0	0	0	0	0	0	0	0	0	1
	Lempuing Jaya	0	0	0	0	0	2	1	1	0	8	0	0	12
	Mesuji	1	1	0	2	0	1	4	1	3	1	1	0	15
	Mesuji Makmur	0	1	0	0	3	1	5	3	3	3	0	0	19
	Mesuji Raya	0	0	1	0	0	0	0	8	2	1	1	0	13
	Pampangan	0	0	0	0	1	0	7	0	1	0	1	1	11
	Pangkalan Lampam	0	0	2	1	1	4	5	2	1	1	0	2	19
	Pedamaran	0	0	0	1	0	0	0	1	18	1	1	0	22
	Pedamaran Timur	0	0	0	0	0	0	4	0	0	4	1	0	9
	Sirah Pulau Padang	0	0	0	0	0	0	0	0	0	1	0	0	1
	Sungai Menang	0	0	0	1	1	5	27	9	17	5	0	5	70
	Tanjung Lubuk	0	0	0	0	1	0	3	0	2	1	0	0	7
	Teluk Gelam	0	0	0	0	0	0	0	0	1	0	0	0	1
Tulung Selapan	2	0	10	28	23	14	38	16	7	9	0	0	147	
	Total Hotspot	5	6	18	39	43	33	128	71	74	55	8	9	489
2022	Air Sugihan	2	1	4	1	0	2	5	4	3	0	0	0	22
	Cengal	0	5	1	0	2	3	0	2	9	1	0	0	23
	Jejawi	0	0	0	0	1	1	1	2	0	0	0	0	5
	Kayu Agung	1	0	0	0	0	0	0	0	0	0	0	0	1
	Lempuing Jaya	0	0	0	1	0	0	0	0	0	0	0	0	1
	Mesuji	0	0	1	1	0	1	1	1	0	0	1	0	6
	Mesuji Makmur	0	0	0	1	0	0	3	1	1	1	0	0	7
	Mesuji Raya	0	0	0	3	0	0	0	0	0	0	0	0	3
	Pampangan	0	0	0	0	0	2	0	0	0	1	0	0	3
	Pangkalan Lampam	0	0	1	1	5	1	1	3	0	0	0	1	13
	Pedamaran	0	0	0	0	2	0	0	1	0	0	0	1	4
	Pedamaran Timur	0	0	0	0	3	0	0	0	0	0	0	0	3
	Sungai Menang	1	4	0	2	2	0	3	5	11	0	0	0	28
Tanjung Lubuk	0	0	0	0	0	0	2	0	1	0	0	0	3	
Tulung Selapan	2	2	2	6	1	1	3	0	3	1	1	0	22	
	Total Hotspot	6	12	9	16	16	11	19	19	28	4	2	2	144

Forest and land fire hotspot data in South Sumatra shows significant fluctuations between 2020 and 2024. In 2020, 479 hotspots were detected with peaks in March and August, which correlated with the dry season. In 2021, there was a slight increase to 489 hotspots, with a peak in July. A drastic decrease occurred in 2022 with only 144 hotspots, indicating an improvement in conditions or better fire management. However, conditions worsened in 2023 with a total of 10,257 hotspots, especially in September and October. Until October 2024, the number of hotspots decreased significantly again to 349 points, with peaks in September and October.

Sub-districts such as Cengal, Tulung Selapan, and Sungai Menang consistently show a high number of hotspots, indicating vulnerabilities that need to be addressed with priority. Prevention efforts through routine patrols, community education, and technology-based monitoring are important steps that need to be taken. In addition, law enforcement against illegal land burning and sustainable peatland management are also important strategies in mitigating forest and land fires.

