



Multi-hazard perception during COVID-19: Evidence from rural communities in West Sumatra, Indonesia

Agus Nugroho^{a,*}, Mahdi^b, Lora Triana^b, Annisa Umul Fitrah^c,
Ahmad Humam Hamid^a

^a Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh, Indonesia

^b Dept. of Socio-economic of Agriculture, Andalas University, Padang, Indonesia

^c Graduate Program of Regional and Rural Development, Andalas University, Padang, Indonesia

ARTICLE INFO

Keywords:

Multi-hazards
Perception
COVID-19
Rural community
West Sumatera

ABSTRACT

Risk perception in a multi-hazard environment improves the ability of risk prioritization management. The undertaken approaches to reduce the negative impacts of the disaster differ from the single hazard's effects. This work applies an online survey targeting West Sumatra-Indonesia rural communities, aiming to examine their perception of multi-hazards during the COVID-19 pandemic. Descriptive statistical results show that drought, the COVID-19, and earthquakes were perceived to have a proportionally more significant effect on rural communities. Unlike urban areas, rural characteristics have created barriers for the COVID-19 to spread. As a result, the economic sector is considered as the most important factors in comparison to health. Labor migration and social conflicts become more apparent, whereas farmer groups were absent in providing basic supports to their members. Likely, borrowing cash from relatives and financial institutions would be the most applicable option to reduce farmers' vulnerability.

1. Introduction

Recent studies have shown a growing interest in focusing on multi-hazard analysis. Both theory and method of multi-hazard analysis have also been applied in several areas [1]. It arises because natural hazard risk assessments generally focus on a single type of hazards, such as floods, earthquakes, or landslides. In a multi-hazard analysis, the interaction between hazard characteristics and impacts should be considered. Hence, the assumption of isolation in the single-hazard risk assessment is not applicable [2,3].

Why is it important to understand multi-hazard analysis? First, the probability of a multi-hazard event is increasing as the population density is also growing [4]. Eventually, it will increase risk exposure across nations. Second, understanding and mitigating multi-hazard risks have become an important task to increase the resilience of critical infrastructure systems [4,5]. Third, multi-hazard risk analysis is more complex and challenging than single hazard risk analysis because different characteristics are involved in the process [1], e.g. hazard exposure, vulnerability and risk assessments [6]. Fourth, few studies are available on how individuals perceive and prioritize several hazards at once and their relation to implementing mitigation and adaptation strategies towards multi-hazards in developing countries [7]. Finally, the concept of multi-hazard and multi-risk is a relatively young concept of natural risk governance. Therefore, there are only a few multi-risk models coupled with practitioner experience in using these models [8].

* Corresponding author.

E-mail addresses: nugroho@unsyiah.ac.id (A. Nugroho), mahdi@agr.unand.ac.id (Mahdi), loratriana@agr.unand.ac.id (L. Triana), annisaumulf@gmail.com (A.U. Fitrah), humamhamid@unsyiah.ac.id (A.H. Hamid).

In addition, there are specific differences between the methodologies used in single-hazard and multi-hazard analyses. Several studies have proposed a multi-hazard risk framework based on probability; however, the quality and quantity of data required for such an approach are often unavailable in developing countries [2]. In general, researchers use geo-spatial and socio-economic data and modelling them into a multi-hazard map. In practice, this multi-hazard map helps local governments in planning, e.g. land use, sustainable infrastructure development, and integrated watershed management [3,9]. Tilloy et al. [10] propose another approach by identifying 19 different modelling methods. They measured multi-hazard linkages and grouped them into three models: stochastic, empirical, and mechanistic. Furthermore, there is another method called Multi-Hazards Risk Aggregation (MHRA) developed by Bani-Mustafa et al. [11].

Several studies specifically measure the dynamic interaction of cascading phenomena and their characteristics [12–14]; Suppasri et al., 2021). Of these, the number of studies addressing the more complex cross-border multi-hazard dynamics is still very few [15]. Experts begin by providing framework to understand cascading, compound, interacting, and interconnected risk to support the implementation of SFDRR [13]. Furthermore, others present a multi-hazard process through a physical-engineering approach, the possible interactions between separate hazards, and interactions between elements of vulnerability and hazards [16]; Suppasri et al., 2021). Zhang [17] concludes that a multi-hazard dynamic risk assessment requires a more comprehensive physical analysis than conventional analysis.

On the one hand, the interactions between environmental and anthropogenic processes are essential. Ignoring these interactions can distort disaster risk management priorities and increase vulnerability to hazards [18]. On the other hand, the geophysical-environmental factors of the main hazards need to be derived to identify the stable factor. Liu et al. [19] used these stable factors to determine which types of natural hazards affect a given area, and they classified the interactions between these hazards into four types: independent, mutex, parallel, and series interactions.

