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Farmers' lives and adaptation strategies toward the forest and peatland fires in Indonesia: Evidence from Central and South Kalimantan, Indonesia

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Abstract. *Rozaki Z, Nopembereni ED, Rahayu L, Rahmawati N, Murhidayah ML, Rejeki TM, Ariffin AS, Azizah SN, Tjale MM. 2022. Farmers' lives and adaptation strategies toward the forest and peatland fires in Indonesia: Evidence from Central and South Kalimantan, Indonesia. Biodiversitas 23: 2379-2388.* The frequency of forest and peatland fires in Kalimantan is high yearly, impacting many farmers' agricultural activities and the environment, especially in the dry season. Farmers conduct agricultural activities in this vulnerable area. This study aimed to analyze farmers' livelihood and adaptation strategies in Central and South Kalimantan, an area prone to forest and peatland fires. The sample comprised 200 farmers as respondents while the data were collected using a semi-structured questionnaire and analyzed using descriptive and rank spearman analysis. The results showed that the willingness to adapt, community resilience, and government support play important roles in dealing with forest and peatland fires. Therefore, inter-stakeholder coordination should be conducted appropriately for effective risk management to benefit farmers and all impacted parties.

Keywords: Adaptation, farmer, forest and peatland fire, Kalimantan

INTRODUCTION

Indonesia is struggling to fulfill its food needs from production and shelters, but this becomes harder with the climate change and growing population (Bakari and Hella 2019; Duffy et al. 2021; Sopian et al. 2019). Intensification program to boost production is limited by converting agricultural land for other uses, such as industries or settlement (Haggar et al. 2020). Therefore, food production could be increased through extensification by expanding the agricultural land (Masikati et al. 2021). The government implements extensification by developing peatland for agricultural land, particularly for paddy.

Java Island, the center of rice production in Indonesia, faces great agricultural land-use change. There is need to expand agriculture land outside this island, such as Kalimantan, Sumatra, Sulawesi, and Papua (Surahman et al. 2017; Wahyunto et al. 2013). The central government launched the development of peatland as agricultural land in Indonesia in response to the food security issue. Surahman et al. (2017) stated that one of the marginal lands with great potential to develop into agricultural land is a peatland. Also, Indonesia's peatland area is 14.9 million hectares and 33% of which is fit for agricultural use.

Over-action on developing peatland makes fires frequently occur in the area, especially in the dry season (Syaufina 2018). Peatland fire has become common in Indonesia, such as Sumatra or Kalimantan (Carmenta et al. 2021). Forest and peatland fires have the same effect on the surrounding area, affecting neighborhood countries. They have caused dense haze and serious air pollution in Southeast Asia countries, such as visibility impairment and various health impacts (Helmi et al. 2021). Therefore, mitigation strategies should be implemented concerning forest and peatland fires based on the latest scientific knowledge (Fujii et al. 2015). According to Carmenta et al. (2017), forest and peatland fires reduce biodiversity, and small-holder farmers lose income when their farms are burnt. Indirect impacts include weakening the reputation of Indonesia's oil palm industry and increasing the risk of other people invading the burnt land that looks vacant.

Kalimantan is undergoing agricultural land expansion through massive peatland conversion (Uda et al. 2018). The frequent forest fires are caused by slash burn agriculture practices, palm oil companies' activities, and illegal logging (Watts et al. 2019). Kusin et al. (2020) stated that fire is a major threat to the existence of peatlands because once the area is drained, dry peat is more flammable. Furthermore, tropical peat ecosystems, including their flora and fauna, are affected more severely by fire than illegal logging. Fires in peatlands are mostly caused by human activities, such as opening canals for plantations and agricultural

expansion.

The frequency of forest fires in Kalimantan is high every year (Susetyo et al. 2019). Forest or peatland fires are closely linked to conservation, protection, and planting activities that potentially increase beyond the forest area. In this case, deforestation should be handled accordingly (Ekawati et al. 2019). Forest and peatland fires affect Kalimantan (Hidayati et al. 2020). Although there are risks and hazards from the forest and peatland fires, many people still stay in Kalimantan and more prone areas. Most are farmers, and their houses and agricultural land are near forest and peatland fire-prone areas (Medrilzam et al. 2017). Farmers in developing countries, including Indonesia, are vulnerable to uncertainty in agriculture production due to product price instability, over-dependence on the environmental condition, and aging farmers (Triyono et al. 2021). These challenges also occur in Kalimantan, especially in Central and South Kalimantan (Ekawati et al. 2019), for farmers living and farming near the forest and peatland. Therefore, this study aims to analyze the farmers' lives and adaptation strategies in areas prone to forest and peatland fires in Central and South Kalimantan.

MATERIALS AND METHODS

Data collection and sampling procedure

The data were collected from 100 randomly selected respondents in Central and South Kalimantan, Indonesia as shown in Table 1 and Figure 1. This study was conducted from February - August 2021. The respondents comprised farmers living near the forest and peatland areas vulnerable to the risk and hazards of fire. A semi-structured questionnaire was used to collect the data on basic demographics, risk and hazard perception, adaptation strategies, related support, and community resilience (Medrilzam et al. 2017). Additionally, observation and in-depth interviews were conducted to support the findings.

Demographic data consisted of age, education, family size, gender, farming experience, and farm size. These factors commonly affect the farmers' decision-making regarding their farming and lives (Triyono et al. 2021). Respondents were asked about their perception of forest and peatland fires and their impacts on human life and agriculture. Moreover, they were asked about adaptation strategies to know how to cope and handle this disaster. Other questions addressed the length of stay, gender, government support, risk management education, and benefits. Since community resilience is related to the mitigation strategies for various disasters, it was included in the interview.