These fluctuations are influenced by several factors, including climate conditions such as the El Niño phenomenon which causes a longer and more intense dry season, which increases the risk of forest and land fires (Zaskia et al., 2023). In addition, human activities such as land clearing for agriculture and plantations also contribute significantly to the increase in the number of hotspots, especially in months with low rainfall (Wahyuti & Yeny, 2021). The implementation of effective forest and land fire management policies is crucial to reducing the number of hotspots and the negative impacts they cause (Budiningsih et al., 2022).

The dominance of brown and pink on the map showing production forest areas emphasizes the importance of the forestry sector in supporting national timber needs. Production forests have a primary function as areas that can be used sustainably for the production of timber and non-timber forest products, but still considering sustainability aspects (Senoaji, 2019). On the other hand, the more limited area of protected forest areas, nature reserves, and forest areas with special functions highlights the need for improved conservation policies to maintain ecosystem balance and biodiversity (Jainuddin, 2023).

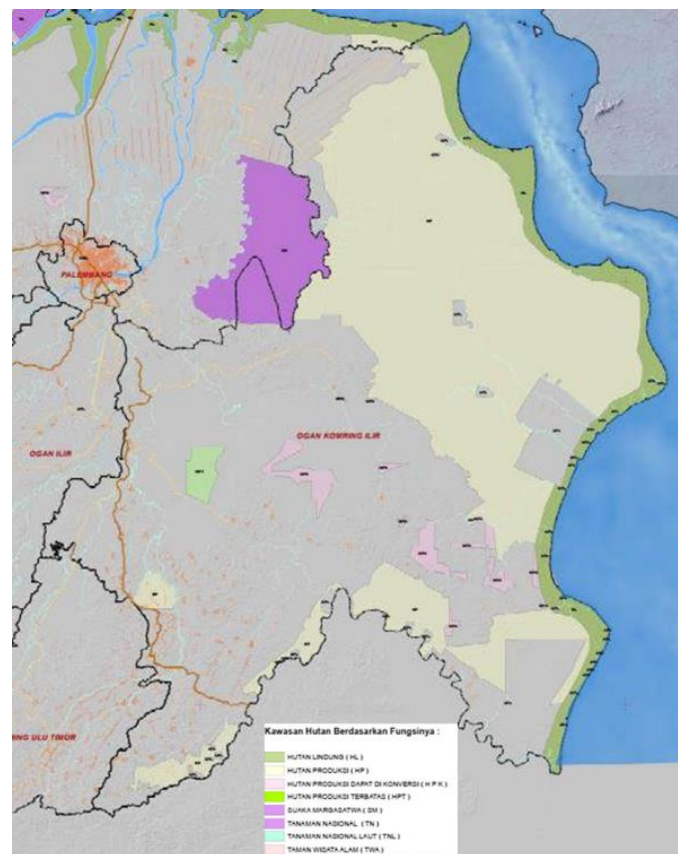


Figure 2. Map of Forest Areas Based on Their Function in Ogan Komering Ilir Regency

The area of fires in Ogan Komering Ilir Regency which showed fluctuations from 2019 to 2024 reflects the dynamics of land fires influenced by weather conditions and human activities (Saharjo et al., 2018). The major fire in 2019 with an area reaching 194,824.5 hectares can be

associated with the long dry season and high land clearing activities which are often carried out using the burning method (Budinarsih, 2017). This condition is in line with the report that 2019 was one of the years with an extreme dry season in Indonesia, which increased the risk of land fires (Trinirmalaningrum et al., 2015).

Table 2. Area of Fires in Ogan Komering Ilir Regency 2019-2024

Years	Mineral	Gambut	Total
2019	103.159,3	91.665,2	194.824,5
2020	53,9	515,0	568,9
2021	786,1	248,4	1.034,6
2022	219,4	27,6	247,0
2023	39.566,0	40.459,9	80.026,0
2024	1.962,7	571,1	2.533,9

The drastic decrease in fires in 2020 to only 568.9 hectares indicates the success of fire mitigation efforts carried out by the government and the community, such as increasing patrols and fire prevention education (Kospa & Praja, 2023). This is in line with research stating that community-based approaches and technology-based monitoring can significantly reduce fire incidents.

