Resilience Of Affected Wetland Rice Farmer Households Flooding: An Integrated Model

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ABSTRACT

Natural disasters can hamper development plans, especially in the development of food commodities. A major impact is felt by rice farmers due to the occurrence of flood disasters that often come and affect the continuity of their farms. There are many disaster-prone areas so that efforts are needed to reduce the risks that occur from these disasters. The purpose of this study was to analyze the determinants of resilience of households of rice farmers affected by flooding. This research uses a quantitative analysis approach with a survey method. The research data were collected through primary and secondary data. The respondent sampling technique used multi-stage cluster random sampling with a total of 306 respondents. The results showed that mitigation, adaptation, coping mechanisms, and risk levels had a significant influence on the resilience model of households of flood-affected wetland rice farmers. The significant influence of mitigation and adaptation that has been carried out can be seen from farmers' perceptions of the level of risk that is categorized as low. Although floods occur every year, with a span of more than three months, it does not discourage farmers to continue cultivating rice. Furthermore, the process of disaster adaptation carried out by farmers continuously and repeatedly creates a high level of resilience by carrying out a form of adaptation that is deemed appropriate to deal with flood disasters that hit their rice fields. Therefore, this research can be a reference for practitioners in increasing the intention of resilience actions against natural disasters that occur. Furthermore, the need for policies from the government to respond to natural disasters so that they do not have a long impact on the continuity of farming that is managed.

Keywords: natural disasters; food commodities; paddy; wetlands

INTRODUCTION

Disaster events create a major impact on changes in community conditions physically and non-physically. A natural disaster is an event that can occur suddenly so that it has an impact on the disruption of community activities (Drake et al., 2023). In tropical conditions with two seasons, namely the rainy season and the dry season, there are extreme changes in wind direction, temperature, and weather. The number of disaster-prone areas strengthens the assumption that efforts are needed to reduce the risks that occur from these disasters (Hadiani etal., 2021; Erlandsson et al., 2023).

Flooding is one of the natural disasters where an area or land is submerged due to increased water volume (Angelakis et al., 2023). Floods can occur due to increased rainfall and have an impact on economic losses and hampering daily activities for the community (Hu et al., 2021). Referring to the perspective of disaster events, West Java Province is the highest location for disaster events nationally (Cahyo et al., 2023 & Rahayu et al., 2023). Catastrophic events are not only caused by natural factors but also by natural disasters. Flooding is also caused by human factors, one of which is the change in watershed conditions (Sebastian, 2008).

Changes in watershed conditions include the destruction of river flow retention caused by various things both natural and human, the development of various infrastructure and land in the watershed, the deforestation that is carried out continuously, the expansion of urban land that erodes the green environmental area of the watershed, and changes in land use in the watershed (Apriani, 2018). These changes in conditions can worsen the impact of flooding due to the increased water flow that occurs. Fatal flood conditions caused by watershed conditions are detrimental to the environment and surrounding ecosystems, where one of the sectors most affected by these impacts is the rice paddy agriculture sector (Imai et al., 2022).

Referring to the perspective of flood disasters that occur, it is necessary to take action to mitigate disasters so that when the rainy season comes, it can reduce the risk of hydrometeorological disasters (Haidar et al., 2022). Handling flood disasters is not only in the form of physical assistance, but also providing counseling and debriefing to the community about disasters. The community must anticipate disasters by cleaning sewers, canals, irrigation, and rivers so that they do not become the initial trigger for flood disasters (Fatmah, 2022).

As an effort after disaster mitigation is carried out, it is necessary to have an adaptation process from the community in order to find ways to adjust to the conditions of natural disasters that continue to occur (Chowdooree et al., 2020). Adaptation is a personal adjustment to the environment either by changing the personal self-according to the state of the environment or changing the environment according to personal wishes (Watkins et al., 2023). Various studies have shown that without adaptation, climate change in general will have very damaging effects on the agricultural sector (Bryan et al., 2009). Farmers' adaptation to climate change involves adjusting practices and processes to minimize the negative impacts of climate change in the present and future.