Table 1. Sample detail of each area

Area		Sample size
Central Kalimantan	Jabiren Raya Sub-district, Pulang Pisau District	50
	Sabangau Sub-district, Palangkaraya City	50
South Kalimantan	Sungai Tabuk Sub-district, Banjar District	50
	Gambut Sub-district, Banjar District	50

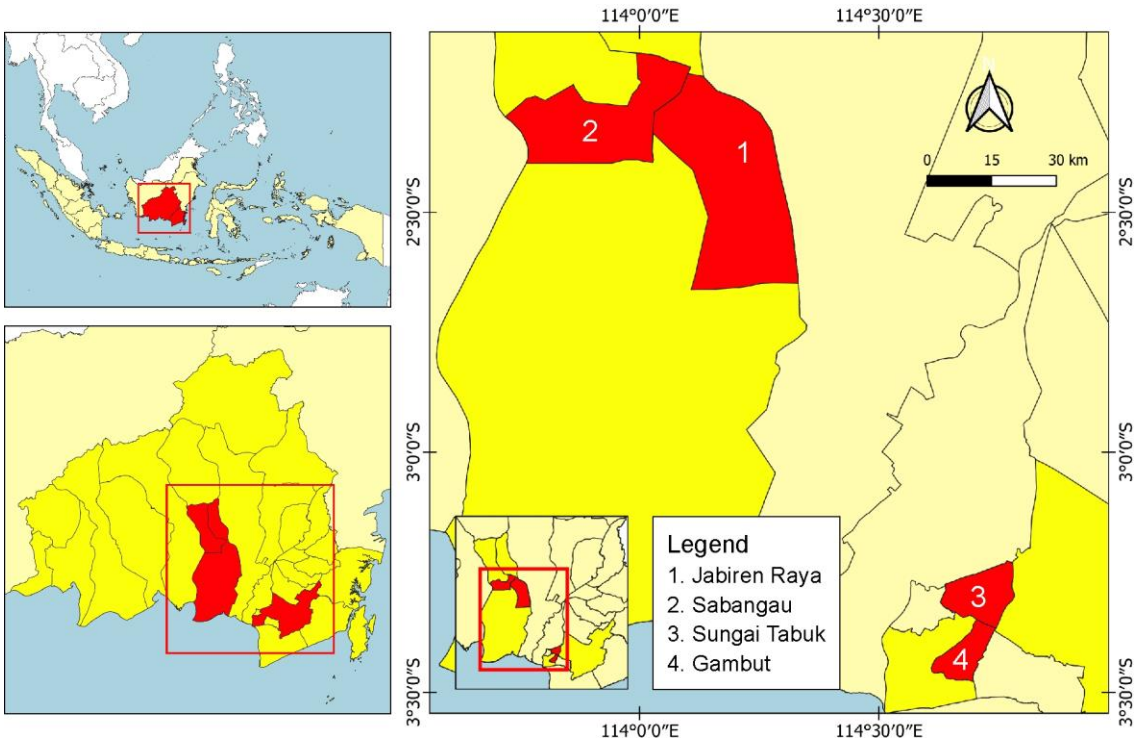

Figure 1. Study area in Central and South Kalimantan, Indonesia

Data analysis

The findings were presented as mean and percentage and formulated using the descriptive method to recommend suitable forest and peatland fires risk management strategies for farmers. Rank Spearman analysis was used to analyze the correlation among variables. The dependent variables were the willingness to implement adaptation strategies, government support, and community resilience. The independent variable was risk management effectiveness before, during, and after the disaster.

RESULTS AND DISCUSSION

Respondents' demography

Most Indonesian farmers are older because young people have low motivation to work on farms (Saiyut et al. 2017). In this study, the farmers' average age was 46.17, where 40% ranged from 41-53 years (Table 2). Most respondents started farming at about 20 years because the average farming experience was 19.65 years. The long farming experience affects farmers' ability to farm. It makes them think their farming ways are better than the new method to reduce the innovation adoption rate (Kuasa et al. 2015). More than 60% of the respondents had junior and high school education levels, and only 4% had a diploma or university education. This proves that education affects the general agriculture sector, where farmers have low education levels (David and Ardiansyah 2017) so which affects innovation adoption. Family size is an internal factor for farmers to grow. The average family size in this study was 3.77, which is common, meaning that most families in Indonesia have three members (Hidayati et al. 2019). Rozaki et al. (2020) showed that farmers on Java Island are fewer than those outside Java, such as in Sulawesi. This study also found that the farm size was big, with an average of more than 9,000 m^2. Regarding gender, 62% of the respondents in this study were male farmers, with few activities performed by women (Rietveld et al. 2020).

The average length of stay was 23.78 years, with a minimum of three years and a maximum of 72 years. This condition matches the farming experience, where they start farming from the beginning of their stay in forest and peatland fires-prone areas. Many people stay in the disaster-prone area because they were born there or it is their only place. Farmers have the following reasons to live in the area:

Family: Their family lives there, and they want to live near their family. Inheritance: Their house and land are inherited from their ancestors. Fertile land: The fertile soil makes them more willing to stay and carry out agriculture.

Risk and hazard perception

Forest and peatland fires are serious disasters in Indonesia, though the impacts could be minimized. In this study, farmers felt that such a disaster was dangerous, with 48.50% stating that it was very dangerous, 50.50% stating it was dangerous, and no one stated it was harmless (Figure 2). Furthermore, they felt that the hazard type varies, i.e., 66% for both haze and fire, and 34% only for haze (Figure 3). However, haze affects people's health, especially the respiratory, and limits their daily activities (Evizal et al. 2022).

The disaster affects family life, properties, and agriculture. In this study, 64.5% of the farmers stated that the disaster had no direct impact on family life, while 33.5% felt they had minor injuries to farmers' family members (Figure 4). Only 2% stated that forest and peatland fires heavily injure their family members. The heavily injured were those close to the fires, experiencing respiratory complications due to the haze (Murhaini and Achmadi 2021).

The fires caused minor and heavy damage to properties by 46% and 37%, respectively (Figure 5), and 0.5% lost their properties due to this disaster. Since farmers have low incomes, they are vulnerable to the loss of properties.