It is recognized that public risk perception is an important factor for the development of risk reduction policies. There is a lack of understanding of the types of hazards people pay most attention to and how they perceive other hazard groups [20]. This raises the question of how society responds to the effects of a single hazard or multiple hazards [21]. For example, some researchers have focused on the relationship between gender and understanding risk perceptions associated with multi-hazards to launch appropriate disaster risk reduction strategies [22]. Another study was interested in measuring perceptions of multi-hazard risk in the context of secondary school students [23]. Identification of risk perceptions involving the right multi-hazards can help in the decision-making process, for example, risk ranking [8].

Several studies on risk perception in the early stages of covid-19 in Indonesia have been done so far. For example, Harapan et al. [24] examine the socio-demographic factors affecting the level of coronavirus disease 2019 (COVID-19) risk perceptions using a cross sectional survey. Their findings suggest that citizens who lived in cities and healthcare workers also had a higher perceived risk compared to those in the rural areas and non-healthcare workers, respectively. Similarly, Nanda et al. [25] found that respondents' knowledge, type of occupation and geographical location have influenced risk perception toward covid-19. Nurrahmi et al. [26] also conducted study focusing on the influence of religion on risk perception by comparing precautionary behaviors in public and in mosques. Based on an online survey on 327 moslem men, their study shows that the adoption of protective behaviours was higher in public rather than in mosques and the multiple understanding of Islamic teachings has influenced perceived risk on protective guidelines. However, none of the previous studies discuss the risk perception in the context interconnected, interacting and compounding hazards in Indonesia.

This study uses an online survey targeting the people of West Sumatra-Indonesia, aiming to understand community perceptions and behaviours towards multi-hazards better. This is important because, during the COVID-19 pandemic, the aggregation of refugees into the communal environment and the increased demand for medical, economic and infrastructure capacity related to the impact of natural hazards can increase the risk and vulnerability of exposure to COVID-19 [27,28]. At the level of policymakers, studies related to the relationship between people's behaviour in the midst of a pandemic and multi-hazard threats are important to understand social and ecological risks and prepare appropriate strategies from the local community to the intergovernmental level [29,30].

Most of the agriculture in West Sumatra-Indonesia has been arguably affected by the spread of the coronavirus (COVID-19), such as a decrease in the number of customers and market demand, the price has dropped very dramatically, and the conditions of the rural communities, e.g., farmers, into a more complicated situation. At this stage, the call to *stay at home* is not effectively applied to the farmers due to their dependence on farming [31].

On the one hand, labor-intensive farmings may create COVID-19 new contagious clusters in rural areas since the likelihood of contact borne spreading is higher [32]. On the other hand, food sovereignty is the most important aspect which may affect national security [31,32]. As the domestic food supply inadequate, import becomes one of the alternatives to provide balance. However, the government's spending on imports will eventually deteriorate the fiscal budget. Furthermore, the economic impact of COVID-19 requires abundant spending to protect the health system, provide cash transfer, and basic needs. In the revenue side, COVID-19 has caused major force in business so that companies must take efficiency steps and reduce the number of employees. Income from the tax will be more fragile. Hence, difficult options must be chosen to protect food sovereignty, and one of them is to let farmers produce foods under new normal circumstances.

The West Sumatra Province is prone to several major disasters such as earthquakes and tsunami, floods, drought, and landslides. A 7.6 M of earthquake devastated Padang city on September 30, 2009, resulted in 1117 death tolls [33]. Single hazard may be perceived specifically in relation to the mitigation steps prioritization. However, a similar approach may not function under the co-occurrence of multi-hazards event [34,35].

The structure of this paper is as follow: the background and motivation of the study is described in the introduction; section two describes the area of the study, questionnaire design, socio-demographic of the respondent and analysis method; section three provides

result of the findings and discussion; and the conclusion is provided in section four.

2. Methods

2.1. Survey

In this study, we examine the views and perceptions of natural hazards commonly occurring in 11 districts in West Sumatra Province-Indonesia and add the risk of the COVID-19 pandemic. The hazards include floods, EQ, drought, wildfires, landslides, typhoons, against the current global pandemic, i.e., COVID-19. The detailed survey locations is shown by Fig. 1.