Given that the mitigation and adaptation processes that occur need to run in harmony, the support of coping mechanisms is defined as cognitive and behavioral efforts to cope, reduce, and withstand demands (Folkman, 1984). Coping mechanisms are needed to anticipate the challenges faced, namely the flood disaster that occurred. This condition is very worrying because it affects agricultural production which results in food insecurity so that it will affect the food security of people living in affected areas (Karki Nepal & Neupane, 2022).

In disaster risk analysis, there is a factor of vulnerability or low community resilience in accepting threats that affect the level of disaster risk. Vulnerability can be seen from environmental, socio-cultural factors, social conditions such as poverty, social pressure and a non-strategic environment that reduces the community's resilience in accepting threats. receive threats (Szewranski and Kazak, 2020).

The magnitude of risk can be reduced by the ability of communities that have the power and ability to assess and assess threats and how communities can manage the environment and existing resources (Keitumetse, 2014). In this condition, the community as a beneficiary and recipient of disaster risk becomes an important part as a key actor in environmental management to reduce disaster risk (Chuang et al., 2023).

As an effort to manage the level of risk of disaster events that occur, it is necessary to support the concept of resilience. Resilience is the ability to bounce back from adversity and become stronger and thrive after going through a crisis (Walsh, 2006). The effect of the level of risk on resilience in farmers is complex and varies depending on various factors, including the type of risk, the adaptive capacity of farmers, and local environmental conditions (Kalogiannidis et al., 2023).

The conditions under which risk levels can affect farmers' resilience to disasters can be seen from several aspects, including high risk levels such as extreme weather risks or climate change can test farmers' resilience and increase the need for effective adaptation strategies; more resilient farmers may have better agricultural diversification or risk management techniques to maintain the sustainability of their food production; more resilient farmers may have income diversification, savings, or access to financial services that can help cope with economic stress; high levels of risk may encourage farmers to seek innovative solutions or adopt improved technologies to increase resilience to challenges; farmers' resilience can be enhanced by improving their access to resources and services that support sustainable agriculture (Bohaen et al., 2014)., 2023).

Therefore, this study aims to analyze the determinants of resilience of flood-affected wetland rice farmer households that are influenced by mitigation, adaptation, coping mechanisms, and risk levels. The results of this study provide an empirical reference to increase the level of resilience of wetland rice farmers affected by floods. The practical implications resulting from this research are, (a) for farmers, this research is expected to be used as a basis for development in the application of the resilience level of flood-affected farmers starting from the cultivation aspect to increase farmers' understanding to take further action in anticipating and overcoming disasters that occur which will ultimately improvethe welfare of farmers and have implications for the sustainability of their farms; (b) for the government, this research is expected to be a consideration for making policies to increase farmers' resilience to disasters by understanding the various characteristics of farmers, differences in farming agroecosystems and considering the model compiled as a policy basis in increasing the level of resilience offarmers to disasters.

MATERIALS AND METHODS

Research Methods

This research uses a quantitative method with a verification method approach used to test the truth of a hypothesis carried out through data collection in the field. The sampling technique used multi-stage cluster random sampling (Widayanto et al., 2021). Data were collected from 506 farmer respondents through the distribution of questionnaires and in-depth interviews. All research respondents were selected from the agricultural sector with a livelihood as afarmer. Respondent farmers are wet-rice farmers who annually have paddy fields affected by floods.

In this study, the variables were measured using a Likert scale, which regularly gives a value of 1 to 5 categories, ranging from strongly disagreeing (1) to strongly agree (5) and involves respondents to decide whether their answers agree or disagree with a set of statements about a particular object or situation.

The formulation of hypotheses in this study has gone through a screening process by meeting certain criteria, namely stating the relationship between two ormore variables, can be tested, based on facts, and must be based on opinions or theories from experts or other relevant research results. In addition, triangulation of research data sources is carried out by checking the validity of data by utilizing various data sources such as documents, interview results, observation results, or also by interviewing more than one subject who is considered to have a different point of view.

Measurement Scale

As a measurement instrument, this study used a modified multi-item scale from the previous one. As mentioned below, most of the scales in this study were adapted to suit the context of the indicators.