Table 2. Respondents' demography

Variable	Freq.	Percentage
Age in year (min/max/avg.: 18/80/46.17)		
15-27	7	3.5
28-40	62	31
41-53	80	40
54-64	41	20.5
More than 64	10	5
Education		
None	1	0.5
Elementary	42	21
Junior	73	36.5
High	76	38
Diploma/Univ.	8	4
Family Size (min/max/avg.: 1/7/3.77)		
One or none	4	2
2	16	8
3	42	21
4	74	37
Five or more	64	32
Gender		
Male	124	62
Female	76	38
Farming Exp. in year (min/max/avg.: 1/60/19.65)		
0-10	73	36.5
11 to 20	61	30.5
21-30	41	20.5
31-40	19	9.5
41 and more	6	3
Farm Size in m^2 (min/max/avg.: 100/50,000/9,063)		
≤1,500	105	52.5
1,501-3,000	40	20
3,001-4,500	2	1
4,501-6,000	11	5.5
6,001≤	42	21

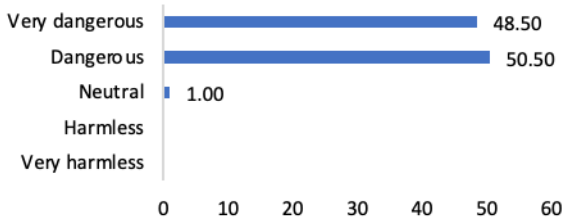

Figure 2. Forest and peatland fires harmfulness

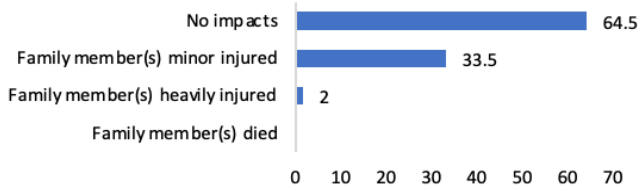

Figure 4. Impacts on family living

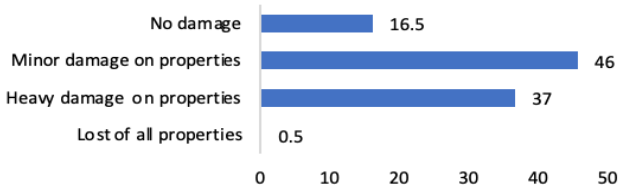

Figure 5. Forest fires impact properties

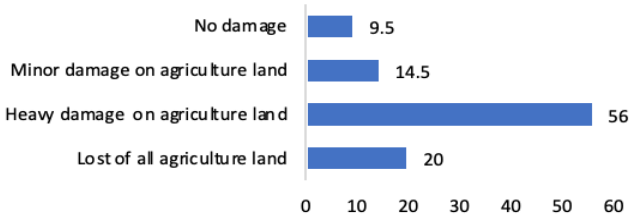

Figure 6. Forest fires impact agriculture

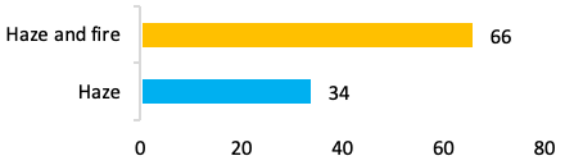

Figure 3. Hazard type

Agriculture is the most vulnerable compared to family and properties because it is carried out near the fires. About 56% of the farmers faced heavy damage to their agricultural land from the fires (Figure 6). Moreover, 20% were losing their agricultural land, including crops or plants. These impacts make forest and peatland fires considered hazardous for farmers' lives which is in line with the study conducted by Merten et al. (2021).

Adaptation strategies

Forest and peatland fires are an annual disaster, especially in the dry season. In some areas, the rainy season does not end the disaster because the destroyed peatland makes the water infiltration ineffective, causing floods that threaten farmers' lives. Therefore, there is a need for adaptation strategies to mitigate the risks of the disaster. This study showed that 52% of farmers are willing to implement adaptation, 38% are very willing, and 2% are not willing. The willingness to adapt comes from the experience that makes them want to reduce the impacts of the disaster.

There are two main adaptations that farmers exercise to cope with the fires disasters:

Change crop pattern

Farmers implement this adaptation strategy by changing dryland paddy with trees such as rubber, orange, or common guava that could be harvested many times and have a lower cost of cultivation. Also, they plant other crops such as scallion, sweet potato, cassava, banana, and maize. This adaptation strategy could become stronger with the fire disaster rather than the more flammable paddy.

Agroforestry

This agriculture system involves combining trees and crops, positively affecting water and soil conservation or restoration. In this study, farmers implement agroforestry to support water conservation and reforestation efforts. This strategy matches the crop changing pattern.

The willingness to adapt is high, but farmers have second thoughts regarding its implementation. The change crop pattern strategy is agreed upon and strongly agreed to by 20% and 10.5% of farmers, respectively (Figure 7). Although this adaptation strategy effectively deals with the fires, some farmers prefer growing dryland paddy due to financial constraints. Regarding infrastructure, 44.5% of the farmers stated that it is not good enough to support adaptation (Figure 8). Infrastructure refers to transportation, input, and product selling access. The agriculture sector in the disaster area is complicated and vulnerable and requires disaster mitigation strategies, such as agroforestry. In this study, 36% and 48.5% of the farmers agreed and strongly agreed that agroforestry supports the fires adaptation strategies, respectively (Figure 9).

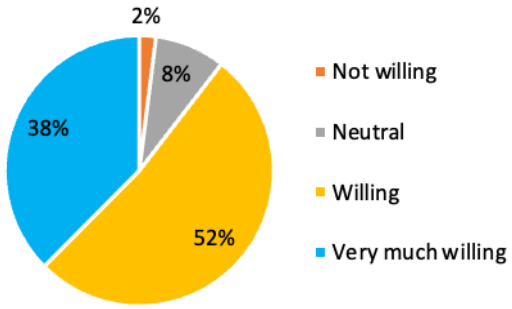

Figure 7. The willingness to make the adaptation

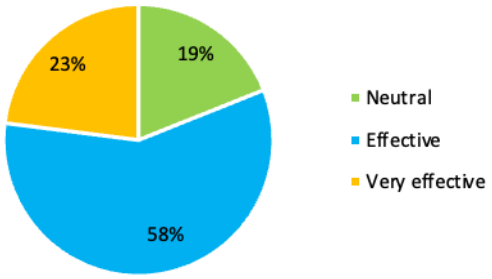

Figure 10. Forest fires disaster adaptation effectiveness

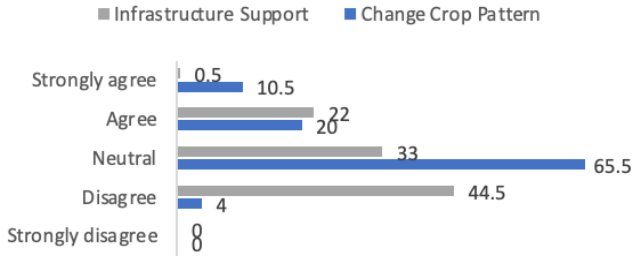

Figure 8. Change crop pattern and infrastructure support

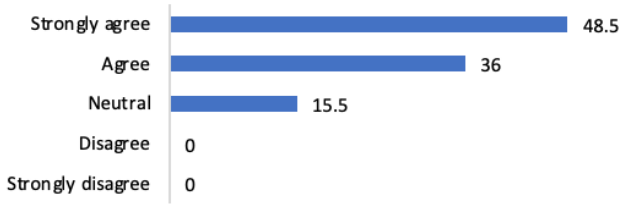

Figure 9. Agroforestry for adaptation strategies

Through adaptation, 58% of farmers stated that the efforts are effective, while 23% felt that the strategies are very effective (Figure 10). This shows that facing forest and peatland fires is beneficial, though adaptation strategies take time.