We constructed an online survey questionnaire using Google Form. Our local surveyors in each district conducted the interviews and assisted them to deal with technical issues. We used an area/a clustered random sampling technique. First, we divided our population in West Sumatra province into districts/clusters. Out of 19 districts, 11 districts were selected randomly. The districts are: Agam, Padang, Padang Pariaman, Padang Panjang, Pasaman Barat, Paya Kumbuh, Pesisir Selatan, Sawah Lunto, Sijunjung, Solok, and Tanah Datar. The local surveyor in the each district then selects the sample randomly. In total we gathered 122 respondents. Some areas are characterized either by poor internet connections or by unavailability of devices e.g. smartphones. We could not solely share the Google Form link directly to the respondent in regions. Therefore, the role of local surveyors in each district is essential to collect responses from the respondents. We do understand the limitation in the number of respondents in this study. However, at this stage, we do plan to proceed into statistical inference, which may lead to some statistical biases. We prefer to provide ‘initial’ works and describe the finding descriptively. The respondents were required to answer each survey question. The type of survey questions was closed-ended questions: Rating scale (Likert-type scales), multiple-choice questions, and dichotomous. The questionnaire was distributed online for six days (20–25 July 2020). It was structured in the following order:

- Section 1: survey introduction
- Section 2: demographics profile of the respondents (i.e., gender, age, education, expenditure, etc.)
- Section 3: hazard perceptions (impacts, worry, and the likelihood of occurrence)
- Section 4: production characteristic shifts during COVID-19.
- Section 5: labor mobility (job loss, labor migration, etc.)
- Section 6: perceived social conflicts and social network (perception of migrants and farmer group)
- Section 7: mitigation plan (stay at home, applying other occupation, selling assets, etc.)

2.2. Sample profile

Table 1 provides a summary of participant demographics compared to the West Sumatran farmers. Compared to male, females are

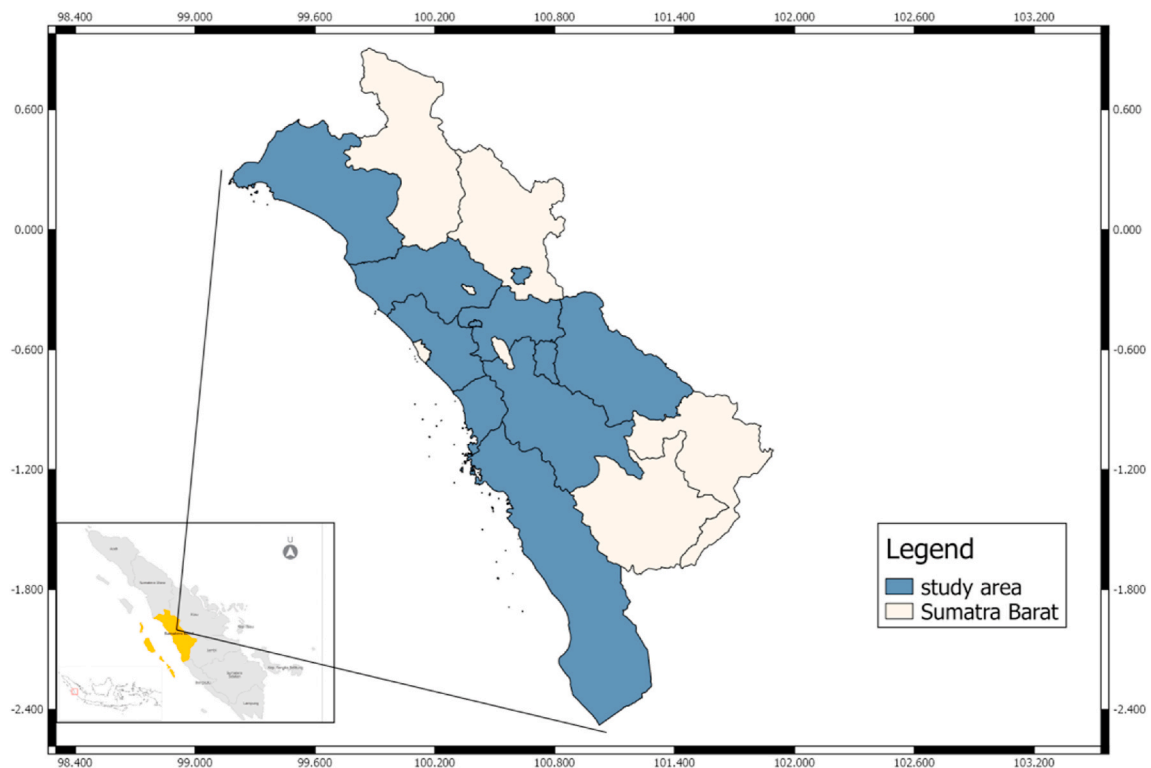


Fig. 1. Study area: Sumatra Barat province, Indonesia.

slightly overrepresented (59% of the sample), and most of the samples (81%) depends on farmings as their main income. Approximately 44% of the respondents are monoculture in paddy; 30.33% of the respondents combine their crop between paddy and other edible crops such as corns, beans and other vegetables; whereas the remaining 25% are palm oil farmers. In terms of land ownership, the portions of the respondents are relatively balanced either self-owned or rented. Most of the land is less than 1 ha meaning that farmers work in a relatively small scale of farming. Most of the respondent also live in their own houses (82%) while the rest live in rental houses.