Table 1. Variables and Measurement of Research Model

Variables	Indicators	Sources
Mitigation	Structural	Coppola (2015); Badan Nasional Penanggulangan Bencana (2017)
	Non structural	
Adaptation	Physical and environmental	Sunaryo (2002); Robbins (2003); Moran (1982); Sahlins (1968); (Hardoyo et al., 2011); Soerjono Soekanto (2000)
	Social	
	Economy	
	Institutional	
Coping Mecanism	Problem focused coping	Nevid, Rathus & Greene (2003); Lazarus and Folkman (1984); Parker and Endler (in Elfida & Nesfvi (2009)
	Emotion focused coping	
Risk Level	Danger	
	Vulnerability	
	Capacity	
Resilience	Duration of the situation difficult	Benard (2004); Connor and Davidson (2003); Everall, Alrows, and Paulson (2006); Walsh (2006)
	Development family	
	Source support	

Data Analysis and Hypothesis Testing

The hypothesis test used is the Structural Equation Model (SEM) to determine the direct effect between variables. This study uses path analysis to determine the effect of mitigation, adaptation, and coping mechanisms on the level of risk and resilience. Path analysis is based on structural equation analysis (SEM) using Partial Least Squares (PLS), while SEM is a variant-based statistical method designed to solve multiple regression when specific problems occur in the data.

To test the construction validity and reliability of the instrument, a measurement model in the form of confirmatory factor analysis was used. The correlation between indicators and variable scores indicates the convergent validity of the measurement model. If the AVE value and variable dimension outer loading both have a loading value greater than 0.5, then the indicator is considered valid. Composite reliability and Cronbach's alpha values greater than 0.7 are used in the reliability test. The t-statistic value of the test parameters and the p-value are obtained from the structural model to predict the evidence of the causal relationship using the bootstrapping process (Hair Joseph et al., 2016).

RESULTS

Before discussing further about the test results and factors affecting the resilience model of flood-affected rice paddy farmer households, a description of the research data will be conducted first. Furthermore, the model will be tested on the data that has been collected using the test instrument. A more detailed discussion will then be described in the discussion sub chapter.

Measurement Model Testing (Outer Model)

Convergent validity is carried out to test the level of items that are accurate to measure the object of research. In this study, convergent validity can be seen from the loading factor test results. The following are the results of convergent validity testing which consists of loading factors, composite reliability, and average variance extracted described in Table 2.

Table 2. Convergent Validity Test

Variables	Indicators	Loading Factor	Composite Reliability	AVE
Mitigation	Structural	0.625	0.746	0.601
	Non structural	0.907	0.923	0.668
Adaptation	Physical and environmental	0.672	0.718	0.551
	Social	0.942	0.956	0.844
	Economy	0.793	0.864	0.682
	Institutional	0.846	0.892	0.735
Coping Mecanism	Problem focused coping	0.641	0.770	0.631
	Emotion focused coping	0.891	0.921	0.796
Risk Level	Danger	0.653	0.793	0.553
	Vulnerability	0.894	0.920	0.698
	Capacity	0.878	0.888	0.576
Resilience	Duration of the situation difficult	0.799	0.906	0.829
	Development family	0,908	0.940	0.839
	Source support	0.815	0.915	0.844

Based on Table 2, the loading factor value of each indicator is greater than 0.5. This implies that each indicator of the latent variable can be used as a measuring instrument. The idea of discriminant validity states that the manifest variables of various constructs should not be highly correlated. Therefore, composite reliability and Cronbach's alpha were used for reliability testing in this study. Although a value of 0.5 is acceptable, the alpha value or composite reliability value should be greater than 0.7 as a general rule (Table 2).

Assessment of Goodness of Fit

The goodness of fit index can be determined using the global optimization criteria identified with path modeling in PLS. The goodness of fit index or GoF index is used to evaluate structural and measurement models. The GoF index also provides a direct measurement of the predictability of the model as a whole. Referring to (x103), the GoF value criteria are 0.10; 0.25; and 0.36, which indicate that the GoF is small, medium, or large, respectively. The information in Table 3 can be used to determine the GoF value.

Table 3. GoF value

Variables	R^2	GoF
Mitigation (X1)	0.964	
Adaptation (X2)	0.959	
Coping Mechanism (X3)	0.795	
Risk Level (Y1)	0.975	
Resilience (Y2)	0.959	
Average	0.930	
GoF		**0.809**

Based on Table. 3 results show that the GoF value is 0.809. Thus, the model is included in the large criteria, where the greater the GoF value, the more appropriate the model is in describing the research sample.