Government support

Farmers cannot survive and struggle without government support in facing a disaster. The three phases of a disaster, i.e., pre, during, and post, require support from the related parties, including the government. Some government supports for farmers and other people in fires prone areas are:

Artesian well and pump machine

The distant water source to extinguish hinders rapid action to control the fire spread. Therefore, the government built an artesian well to make the water source nearer to ensure rapid-fire control. Based on observation, some pump machines were not well maintained and required good maintenance to anticipate fire break up.

Village fund

Government financial support through village funds and infrastructure is essential in facilitating the farmers' adaptation strategies. A village fund is common financial support from the central government to develop the village, amounting to IDR 1 billion (US$ 71,400) in 2018 (Arifin et al. 2020). The fund is meant for developing the village to become economically independent through village-owned enterprises. Furthermore, it could be used for disaster relief programs because it should be handled quickly (Srikandini et al. 2022), particularly for peatland restoration post fires disasters. According to Sujai et al. (2021), the village fund has the potency to support the mitigation strategies in facing forest and peatland fires but needs a management system to guarantee its effectiveness and efficient usage. In this study, the government's financial support helped 42% of farmers handle the forest and peatland fires (Figure 11). However, 17% of the farmers felt that the financial support does not significantly help them face the fires.

Food aid: During a disaster, this support is delivered to farmers, especially in the evacuation camp. Fire control: Since the impacts of the fire spread to the surrounding area; the government implemented control with help from firefighters and other volunteer communities. Ditches: These ditches are built by the government to keep the surrounded area wet and prevent fire from spreading. Evacuation: This support is necessary when the hazard level requires evacuation by the farmer. The community has the coordination to prepare evacuation vehicles when the fires spread. Warning Sign Board: The government put up billboards and posters warning about forest and peatland fires. For instance, people are not allowed to burn the garbage or land near the forest and peatland area, with fines imposed on violators.

Government support is crucial for the forest and peatland fires adaptation strategies, especially during the disaster, as agreed to by 79.01% of farmers in this study (Figure 12). However, 54.31% and 51.23% of the farmers were neutral about the significance of government support pre and post-disaster, respectively. The support is important for minimizing the impacts of this disaster. Purnomo et al. (2021) found that the government understands the importance of its support for the forest and peatland fires.

Risk management education

The four hazard signs in Indonesia are Normal (Level l), *Waspada* (Level 2: alert), *Siaga* (Level 3: standby), and *Awas* (Level 4: beware) (Andreastuti et al. 2019). These hazard signs are used for mountain volcanicity and other disasters, including forest and peatland fires. There is a hazard signboard in the town center showing the hazard level. 70% of farmers knew the hazard signs in this study, while 30% were not (Figure 13). However, those that did not know the sign still followed the instruction regarding evacuation or other measures.

The signs help farmers and stakeholders rise, reduce, and anticipate the hazard impacts. The common standard operating procedure requires people to evacuate the hazard when it becomes *siaga* (stand by) because *awas* (beware) is dangerous. In this study, 82.5% of farmers evacuated when the level became *waspada* (alert) (Figure 14). At the level of *waspada*, people must move fast in the case of fire because it spreads very fast (Murhaini and Achmadi 2021).

Education regarding the hazard sign and the necessary action when the hazard comes is important for forest and peatland fires management (Andreastuti et al. 2019). Without education, people cannot understand the hazardous impact of fires (Rozaki et al. 2021). In Figure 13, 0.5% of farmers evacuated when the hazard level reached *awas* (beware), and dangerous for fires disaster that spread rapidly. However, this contradicts farmers' preference regarding their response toward the forest and peatland fires hazard. The farmers prefer staying in forest and peatland fires-prone areas to monitor and extinguish the fire when it spreads to their agricultural land (Figure 15).

This study showed that risk management education regarding hazard levels should be conducted regularly for farmers to understand the impacts of forest and peatland fires. Farmers are unaware of the hazard impacts until it happens, so implying risk management education is necessary. However, this is challenging due to the cultural wall and the education level of the farmers. Risk management education should be applied to the adaptation strategies, i.e., how the farmers are educated about the strategies that reduce or minimize the impacts of fires, especially during and post-disaster. The education is conducted by government advisors and other private parties such as volunteer communities to farmers and impacted parties. In this study, 74% of the farmers agreed that risk management benefits them, especially pre-disaster. Also, 63% and 62.5% of the farmers benefited during and post-disaster, respectively (Figure 16). No one stated that risk management education is needless in facing fire disasters.