This study faced significant challenges when we conducted an online survey targeting farmers living a remote areas. Respondents with ages between 46 and 65 years old are more dominant and the year of schooling is relatively low. This implies less familiarity with mobile phone application and the difficulty in getting a better internet connection during the data gathering. The age demography of the respondent also implies a decreasing trend in the farming productivity in the near future. Additionally, equipments such as mobile phones or laptops are perceived as superior goods since their monthly expenditures are less than IDR 1 million.

2.3. Analysis methods

A five-point of Likert-scale questions were coded on responses, such as 1 = “strongly disagree”, 2 = “disagree”, 3 = “neutral”, 4 = “agree”, and 5 means “strongly agree”. To some extent, the codes consist of “very low” to “very high” on the degree of worriedness; “very unlikely” to “very likely” on the degree of occurrence; and, “insignificant” to “severe” on the degree of impacts. Some statements also required responses in the form of “Yes” or “No”. We treated income, and age level variables as continuous. Gender, occupation, farming types, house and land ownerships and education variables are treated as categorical. To assess the survey responses, a simple statistical analysis was applied. Descriptive and statistical analyses were assisted by computer software STATA.

3. Result and discussion

3.1. Hazard perceptions

Participants were asked about their overall perception of the importance of the risks, the worry they feel about each of them, as well as their view of the likelihood of each hazard's occurrence. Table 2 shows the descriptive statistics for the three variables of threat perception: Risk perception, worry, and perception of the likelihood of occurrence of each hazard.

On a 1 to 5 scale, with 1 indicating “insignificant” and 5 indicating “severe” impact, the average risk perception is found to be the highest for drought (mean value = 3.98), followed by COVID-19 (mean value = 3.81), and EQ ($M = 3.68$). In terms of likelihood, we see a roughly similar result.

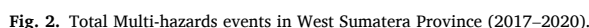
Overall, drought is perceived as the first rank in terms of worry, the likelihood of occurrence, and impact. Earthquake and the

Table 1
Profile of the respondents.

Demographic Statistics			
Characteristic	Sample (%)	Characteristic	Sample (%)
Gender		Main Occupation	
Male	40.98	Farming	81.15
Female	59.02	Non-Farming	18.85
Farming types		Land size	
Paddy	44.26	<0.5 Ha	42.62
Paddy and edible crops	30.33	0.5–1 Ha	44.26
Others than paddy	25.41	>1 Ha	13.11
Land Ownership		House Ownership	
Owned	50.82	Owned	82.79
Rented	49.18	Rented	15.57
Age		Expenditure	
<25 yo	8.20	<1 mil	67.21
26–45 yo	35.24	1–2 Mil	17.21
46–65 yo	52.46	3–4 mil	14.75
>65 yo	4.10	>4 mil	0.82
Dependants		Distribution of sample	
1	16.39	Agam	8.20
2	24.59	Padang	9.02
3	22.13	Padang Panjang	1.64
>4	36.89	Padang Pariaman	8.20
Education		Pasaman Barat	23.77
Primary	31.97	Paya Kumbuh	8.20
Junior HS	20.49	Pesisir Selatan	8.20
Senior HS	36.07	Sawah Lunto	9.02
University	11.48	Sijunjung	8.20
		Solok	8.20
		Tanah Datar	7.38

Hazard Type	Obs	Worry		Likelihood of occurrence		Perceived Impact	
		Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Flood	122	3.20	1.62	2.64	1.27	3.49	1.46
earthquake	122	3.60	1.49	3.47	1.19	3.68	1.41
Fire	122	3.21	1.42	2.68	1.03	3.38	1.31
Landslide	122	2.84	1.45	2.41	1.26	3.00	1.33
Drought	122	3.91	1.26	3.63	1.14	3.98	1.15
Typhoon	122	3.39	1.48	3.04	1.41	3.37	1.40
COVID-19	122	3.69	1.46	3.31	1.35	3.81	1.43

Data on positive cases of the COVID-19 during 2020 in West Sumatra Province on March 25th, 2020, showed 0 cases. Afterward, the COVID-19 showed an increasing trend of 52 cases by April 25th, 190 cases by May 25th, and 100 cases by June 25th (corona.sumbarprov.go.id). When the survey was conducted in July 2020, the number of positive cases was still relatively high, at 86 cases. News coverage in the mass media related to the COVID-19 contributed to the increasing worry and impact perception. The two scores of the perception (worry and impact) exceeded the score of the earthquake. Djalante et al. [37] point out lack of data transparency during the early occurrence of covid-19 and its impact on public trust. The lack of data transparency leads to misinformation regarding the number of actual cases detected, the lack of proper diagnose and false information regarding testing kits. Distorsion of the news



coverage also affected local community perception on the state of local transmission which lead to improper and untimely efforts of protection [38]. Nevertheless, most of the respondents live in rural areas, and the score of the likelihood of getting infected by the COVID-19 virus is slightly lower than that of an earthquake.