Test Results of the Partial Least Squares (PLS) Structural Model

Each relationship is tested in the PLS model by simulating the sample using the bootstrapping technique. The purpose of this test is to reduce the amount of abnormal research data. The following are the results of the PLS-SEM analysis bootstrapping test, shown in Figure 1.

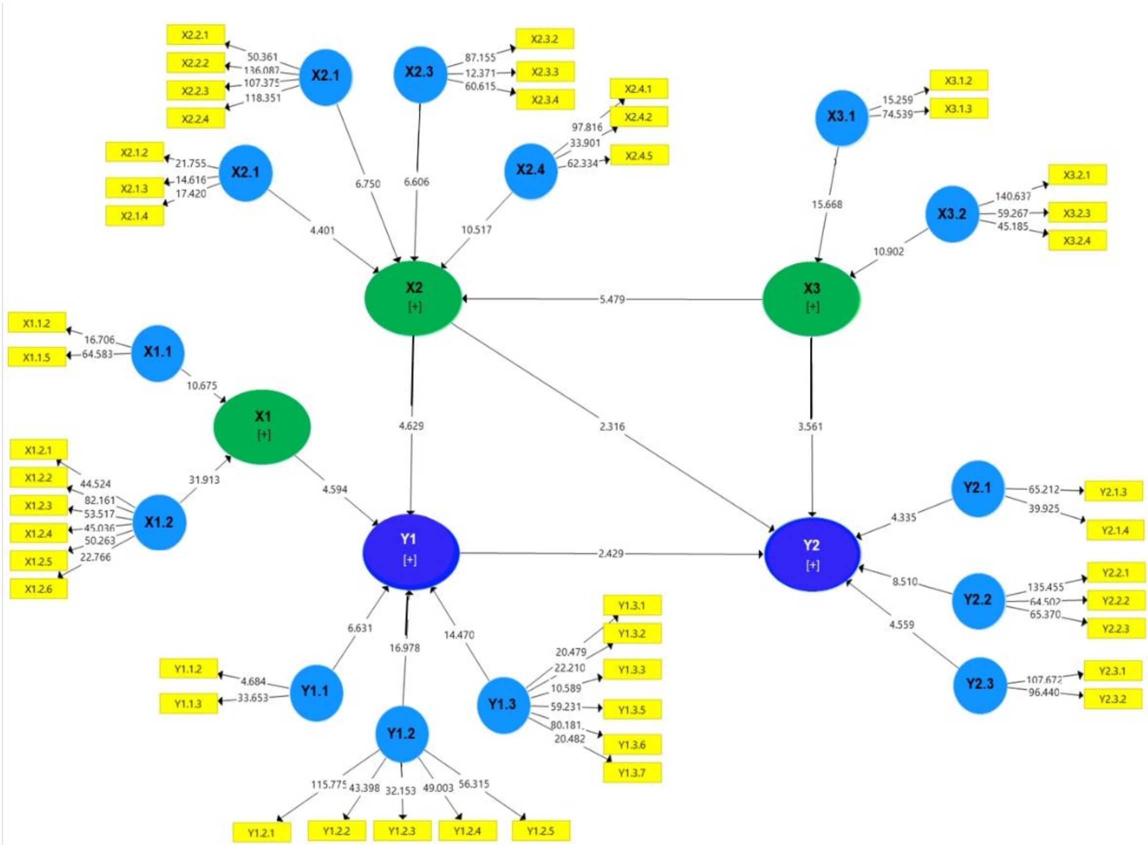

Figure 1. Output of Bootstrapping

Hypothesis Test

Two hypotheses need to be tested in this study, namely:

1. The level of risk is influenced by mitigation and adaptation both simultaneously and partially.
2. Resilience is influenced by adaptation, coping mechanisms, and the level of risk both simultaneously and partially.

Where, the t-statistic value and path coefficient are two criteria used in hypothesis testing. A positive path coefficient indicates that a variable has an influence on the variable it affects. A negative path coefficient indicates that a variable has the opposite effect on other variables. The hypothesis of this study can be accepted if the t-count (t-statistic) value is higher than the t-table for a prediction error of 5%, which is 1.96. The research path coefficient and research t-value are shown in Table 4.