The increase again in 2021 with a fire area of 1,034.6 hectares shows that challenges in controlling fires still exist, especially in mineral lands that tend to burn faster during the dry season (Rasyid, 2014). The decrease in the fire area in 2022 to 247.0 hectares indicates the continued success of consistent mitigation efforts.

However, fires increased significantly again in 2023 with a total of 80,026.0 hectares burned, indicating that weather factors and possible relaxation of policy enforcement could trigger large fires. Fires on peat and mineral lands that are almost balanced indicate the need for different approaches in fire mitigation on both types of land (Shofiyati & Kuncoro, 2007). The decline again in 2024 to 2,533.9 hectares shows the positive impact of more intensive fire mitigation efforts. Efforts to strengthen policies, increase patrols, and utilize satellite-based monitoring technology are still needed to maintain the stability of the reduction in the area of fires in the future.

Efforts that have been made

Integrated Forest and Land Fire Control Operating System (SONGKET)

The Songket application is one of the technological innovations developed to help manage forest and land fires in Indonesia, especially in vulnerable areas such as South Sumatra. For the police, this application is not only a supporting tool in detecting and preventing fires, but also an important means of maintaining public security and order in areas prone to forest and land fires. The role of the police in controlling forest and land fires includes preventive measures, coordination with other stakeholders, law enforcement, and supervision of fire-prone areas that are often caused by human activities.

The Songket application supports the police in carrying out their responsibilities in several aspects, namely: Songket allows real-time monitoring of hotspots through satellite data that is updated regularly. This information is very useful for the police to know potential locations for fires so that they can anticipate potential disturbances to public order and security before the fire spreads. In this case, the police can immediately coordinate with related agencies to prepare preventive measures or even evacuate residents if the situation worsens. Thus, the Songket

application provides much-needed support in maintaining public security and preventing escalation of conflicts that may arise due to the impact of forest and land fires, such as health problems, property damage, and potential social conflict due to haze.

This application also supports law enforcement, especially in cases of deliberate land burning. One of the biggest challenges in dealing with forest and land fires is the practice of land burning by individuals who aim to open agricultural land cheaply.