Similar to Papagiannaki et al. [20]; ranking estimated from multi-hazards risk perception can be biased due to several conditions. In many cases, losses due to floods are normally higher than those caused by either drought or the COVID-19. Flooding also deprives the affected victims of their livelihood opportunities and forces temporary migration to evacuation centers.

In this survey, floods, landslides and typhoon are also considered less likely to occur than some other types of disasters. Meanwhile, historical data shows that those three disaster recorded as the highest event among the natural hazards (Fig. 2). However, flood risks are perceived to have a low and temporary impact on the community. Finally, in terms of worry, the floods score was relatively lower than that of earthquakes and droughts, and covid. This study suggests that some communities living in floods prone along the river basin possess higher familiarity with the flood hazards.

3.2. The shift in production and labor migration

The impact of COVID-19 on the general population's health is no doubt. Globally, as of 4:03 p.m. CEST, June 30, 2020, there have been 10,185,374 confirmed cases of COVID-19, including 503,862 deaths, [39]. However, its impacts on specific samples (i.e., farmers) have not been observed clearly. Many underlying assumptions affect to which sectors or aspect COVID-19 have a negative impact most. For example, rural communities are assumed to be less mobile due to undeveloped transportation infrastructures, less openness, small, diverse main occupations (mostly are farmers), and a higher level of food independence (self-produced). Those characteristics may contribute to the low level of COVID-19 contagious in rural areas. As a result, sectors other than health may be more affected.

This study found that farming activities during the COVID-19 pandemic in the rural areas are less stringent compare to the activities in the urban areas. The economic sector (93%) has been perceived as the most severe sector affected by COVID-19, followed by social sector (7%). The other three sectors (health, education, and religious) gained zero responses regarding the impact of COVID-19. We displayed the economic and social impact according to educational level of the respondents as illustrated in Fig. 3. Most of the respondents coming from primary dan senior high school agreed that the pandemic has caused negative impacts on their economies. Rural economies resourced by labors with relatively low educational levels. This situation limits the opportunity for the rural youth to look for jobs available for university graduates. Similarly, the majority of youth graduated from senior high schools agreed that the pandemic affected the youth's social relationships. As a result, the pandemic has narrowed the economic and social activities especially for the respondent who have not gained degree from higher educations.

There is a tendency that farmers reduced outside activities including farmings (54%) and applied physical distancing (87%). Fig. 3 shows that most respondents with primary school (48%) in their education stated that they continued to work to the paddy fields as usual despite the pandemic. This category also took no actions regarding health protocols such as wearing masks and, or social distancing. Meanwhile, the respondents with an education equivalent to high school (40%) stated that they reduced their farming activities gradually as well as possessed higher degree of health protocols awareness.

Furthermore, this study shows a direct impact of the COVID-19 on fertilizer availability and price as well as yield price. On the one hand, farmers agree that the fertilizer became rarer (61%), and the prices have been increasing in the market (93%) (Fig. 4). On the other hand, there is a decreasing trend in both crop prices and quantity of crop sales. Worse yet, farmers' expenditure on agricultural inputs increased implies a greater burden in the rural economies.

Fig. 5 shows the influence of COVID-19 on labor mobility. Approximately 82% of farmers perceived that labors were scare. Similarly, 80% of the respondents found difficulty in accessing the machineries. In terms of internal mobility, the existing labors preferred to stay at home and reduced outside activities due to COVID-19. On the contrary, 88% of farmers agree that external mobility