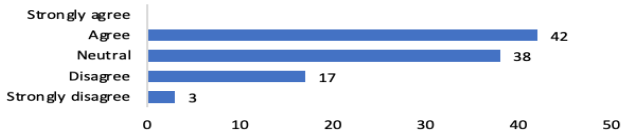

Figure 11. Financial support from the government or others

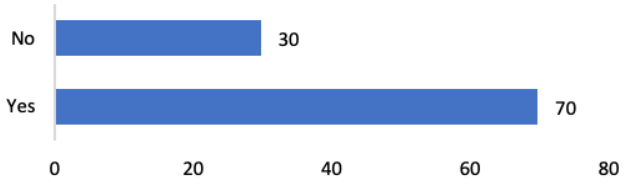

Figure 13. The understanding of hazard sign

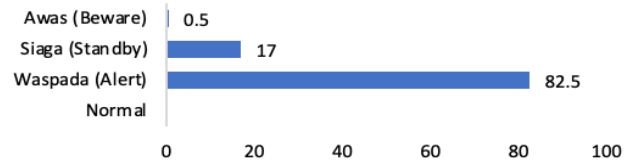

Figure 14. Which state farmers will do evacuation

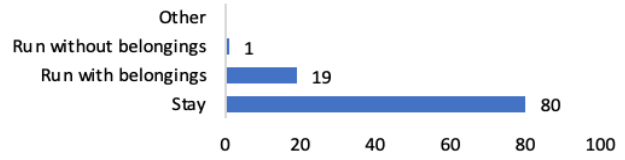

Figure 15. Farmers' action when the fire hazard come

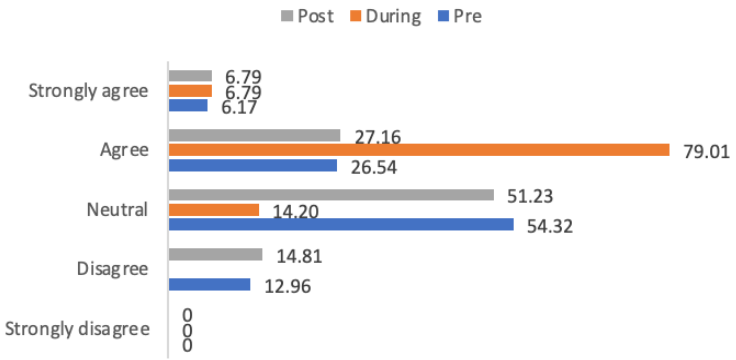

Figure 12. Benefits of government support

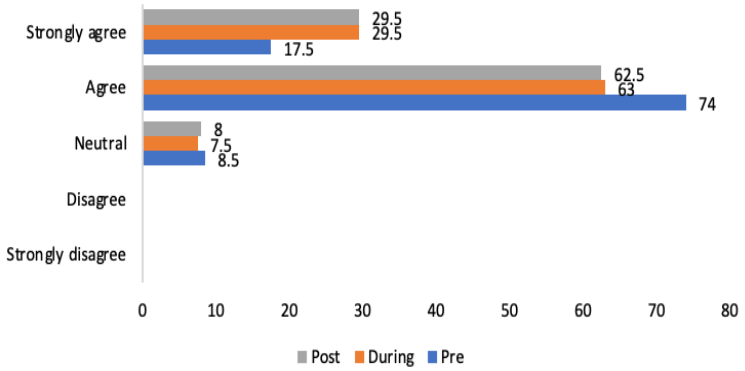

Figure 16. The benefit of risk management education

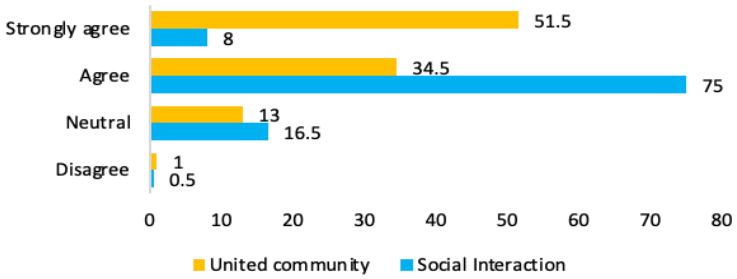

Figure 17. Community resilience

Community resilience

People live in communities that vary depending on the place and the common purposes. Farmers live in two communities in their neighborhood and group or associations. A community constitutes people living in the same area and having common interests. Community resilience is how the people face the disaster with their strength and unity, including their physical and non-physical resources (Bong et al. 2019). The strong community resilience comes from good social interaction and unity among the members. Figure 17 showed that 75% of the farmers agreed that their social interaction is good, while 51% strongly agreed to good unity, and 34.5% agreed. These social capitals increase their community resilience toward fires. The main principle of farmers' community resilience in Indonesia is "*gotong royong*." This term is well known for big or small communities and means mutual assistance, where people work together for common purposes (Andreastuti et al. 2019).

Some community activities are conducted out of resilience, mutual assistance can be seen in pre, during, and post-fires. Farmers monitor the occurrence of the fire, mobilize and inform people when the disasters worsen and help during evacuation. Pre-disaster activities include making ditches to prevent the fires from spreading (Fernandez-Anez et al. 2021). Also, fires watchtowers were constructed by the government and other parties to help the community monitor the occurrence of the fire and its spread. During the disasters, farmers and other impacted people collaborate to minimize the impacts (Rozaki et al. 2021). They use simple equipment such as buckets and wet gunny sacks to extinguish surface fires. The fire underneath the peatland is extinguished using big equipment operated by trained people. During the post-disaster, farmers and the community carry out relief activities such as extinguishing the remaining fires, restoring burned land, and replanting. These activities are conducted by farmers supported by farmers' groups and the fires community.

Gender issue

Gender is relevant in agriculture households, where different areas have different characteristics, such as practicing the matrilineal or patrilineal system. In this study, agriculture, agroforestry, and non-economic activities are dominated by an "equal" workload (Rozaki et al. 2021). The husband dominates Non-agricultural economic activities for the workload. It comes from 131 farmers with economic activities out of agriculture (Figure 18). Low and often uncertain income make farmers have a side job to support their lives. Involvement of husband and spouse in agriculture, and fires mitigation strategies make it more effective.

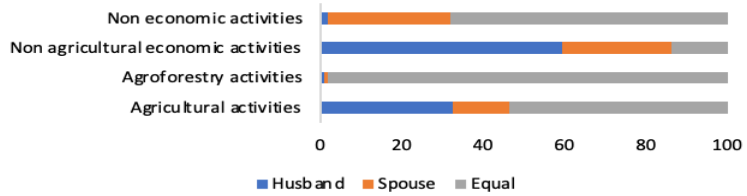

Figure 18. Gender issue

Table 3. Correlation risk management (pre, during, post)

Variable		Risk management effectiveness		
		Pre	**During**	**Post**
Willingness to do adaptation strategies	Correlation Coefficient	0.05	.344**	.345**
	Sig. (2-tailed)	0.483	0	0
Government support	Correlation Coefficient	.329**	.411**	-.414**
	Sig. (2-tailed)	0	0	0
Community resilience	Correlation Coefficient	.166*	.349**	.358**
	Sig. (2-tailed)	0.019	0	0

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Variable correlation

Each dependent variable showed a significant correlation with independent variables, except a willingness to implement adaptation and risk management effectiveness in the pre-stage (Table 3). The significant correlation means a strong connection between willingness to do adaptation strategies, government support, and community resilience with risk management effectiveness. Farmers need to avoid forests and peatland fires so that they will not affect agriculture. Additionally, farmers' lives are more likely to involve other factors such as their willingness, government support, and community resilience.