Table 4. Research results of the Hypothesis Test

Hypothesis	Path	t-value	p-value
Mitigation → Risk Level	0.130	4.594	0.000
Adaptation → Level of Risk	0.133	4.629	0.000
Adaptation → Resilience	0.131	2.316	0.023
Coping mechanism → Resilience	0.237	3.561	0.001
Risk Level → Resilience	0.150	2.429	0.017

Based on Table 4. the two hypotheses proposed in this study are "accepted", where the mitigation and adaptation variables each have a t-value> t-table (1.96) so that it can be interpreted that the two variables have a significant and positive effect on the level of risk. Likewise, the adaptation variables, coping mechanisms, and risk levels each have a t-value> t-table (1.96) so that it can be interpreted that the three variables have a significant and positive effect on resilience.

DISCUSSION

Effect of Mitigation and Adaptation on Risk Level

The results of hypothesis testing show that the level of risk is influenced by mitigation and adaptation. This means that the better the mitigation and adaptation, the better the risk control. The results of the analysis also show that mitigation has a greater influence in controlling and reducing flood risk. The results of this study are in line with the results of research by Poussin, Botzen and Aerts (2015); Genovese and Thaler (2020); Pancasilawan et al., (2020); and Wibowo (2019) which state that mitigation has reduced the risk of flood disasters. Then, the results of research by Muzdalifah (2022) and Huda (2016) state that adaptation can reduce the risk of flood disasters. Then, the results of research by Kundzewicz and Matczak (2012); IPCC (2012); Isa et al., (2013); Rasdiana, Barkey and Safry (2021) state that mitigation and adaptation both partially and simultaneously can reduce the risk of flood disasters.

The significant effect of mitigation and adaptation that has been carried out can be seen from farmers' perceptions of the level of risk that is categorized aslow. Although flooding in the research location occurs every year, even the duration of flooding can be more than three months and farmers do not get production from their flooded rice fields. However, this does not discourage farmers from continuing to cultivate rice. The low level of risk is influenced bythe high capacity owned by farmers (Kusumadinata et al., 2020). Although flooding in rice fields occurs every year, the capacity to deal with it makesfarmers accustomed to dealing with it (Saha et al., 2022).

Mitigation is a preventive effort designed to prevent or minimize disaster-related risks beginning with risk identification to take appropriate steps to reduce risk (ICN, 2009); (Urbanus et al., 2021); and Triana, et al. 2017). The identification carried out by farmers begins with knowing the sources and causes of flooding that occurs in their rice fields. Repeated events provide an overview ofwhat risks they will receive (Kumar et al., 2022).

Disaster events such as floods may not be completely eliminated, but their impact can be minimized (Kiedrzynska, Kiedrzynski, & Zalewski, 2014). Mitigation planning is a form of effort that must be made to reduce disaster risk through the development of physical aspects as well as increasing community awareness and capacity in facing disasters (Rezende, de Franco, de Oliveira, Jacob, & Miguez, 2019). In addition, it is also aligned with increasing knowledge about mitigation by the community, especially farmers. Appropriate and good disaster mitigation planning can not only minimizerisks, but also create disaster resilience for the entire community in the area, especially farming families who are directly faced with flood disasters (George et al., 2022).

Understanding farmers' perceptions of flooding events in rice fields that they experience every year is very important to shape farmers' readiness to adapt, including adjustments to cultivation techniques (Faruk and Maharjan, 2022 & Heriansyah et al., 2022). Climate change, which results in flooding, will generally have very damaging effects on the agricultural sector (Bryan et al., 2009 & Rita, 2023). The importance of this is because flood events have a direct impact on farmers so that farmers have direct experience in the form of attitudes or actions in dealing with these floods, both as individuals and families (Akbar et al., 2023; Friday et al., 2023).

The accumulation of these experiences results in adaptation strategies carried out by farmers in dealing with floods (Rusdi et al., 2023 & Diana and Atikah, 2023). The process of determining the form of adaptation is dynamic, because the time, intensity and frequency are always changing, as well as the experience and capacity of farmers who also change accompanied by the existence of Standard Operating Procedures (SOPs) for disaster management and trainings related to floods and rice paddy cultivation techniques.