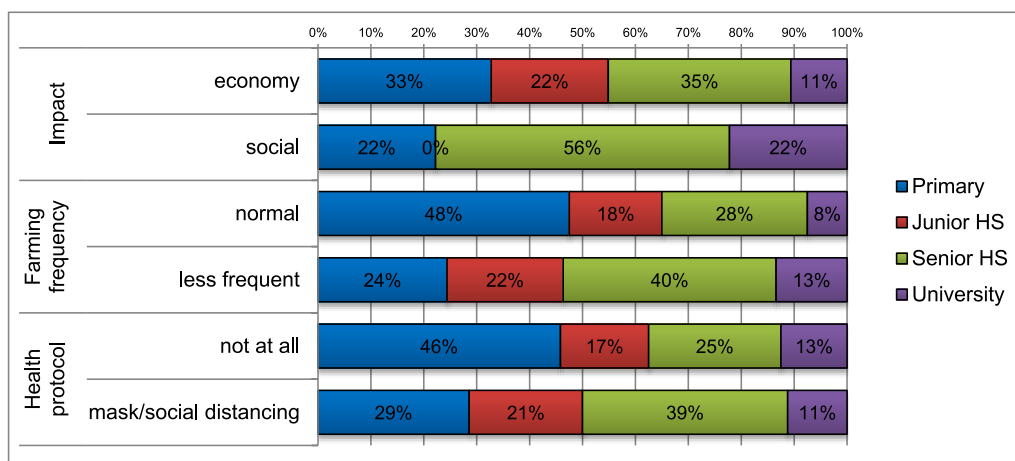


Fig. 3. Behavioural changes and perceived impact of the COVID-19 in rural farmings.

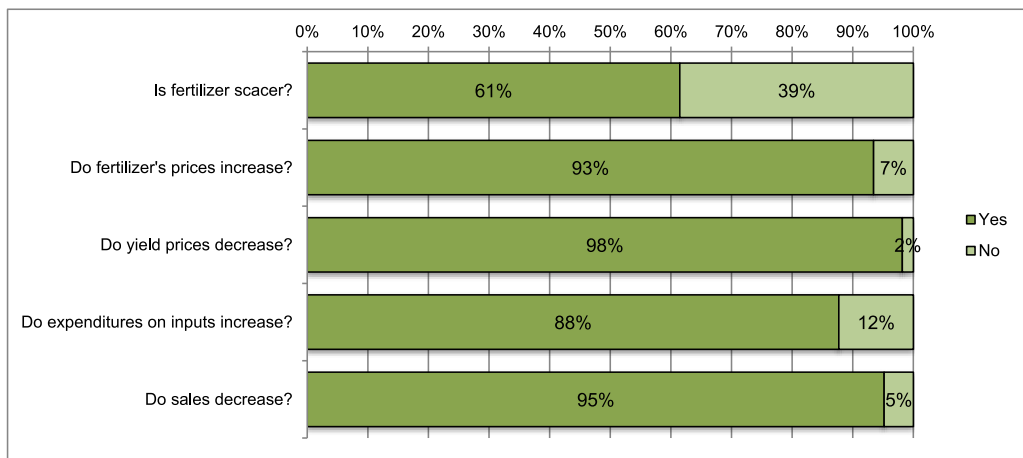


Fig. 4. Characteristics of farmings during COVID-19.

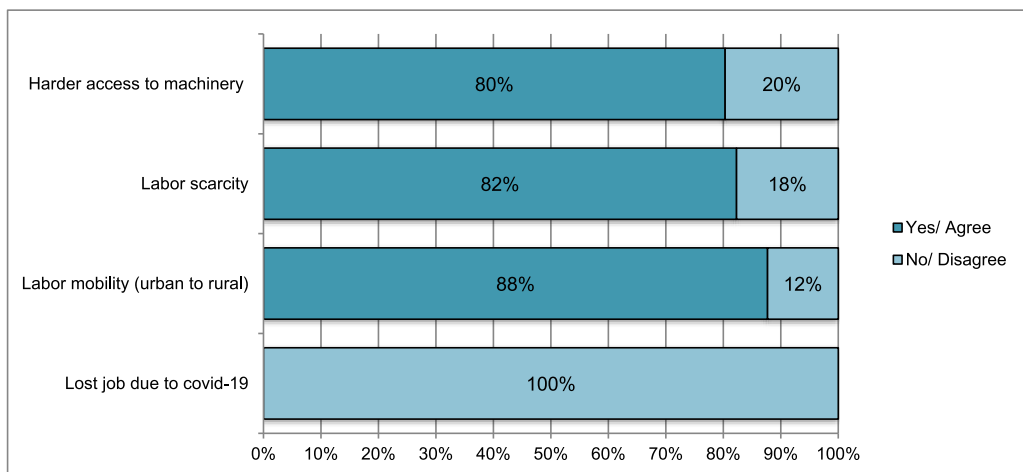


Fig. 5. Labor mobility during COVID-19.