Discussion

Forest and peatland fires adaptation strategies are important for reducing the impacts. Pre, during, and post-disaster efforts should be carried out. Farmers are the victims of high risk of this disaster. It impacts family members, agricultural land, and properties. The efforts to minimize the impacts are known as risk management or disaster mitigations (Peng et al. 2020). Farmers' adaptation strategies in facing forest and peatland fires include changing the crop pattern and agroforestry. This finding is supported by Syaufina (2018), which showed that the strategies effectively face the forest and peatland fires to a particular degree. Their effectiveness depends on the momentum of the planting time method and the suitable trees and crop combination. Other adaptation strategies are fire monitoring towers, ditches, and fires community. They are effective for controlling fires. However, further studies should examine the effectiveness of these strategies toward biophysical conditions.

Risk management becomes effective when some factors work together for maximum results (Figure 19). The farmers' willingness to adopt adaptation strategies is necessary for mitigation efforts to be successful. This requires education by government field advisors regarding the important and beneficial adaptation strategies to increase the willingness. Furthermore, funds and infrastructure may boost farmers' willingness to adopt adaptation strategies. In line with this, Schaafsma et al. (2017) found that financial support could compensate farmers by motivating them to participate in disaster preparation and recovery. The government could also issue regulations that support fires control, including prevention. According to Uda et al. (2018), the Indonesian Government issued regulations to support the effort to prevent and control the forest and peatland fires but has not been obligated in the field. Purnomo et al. (2021) found that strict regulations should be made to ensure key actors in forest and peatland fires obey the rules, which requires government and private coordination.

Social capital, such as unity or community resilience, also supports the forest and peatland fires in line with Muir et al. (2020) regarding the volcano disaster. A united community makes the disaster mitigation effort more effective. This is supported by *gotong royong* culture in Indonesia, where for community works together. The forest and peatland fires risk management by farmers and other parties becomes effective through a synergy of the three factors (willingness to adapt, government support, and community resilience). These factors make the community's resilience stronger toward forest and peatland fires. Community resilience toward disaster supports and enables people to survive and live in disaster-prone areas. It is usually built up with local wisdom (Murhaini and Achmadi 2021). Moreover, understanding the human need to live with nature makes farmers practice their farming wisely. Open land with burning is strictly controlled. Farmers are only allowed to burn a maximum of two hectares of their land with permission from the local government. Most farmers take the opportunity from forest and peatland fires to plant dryland rice after burning the land. Also, they realize the danger of fires and feel blessed because they plant the dryland rice without burning the land.

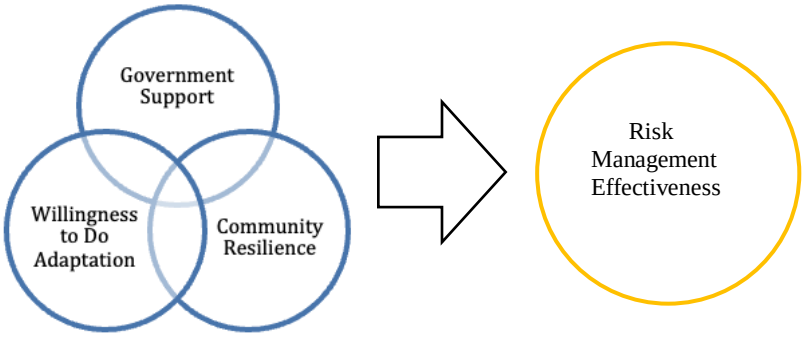

Figure 19. Forest and peatland fires control factors

Surahman et al. (2018) suggested that forest and peatland fires prevention efforts should also be conducted besides disaster handling. These efforts include stopping the agriculture expansion that needs drainage, oil palm, and illegal logging. Developing a certain agricultural commodity that supports regional development may improve the economy by considering the effects (Tanjung et al. 2021). The prevention actions need good inter stakeholder coordination to obtain maximum results (Handayani et al. 2019). Additionally, the awareness of all related parties, including farmers, should be raised (Budhathoki et al. 2020).

In conclusion, forest and peatland fires in Indonesia have become a frequent disaster in the dry season, affecting the surrounding community's properties and health. The main impacts of this disaster are property loss, family injuries, and respiratory problems. The forest and peatland area is dominated by agricultural activities on which many people depend for their livelihoods. Farmers living in forest and peatland fire-prone areas face the risk of yearly disasters in the dry season. Various adaptation strategies need government support in funds, infrastructure, or others. Also, risk management education helps the farmers prepare for a fire disaster. The community plays an important role in the people's ability to face disasters. Community resilience, unity, and good social interaction make farmers stronger in facing fires in terms of preparation, adaptation, and recovery. Furthermore, the gender issue shows that equality in any activities enhances adaptation and recovery from forest and peatland fires. For effective forest and peatland fires risk management, farmers must be willing to adapt and be supported by the community and government. Also, good inter stakeholders coordination supports forest and peatland fires risk management strategies. These efforts should focus on the disaster and the prevention strategies.

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REFERENCES

Andreastuti S, Paripurno ET, Gunawan H, Budianto A, Syahbana D, Pallister J. 2019. Character of community response to volcanic crises at Sinabung and Kelud volcanoes. J Volcanology Geothermal Res 382: 298-310. DOI: 10.1016/J.JVOLGEORES.2017.01.022.

Arifin B, Wicaksono E, Tenrini RH, Wardhana IW, Setiawan H, Damayanty SA, Solikin A, Suhendra M, Saputra AH, Ariutama GA, Djunedi P, Rahman AB, Handoko R. 2020. Village fund, village-owned-enterprises, and employment: Evidence from Indonesia. J Rural Stud 79: 382-394. DOI: 10.1016/j.jrurstud.2020.08.052.