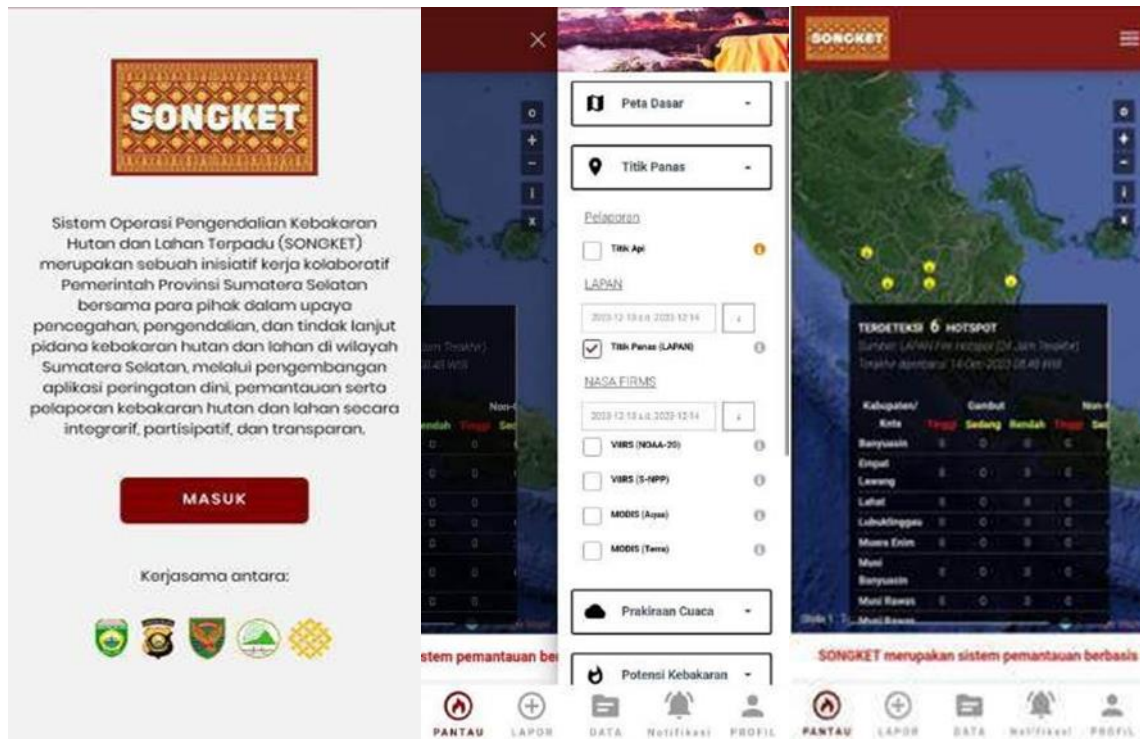


Figure 3. Songket application

Rewetting or keeping peat wet

Structural mitigation focuses on the rewetting stage or keeping peat wet, which leads to the development of a water management system with the main objective of maintaining the groundwater level in its original condition, namely water inundating peatlands. Water treatment in the research area has been carried out by the Peat Restoration Agency (BRG) by building gutters that function as water retainers so that the groundwater level does not drop.

Dissemination of information to the public

Dissemination of information to the public is an important part of efforts to increase public awareness and role. There are three information requirements that can be carried out to achieve this goal, namely: (1) Information is easy to obtain, (2) Information is easy to understand, and (3) Information is useful so that it can be accepted by the public. These three things are fulfilled by the advertising and viralization methods. Advertisements are installed in areas that are frequently passed by the public. Making advertisements helps people get information quickly and easily because they can be seen every day on the roads they pass (Prasetyo, 2021).

Community economic empowerment

Community economic empowerment is undeniably very important in people's lives to support their daily needs. Several areas have been made drainage channels by the community which are used as pineapple plantations. Provision and education programs from experts on how peat

areas can be managed properly and have economic value have been implemented. Assistance from the government is needed in building community economic empowerment on peatlands.

Fire Awareness Community (MAPI)

Entering the dry season, hundreds of hectares of land in Ogan Komering Ilir (OKI) Regency, South Sumatra, burned in 2024. The OKI area consists of 75% swamps and is always an area prone to forest and land fires and is at high risk every year when the dry season hits (BPBD South Sumatra, 2024). The Fire Awareness Community (MAPI) plays an important role in preventing and handling forest and land fires.

Preparedness is an action that allows the government, society, organizations, communities, and individuals to respond to disaster situations quickly and appropriately (BNPB, 2023). Preparedness efforts involve coordination of actions, operational facilities, equipment and supplies of basic necessities, training, public awareness, information, and the ability to deal with emergency situations. The following are some steps taken by MAPI: 1) Increasing public awareness of the importance of preventing forest and land fires (BPBD South Sumatra, 2024); 2) Preparing community groups in villages to deal with forest and land fires; 3) Providing basic knowledge and skills to the community to prevent forest and land fires (Prasetyo, 2021).

Joint Patrols in Fire-Prone Areas

To anticipate forest and land fires, the OKI Regency Government has held a Forest and Land Fire Emergency Preparedness Troop (BPBD OKI) roll call. The apparatus and MAPI carry out patrols in fire-prone areas, especially in peatlands (Manggala Agni). They appealed to remain vigilant through collaborative prevention efforts between parties such as BPBD, TNI, POLRI, Manggala Agni, Sub-district Heads, Village Heads, the private sector, the community, and other related parties.