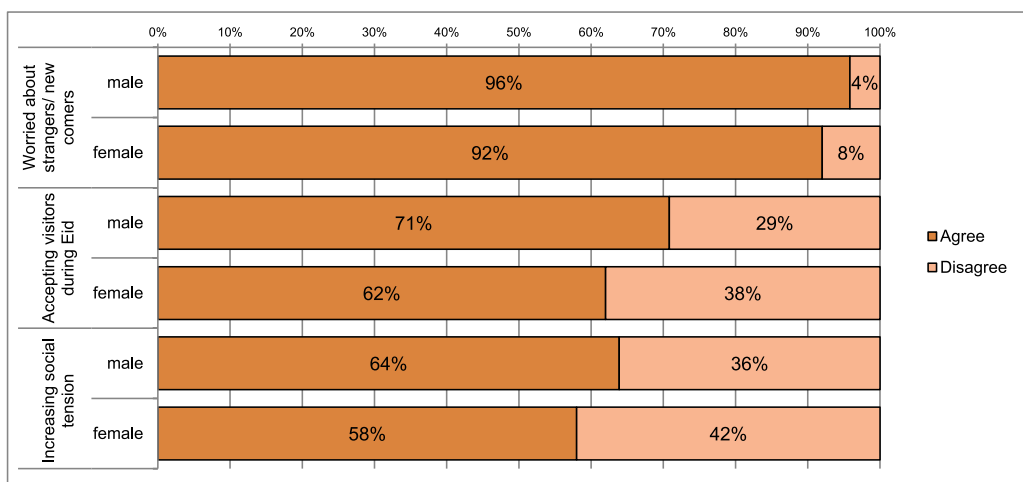


Fig. 6. Social impacts of COVID-19.

were increasing since more relatives were returning back to their villages and involving in agriculture. It implies a strong evidence on reverse migration, a temporary mobility from urban to rural areas due to the pandemic. Additionally, this finding shows that rural environment may provide buffers in terms of life safety and substitute employment. The reasons for reversed migration include termination of the previous job in the urban, to reduce the possibility of being infected by the virus, and to reduce the negative impact of COVID-19 on their economies. However, this study reported that no farmers have lost their primary job in agriculture.

3.3. Social conflict during COVID-19

The *back to village* phenomenon has created tension and increase distress to rural inhabitants. Many of them (92%) were worried that the migrants would bring and spread the virus to the whole community (Fig. 6). On the contrary, this study found that rural inhabitants (67%) were not reluctant to welcome relatives or guests (both from the near neighborhood and other regions) during the *Islamic Calendar of Eid Mubarak* (last week of May). Overall, most of the respondents (61%) agree that COVID-19 has increased social conflict among the communities.

3.4. Social network and vulnerability

This study also investigated the role of social network and institutional supports, which are two strong features of social capital in Indonesia. It has been known that farmer groups play an important role in the paddy cultivation. Key aspects of farmings such as inputs, machinery, subsidy, irrigation system, and planting calendar have based the agreement of the farmers in their groups. Fig. 7 illustrates the relationship between social networks and farmers' vulnerability. Approximately 80% of the samples in this survey are joining in the farmer groups. During the COVID-19, farmers (64%) mentioned that the farmer group has no effect on their resilience. However, the affected people (the poor, unemployed, widow, and other vulnerable population) have been given Village Fund Cash Transfer (BLT-DD) at IDR 600,000 per person for a period of three months. This indicates that there was a separation between paddy related effect and disaster-related effect in general. If the disaster affects paddy cultivation, normally, the group will support farmers in order to reduce the negative impacts such as by providing subsidy, free seeds, and machinery with no rental cost. However, in terms of COVID-19, the group seemed not to have guidance or experience on how to protect their member.

Additionally, the respondent was asked to assess their current vulnerability related to or without aid/life supports. Around 71% of the respondent clearly stated that they were in a vulnerable situation and deserved to receive life support from the government. In more detail, the percentage of agreement is lower (54%) when they were asked a question on whether farmers would survive to continue their life without external supports.

3.5. Mitigation plan

Under a specific hazard, farmers normally will able to create mitigation steps to reduce the impact of such a natural disaster e.g., flood or drought. However, more complex preparedness actions will be needed due to co-occurrence catastrophes i.e., COVID-19 and flood. Flood victims may be evacuated under the same evacuation center. However, the same flood protocols during COVID-19 will cause the spread of the virus more uncontrolled. Here in this study, we selected the option which may appropriate during single or multi-hazard events. Fig. 8 shows that it is unlikely (54%) for farmers to stay at home, leaving their land unproductive. It is also very unlikely (61%) for farmers to increase their food reserves due to cash needed. Selling assets such as jewelry, cattle, or other valuables were complicated options for farmers since 94% of the respondents have not decided yet, and the remaining answer is unlikely (6%). A similar pattern is also found on the question of whether the farmers plan to find another occupation in the future (63% stated not decided). Lastly, borrowing money from relatives or financial institutions may be the most preferred option (47%) available if the disaster becomes more severe in the future.

4. Conclusion

This study concludes that the risk perception assessment in a multi-hazard environment is a useful tool to better understand risk prioritization. Under the COVID-19 pandemic, this study contributes insight on how rural communities in West Sumatra-Indonesia perceived the risks and defines the relationship between the socio-economic of paddy farmings and natural disasters. Tangible impacts due to natural disasters are perceived as the major threats to the rural communities' livelihood. Consequently, drought or earthquake was perceived consistently having a greater effect on rural communities.