Bakari MS, Abdallah JM, Hella JP. 2018. Adaptation strategies of small-scale agriculture production to climate change impacts in Micheweni, Tanzania. Trop Drylands 3 (2): 60-75. DOI: 10.13057/tropdrylands/t030205.

Bong IW, Moeliono M, Wong GY, Brockhaus M. 2019. What is success? Gaps and trade-offs in assessing the performance of traditional social forestry systems in Indonesia. For Soc 3 (1): 1-21. DOI: 10.24259/FS.V3I1.5184.

Budhathoki NK, Paton D, Lassa JA, Zander KK. 2020. Assessing farmers' preparedness to cope with the impacts of multiple climate change-related hazards in the Terai lowlands of Nepal. Intl J Disaster Risk Reduction 49: 101656. DOI: 10.1016/j.ijdrr.2020.101656.

Carmenta R, Zabala A, Daeli W, Phelps J. 2017. Perceptions across scales of governance and the Indonesian peatland fires. Glob Environ Change 46: 50-59. DOI: 10.1016/j.gloenvcha.2017.08.001.

Carmenta R, Zabala A, Trihadmojo B, Gaveau D, Salim MA, Phelps J. 2021. Evaluating bundles of interventions to prevent peat-fires in Indonesia. Glob Environ Change 67: 102154. DOI: 10.1016/j.gloenvcha.2020.102154.

David W, Ardiansyah. 2017. Organic agriculture in Indonesia: challenges and opportunities. Org Agric 7 (3): 329-338. DOI: 10.1007/s13165-016-0160-8.

Duffy C, Toth GG, Hagan RPO, McKeown PC, Rahman SA, Widyaningsih Y, Sunderland TCH, Spillane C. 2021. Agroforestry contributions to smallholder farmer food security in Indonesia. Agrofor Syst 95 (6): 1109-1124. DOI: 10.1007/S10457-021-00632-8.

Ekawati S, Subarudi, Budiningsih K, Sari GK, Muttaqin MZ. 2019. Policies affecting the implementation of REDD+ in Indonesia (cases in Papua, Riau and Central Kalimantan). For Policy Econ 108: 101939. DOI: 10.1016/j.forpol.2019.05.025.

Evizal AK, Sri LR, Abdul S, Mahmod O, Hanita D. 2022. Forest fire spreading and carbon concentration identification in tropical region Indonesia. Alexandria Eng J 61 (2): 1551-1561. DOI: 10.1016/J.AEJ.2021.06.064.

Fernandez-Anez N, Krasovskiy A, Müller M, Vacik H, Baetens J, Hukić E, Kapovic Solomun M, Atanassova I, Glushkova M, Bogunović I, Fajković, H., Djuma H, Boustras G, Adámek M, Devetter M, Hrabalikova M, Huska D, Martínez BP, Vaverková MD, Cerda A. 2021. Current wildland fire patterns and challenges in Europe: A synthesis of national perspectives. Air Soil Water Res. DOI: 10.1177/11786221211028185.

Fujii Y, Kawamoto H, Tohno S, Oda M, Iriana W, Lestari P. 2015. Characteristics of carbonaceous aerosols emitted from peatland fire in