The Effect of Adaptation, Coping Mechanisms, and Level of Risk on Resilience

The results of the analysis show that adaptation has a significant effect on resilience, this is in line with the opinion of Walker et al. (2004) which states that adaptability is the capacity of the system to influence resilience. Meanwhile, Smit & Wandel (2006) suggest that adaptation is an action taken to reduce vulnerabilityand increase resilience. In addition, Shah et al. (2013) stated that the resilienceand adaptation of farmer households can be analyzed using the components that make up the vulnerability index, such as socio-demographics, food, social networks, and livelihood strategies, so that resilience and adaptation are interrelated. The adaptation process carried out by farmers in the research locationis carried out continuously and repeatedly. Resilience is obtained by farmers whenthey carry out a form of adaptation and feel that this form of adaptation isappropriate for dealing with floods that hit their paddy fields.

In addition to adaptation, another variable that also significantly affects resilience is coping mechanisms. Coping mechanisms are ways for individuals or groups of people to be more resilient to disasters (UNISDR, 2005). Emotional coping mechanisms are more likely to be carried out by farmers. Facts in the field, farmers affected by flooding in their rice fields do not immediately move to deal with the problem. Farmers are more likely to choose to understand the conditions that occur and reassess positively about the incident (Chang et al., 2022). Farmers' self-control made themselves calmer in the face of the disaster. After that, farmers think about how they can cover the reducedincome due to the incident and then seek social support as in resilience that external support outside the farmer's household affects resilience (Poon and Chan,2023 & Ziadi, et al., 2023).

Furthermore, the variable level of risk also significantly affects resilience. Discussions about efforts to reduce the level of risk of flood disasters cannot be separated from mitigation and adaptation (Peck et al., 2022; Fournier et al., 2016). The form of understanding the level of risk carried out by farmers is to increase the capacity of farmers in dealing with these risks. The level of risk is also an indicator to make the resilience of wetland rice farmers increase. In addition, mitigation and adaptation actions taken are aimed at reducing risk (vulnerability) and increasing resilience (Pancasilawan et al., 2020; Muzdalifah, 2022; IPCC, 2012; and Rasdiana et al., 2021).

CONCLUSIONS AND SUGGESTIONS

Conclusion

The determinants of resilience of flood-affected wetland rice farmers are positively and significantly influenced by adaptation, coping mechanisms, and risk levels both partially and simultaneously. In summary, the significant effect of mitigation and adaptation that has been carried out can be seen from farmers' perceptions of the level of risk that is categorized as low. Although floods occur every year, even the duration of flooding can be more than three months and farmers do not get production from their flooded rice fields. However, this does not discourage farmers from continuing to cultivate rice. Furthermore, the process of disaster adaptation carried out by farmers continuously and repeatedly creates a high level of resilience. Resilience is obtained by farmers when they carry out a form of adaptation and are deemed appropriate to deal with flood disasters that hit their rice fields.

More details, adaptation encourages farmers toget used to disasters that occur so that they can take action on coping mechanisms to support better economic aspects supported by the level of risk from disasters that occur can be minimized by farmers to create a high level of resilience. Flood- affected wet-rice farmers can already be resilient, which means they can familiarize themselves with disaster events that occur with the adaptation process, coping mechanisms, and the level of risk carried out.

In addition, the level of risk faced by farmers is positively and significantly influenced by mitigation and adaptation both partially and simultaneously. Rice farmers affected by flooding can take disaster mitigation actions that occur as a form of effort made by building physical aspects and increasing awareness and community capacity to reduce the risk of disasters that occur. Then, adaptation is described from the understanding of farmers' perceptions of flood disasters that occur on their rice fields every year so as to form farmers' readiness and create a condition accustomed to adjusting to disasters that occur.

Suggestion

Referring to the conditions that occur, a policy implementation model is needed to increase the resilience of wet-rice farmers affected by flooding, such as the creation of disaster-prone maps and the provision of alarm reminders of disaster events. Furthermore, the need for policies from the government to be responsive to natural disasters so that they do not have a long-lasting impacton the continuity of the farms being managed.

ACKNOELEDGMENT

The research team would like to thank the Rector of Universitas Padjadjaran who has provided funding for our research through the the ALG – 2024 (Academic Leadership Grant) scheme.

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