Additionally, the COVID-19 gives a greater impact on rural economies and social rather than on health, education, or religion. The *work from home* is the most irrational issue for the rural communities since they have to work physically to cultivate the land or to continue productions. This study also implies that a shift in the paddy production system, caused by the COVID-19, was directly correlated with the shortage and the increase of fertilizer price. Although the effect of labor migration from urban to rural areas was still ambiguous, this study implies that this migration has potentially increased tension on social distress. Institutionally, farmer groups seemed to be more passive in giving support to their member due to lack of experience such as COVID-19. This study suggests that cash transfer may be the most applicable policy implication since other mitigation plans may not work well under pandemic situations.

We have explored initial study that can help to develop more understanding on risk perception which will help stakeholders and academics to improve the ability of covid-19 risk prioritization management particularly in the rural areas. There are significant limitations of this study that must be reviewed. First, the readers should note that this article does not cover large regions/province in Indonesia. Instead, it provides an initial review for those readers who are interested in the interconnected issues between multi-hazards risk perception and covid-19 occurrence in the selected region. Future research should better consider both qualitative and quantitative approaches in terms of the. In other words, new research should be developed on how to measure the cascading impacts of covid-

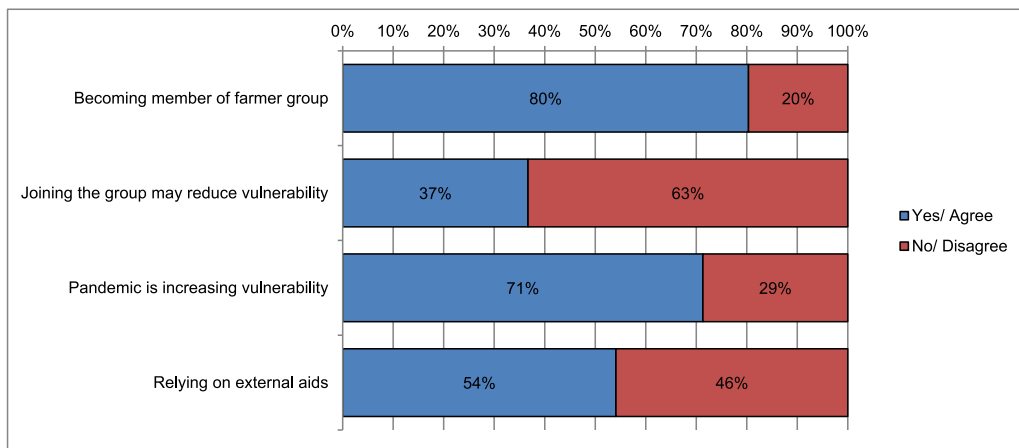


Fig. 7. Social network during COVID-19.

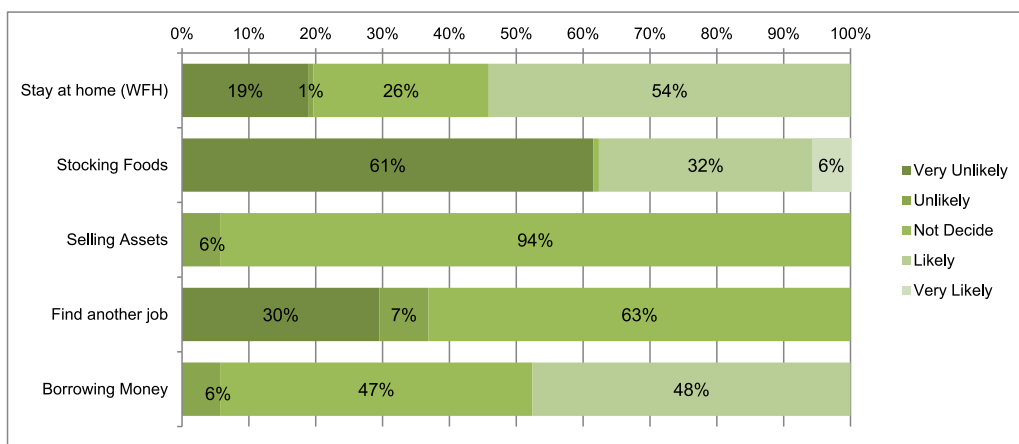


Fig. 8. Mitigation plan.

19 among multiple hazards in certain areas. Reverse migration phenomenon, social tension and mitigating strategies also needs to be addressed in terms of their motivation, changes and impacts in the social structure.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Authors wishing to acknowledge financial support from the Ministry of Education and Culture Republic of Indonesia under the scheme of PPM-UPT research grant for the year 2020-2022.

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