Riau, Sumatra, Indonesia (2): Identification of organic compounds. Atmos Environ 110: 1-7. DOI: 10.1016/j.atmosenv.2015.03.042.
Haggar J, Nelson V, Lamboll R, Rodenburg J. 2020. Understanding and informing decisions on sustainable agricultural intensification in Sub-Saharan Africa. Intl J Agric Sustain 19 (5-6): 349-358. DOI: 10.1080/14735903.2020.1818483.
Handayani W, Fisher MR, Rudiarto I, Sih Setyono J, Foley D. 2019. Operationalizing resilience: A content analysis of flood disaster planning in two coastal cities in Central Java, Indonesia. Intl J Disaster Risk Reduction 35: 101073. DOI: 10.1016/j.ijdrr.2019.101073.
Helmi H, Djafri D, Mutiani C, Abd Halim N, Badri M, Yefni Y. 2021. Indigenous people in the dynamics of land use changes, forest fires, and haze in Riau Province, Indonesia. Natural Resource Governance in Asia. Elsevier. DOI: 10.1016/B978-0-323-85729-1.00023-2.
Hidayati B, Yamamoto N, Kano H. 2019. Investigation of production efficiency and socio-economic factors of organic rice in Sumber Ngepoh District, Indonesia. J Cent Eur Agric 20 (2): 748-758. DOI: 10.5513/JCEA01/20.2.2143.
Hidayati IC, Nalaratih N, Shabrina A, Wahyuni IN, Latifah AL. 2020. Correlation of climate variability and burned area in Borneo using Clustering Methods. For Soc 4 (2): 280-293. DOI: 10.24259/FS.V4I2.9687.
Kuasa W, Rianse U, Widayati W, Sidu D, Abdullah W, Zulfikar Z, Syukur L, Rianse I. 2015. Local wisdom of farmers in meeting of local food. Intl J Sustain Trop Agric Sci 2 (1): 53-60.
Kusin K, Kusin K, Jagau Y, Ricardo J, Saman TN, Aguswan Y, Aguswan Y. 2020. Peat lost by fire in Kalampangan area, Central Kalimantan, Indonesia. IOP Conf Ser: Earth Environ Sci 504 (1). DOI: 10.1088/1755-1315/504/1/012009.
Masikati P, Sisito G, Chipatela F, Tembo H, Winowiecki LA. 2021. Agriculture extensification and associated socio-ecological trade-offs in smallholder farming systems of Zambia. Intl J Agric Sustain 19 (5-6): 497-508. DOI: 10.1080/14735903.2021.1907108.
Medrilzam M, Smith C, Aziz AA, Herbohn J, Dargusch P. 2017. Smallholder farmers and the dynamics of degradation of peatland ecosystems in Central Kalimantan, Indonesia. Ecol Econ 136 (C): 101-113. DOI: 10.1016/j.ecolecon.2017.02.017.
Merten J, Nielsen JØ, Rosyani, Faust H. 2021. Climate change mitigation on tropical peatlands: A triple burden for smallholder farmers in Indonesia. Glob Environ Change 71, 102388. DOI: 10.1016/J.GLOENVCHA.2021.102388.
Muir JA, Cope MR, Angeningsih LR, Brown RB. 2020. Community recovery after a natural disaster: Core data from a survey of communities affected by the 2010 Mt. Merapi eruptions in Central Java, Indonesia. Data in Brief 32: 106040. DOI: 10.1016/j.dib.2020.106040.
Murhaini S, Achmadi. 2021. The farming management of Dayak People's community based on local wisdom ecosystem in Kalimantan Indonesia. Heliyon 7 (12): e08578. DOI: 10.1016/J.HELIYON.2021.E08578.
Peng L, Tan J, Deng W, Liu Y. 2020. Farmers' participation in community-based disaster management: The role of trust, place attachment and self-efficacy. Intl J Disaster Risk Reduction 51: 101895. DOI: 10.1016/j.ijdrr.2020.101895.
Purnomo EP, Zahra AA, Malawani AD, Anand P. 2021. The Kalimantan forest fires: An actor analysis based on supreme court documents in Indonesia. Sustainability 13 (4): 2342. DOI: 10.3390/SU13042342.
Rietveld AM, van der Burg M, Groot JCJ. 2020. Bridging youth and gender studies to analyse rural young women and men's livelihood pathways in Central Uganda. J Rural Stud 75: 152-163. DOI: 10.1016/j.jrurstud.2020.01.020.
Rozaki Z, Rahmawati N, Wijaya O, Rahayu L. 2021. Farmers' disaster mitigation strategies in Indonesia. Rev Agric Sci 9: 178-194. DOI: 10.7831/ras.9.0_178.
Rozaki Z, Rahmawati N, Wijaya O, Safitri F, Senge M, Kamarudin MF. 2021. Gender perspectives on agroforestry practices in Mt. Merapi hazards and risks prone area of Indonesia. Biodiversitas 22 (7): 2980-2987. DOI: 10.13057/biodiv/d220751.
Rozaki Z, Salassa DI, Nugroho RB, Indardi, Triyono. 2020. Farmers' responses to organic rice farming in Indonesia: Findings from Central Java and South Sulawesi. Open Agric 5 (1): 703-710. DOI: 10.1515/opag-2020-0070.
Saiyut P, Bunyasiri I, Sirisupluxana P, Mahathanaseth I. 2017. Changing age structure and input substitutability in the Thai agricultural sector. Kasetsart J Soc Sci 38 (3): 259-263. DOI: 10.1016/j.kjss.2016.07.004.
Schaafsma M, van Beukering PJH, Oskolokaite I. 2017. Combining focus group discussions and choice experiments for economic valuation of peatland restoration: A case study in Central Kalimantan, Indonesia. Ecosyst Serv 27: 150-160. DOI: 10.1016/j.ecoser.2017.08.012.
Sopian A, Hardwinarto S, Aipassa MI, Sumaryono. 2019. Gap analysis of land availability and land needs to identify potential developmentof agricultural landsin Santan watersheds, East Kalimantan, Indonesia. Biodiversitas 20 (4): 1097-1105. DOI: 10.13057/biodiv/d200422.
Srikandini A, Prabandari A, Rizal K. 2022. The Use of 'Village Funds' for Community-Based Disaster Risk Financing in Indonesia. Post-Disaster Governance in Southeast Asia, Singapore. DOI: 10.1007/978-981-16-7401-3_12.
Sujai, M, Mizuno K, Soesilo TEB, Wahyudi R, Haryanto JT. 2021. Village fund for peatlands restoration: Study of community's perceived challenges and opportunities in Muaro Jambi District. For Soc 5 (2): 604-618. DOI: 10.24259/FS.V5I2.14187.
Surahman A, Shivakoti GP, Soni P. 2017. Prospect of sustainable peatland agriculture for supporting food security and mitigating green house gas emission in Central Kalimantan, Indonesia. Redefining Diversity and Dynamics of Natural Resources Management in Asia 1: 291-303. DOI: 10.1016/B978-0-12-805454-3.00015-3.
Surahman A, Soni P, Shivakoti GP. 2017. Are peatland farming systems sustainable? Case study on assessing existing farming systems in the peatland of Central Kalimantan, Indonesia. J Integr Environ Sci 15 (1): 1-19. DOI: 10.1080/1943815X.2017.1412326.
Surahman A, Soni P, Shivakoti GP. 2018. Reducing CO_2 emissions and supporting food security in Central Kalimantan, Indonesia, with improved peatland management. Land Use Policy 72: 325-332. DOI: 10.1016/j.landusepol.2017.12.050.
Susetyo KE, Kusin K, Nina Y, Kawasaki M, Naito D. 2019. Peatland and Forest Fires in Central Kalimantan, Indonesia. Newsletter of Tropical Peatland Society Project. Research Institute for Humanity and Nature.
Syaufina L. 2018. Forest and land fires in Indonesia: Assessment and mitigation. Integrating Disaster Science and Management. Elsevier Inc. DOI: 10.1016/B978-0-12-812056-9.00008-7.
Tanjung GS, Suryantini A, Utami AW. 2021. The priorities of leading sub-sector in the sector of agriculture, forestry, and fisheries in economic development in Bangka Belitung Province. AGRARIS: J Agribusiness Rural Dev Res 7 (2): 160-175. DOI: 10.18196/AGRARIS.V7I2.11615.
Triyono, Rahmawati N, Rozaki Z. 2021. Sustainable value of rice farm based on economic efficiency in Yogyakarta, Indonesia. Open Agric 6 (1): 563-572. DOI: 10.1515/OPAG-2021-0039.
Uda SK, Schouten G, Hein L. 2018. The institutional fit of peatland governance in Indonesia. Land Use Policy 99: 103300. DOI: 10.1016/j.landusepol.2018.03.031.
Wahyunto W, Supriatna W, Agus F. 2013. Land use change and recommendation for sustainable development of peatland for agriculture: case study at Kubu Raya and Pontianak Districts, West Kalimantan. Indones J Agric Sci 11 (1): 32-40. DOI: 10.21082/ijas.v11n1.2010.p32-40.
Watts JD, Tacconi L, Hapsari N, Irawan S, Sloan S, Widiastomo T. 2019. Incentivizing compliance: Evaluating the effectiveness of targeted village incentives for reducing burning in Indonesia. For Pol Econ 108 (98): 101956. DOI: 10.1016/j.forpol.2019.101956.