Preparedness is part of proactive disaster management to reduce risk before a disaster occurs (BNPB, 2023). The preparedness stage is carried out before a disaster when nature shows signs that a disaster is about to occur. At this stage, all elements, especially the community, need to be prepared and always alert to face disasters. Field planning and action are lessons for anticipating forest and land fires in the following year. The government hopes that the collaborative forest and land fire management pattern can be applied during the prevention stage so that it has an optimal impact on handling forest and land fires in OKI Regency (BPBD South Sumatra, 2024).

In addition to MAPI, the government has also taken several steps to handle forest and land fires, such as controlling and minimizing fires through policies, prevention in the field, and strict law enforcement (BPBD South Sumatra, 2024). Forest fires in Indonesia are often caused by the interests of individuals or groups who ignore environmental sustainability (Prasetyo, 2021). The impacts include respiratory tract infections, reduced work efficiency, and cross-border smoke pollution. Some steps that the community can take to prevent forest and land fires include: 1) Do not burn forests to clear land or gardens; 2) Do not throw cigarette butts carelessly in the forest (Prasetyo, 2021); 3) Do not leave campfires in the forest; 3) Do not burn garbage in the land or forest, especially during strong winds.

According to staff at the SP Padang Police Office, forest fire problems occur due to economic factors, individual or group interests, lifestyles, and weaknesses in the environmental regulation and supervision system (SP Padang Police, 2024). Law enforcement is a reflection of the values that must be upheld to protect the environment (Sirah Pulau Padang Kayu Agung Police, 2024).

Community Preparedness

Based on the data provided, the majority of respondents (79%) showed high disaster preparedness, which is reflected in the category "Ready." This shows that most people already have a good understanding and action in dealing with potential disasters. This high level of preparedness can reflect a fairly good awareness of the importance of disaster preparation, either through training, socialization, or personal experience that encourages them to be more prepared.

However, even though most people are prepared, there are still 21% of respondents who fall into the category of "Not Ready." This means that there are still groups that need more attention in terms of counseling or training on disaster preparedness. This group may not have received adequate information or have not felt directly affected, so they have not prioritized preparedness (Lestari et al., 2022). It is important to continue to strengthen community communication and education efforts so that no group is left behind in preparing for disasters (Widodo & Sari, 2020). Overall, these results show significant progress in community disaster preparedness, but there is still room for improvement. The government and related organizations need to involve more communities in training and outreach activities, and focus on groups that are still in the "Not Ready" category, to ensure community safety and resilience more evenly.

Conclusion

Ogan Komering Ilir (OKI) Regency is an area that is vulnerable to forest and land fires due to the condition of the vast peatland and forest ecosystems. The main factors contributing to the occurrence of forest and land fires include peatland conditions that are easily dried out, climate variability such as the El Niño phenomenon, and human activities such as land clearing for agriculture and plantations. Data shows fluctuations in the number of hotspots and the area of land burned from 2019 to 2024. Major fires occurred in 2019 and 2023, while a significant decrease was seen in 2020 and 2024. This decrease reflects the effectiveness of fire mitigation involving the government and the community.

Efforts that have been made to reduce the risk of forest and land fires in OKI Regency include peatland rewetting, community education, peatland-based economic empowerment, joint patrols, and the active role of the Community Care for Fire group. The use of satellite-based monitoring technology is also an important step in fire monitoring and mitigation. Prevention of future forest and land fires requires a comprehensive and sustainable approach, including law enforcement against illegal land burning, increased patrols, and strengthening public education. Collaboration between stakeholders such as BPBD, local governments, communities, and the private sector is essential to maintain the stability of forest and land fire reduction in the OKI region.

Acknowledgment

The author would like to express his deepest gratitude to Polres SP Padang, Polres Sirah Pulau Padang, Kayu Agung, Pemkab OKI, BPBD OKI, Manggala Agni for their support and provision of very valuable data and information, which have made a major contribution to the preparation of this article.

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