JURNAL PAMATOR

Vol. 18, No. 3, 2025, p. 348-361
https://journal.trunojoyo.ac.id/pamator
ISSN: 2654-7856 (Online)
ISSN : 1829 -7935 (Print)

LIVELIHOOD VULNERABILITY INDEX AND ADAPTIVE CAPACITY OF SMALLHOLDER RICE FARMER HOUSEHOLDS TO CLIMATE CHANGE IN THE MANYARAN DISTRICT, WONOGIRI REGENCY

Zulfa Nur Auliatun Nissa'[1*], Azizah Ridha Ulil Albab[2], Ratih Setyowati[1], Liana Fatma Leslie Pratiwi[1]

[1] Agribusiness Study Program, University of Pembangunan Nasional Veteran Yogyakarta Jl. Ring Road Utara No.104, Ngropoh, Condongcatur, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55283, Indonesia, *zulfa.nur@upnyk.ac.id
[2] Agrotechnology Study Program, University of Pembangunan Nasional Veteran Yogyakarta Jl. Ring Road Utara No.104, Ngropoh, Condongcatur, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55283, Indonesia,

DOI : https://doi.org/10.21107/pamator.v18i3.27426

Manuscript received10th May 2025 , Revised 15th July 2025, Published 10st September 2025

Abstract

Agricultural production is vital for income and food security in rural areas. However, in Manyaran District, Wonogiri Regency's rice farming livelihoods are increasingly threatened by climate change, environmental pressures, and policy shifts. This study evaluates the vulnerability of rice farmers' livelihoods using the Livelihood Vulnerability Index (LVI) and the LVI-IPCC framework. Data were gathered from 42 randomly selected households in seven villages, revealing an LVI score of 0.61 and an LVI-IPCC score of 0.04, indicating medium vulnerability to climate change. Key factors contributing to livelihood vulnerability include exposure to droughts, floods, pests, rising rice production costs, and climate variability. Adaptations include strong social networks, technological innovations like simple irrigation systems, and ecological adjustments like crop diversification with alternative and horticultural crops. The study recommends that the government enhance support for farmers in downstream areas by improving irrigation infrastructure, increasing reservoirs and wells, and providing training for developing home-based food industries. These measures are intended to bolster resilience and adaptation in agricultural livelihoods amidst environmental and policy challenges.

Keywords: *Adaptation, climate change, crop diversification, Livelihood, Rice farmers, Vulnerability*

INTRODUCTION

Wonogiri is the second-largest rice-producing regency in the Ex-Karesidenan Surakarta area, following Sragen Regency, with a total rice production of 380,000 tons of milled dry grain in 2022 and an average productivity of 56.36 quintals per hectare. According to the KSA, as of March 2023, during the peak harvest period, the harvested area of paddy fields in Wonogiri Regency reached 13,600 hectares, distributed across the entire region [1]. Climate change presents new challenges in rice cultivation practices. Rising temperatures and drought conditions have led to significant losses in the agricultural sector, particularly in rice production. Additionally, fluctuations in temperature and humidity levels may exacerbate the situation by increasing the frequency and intensity of pest and disease infestations [2].

Wonogiri is among the top ten regencies with the highest rice production in Central Java Province, with a total production of 353,826.22 tons in 2021 [3]. The available land area largely influences the scale of rice production in this area. In Wonogiri Regency, the area of paddy fields is recorded at 60,033.4 hectares, with an additional 16,119 hectares of upland rice fields, which are significant factors in achieving this production level.

Farmers typically plant rice two to three times a year, depending on the rainy and dry seasons. Rice grows optimally with an annual rainfall of 1,000-1,500 mm, so farmers rely on pumps and irrigation to meet water needs. The previous harvest is often capitalized for the next planting season, although yields vary. According to BPS [4] the average rice yield per hectare ranges from 5 to 8 tons, aligning with a 5.2 tons/ha productivity.

Rice cultivation requires various production inputs, and price fluctuations can lead to losses for producers. Rising prices of production inputs, such as fertilizers, combined with limited farmland, can result in lower farmer incomes. Unstable weather patterns and fluctuating input prices increase the vulnerability of rice farming, which heavily depends on water availability. This situation impacts the vulnerability of farming households to economic, social, and environmental risks. In livelihood analysis, vulnerability is related to elements identified as sources of vulnerability, such as shocks, seasonal changes, and household dynamics[5]. During shocks, individuals must cope with sudden, unexpected events such as illness, loss of livelihood, natural disasters, conflicts, and crop failures due

[1] BPS Kabupaten Wonogiri, "*Kabupaten Wonogiri Dalam Angka 2020"*, 2020.

[2] Rani Andriani Budi Kusumo, Gema Wibawa Mukti, and Anne Charina, "Livelihood Diversity of Rainfed Wetland Rice Farmer Households (Case Study in Kroya Sub-District, Indramayu District)'". *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, 10.1 (2024), pp. 1208–16.

[3] BPS Provinsi Jawa Tengah, "Provinsi Jawa Tengah Dalam Angka 2023", *Badan Pusat Statistik Provinsi Jawa Tengah*, 2023, pp. 1–1006.

[4] BPS, "*Harvested Area, Productivity and Production of Paddy by Province"*, 2023.

[5] Augustine Tanle, "Towards an Integrated Framework for Analysing the Links between Migration and Livelihoods", *Norsk Geografisk Tidsskrift*, 69.5 (2015), pp. 257–64, doi:10.1080/00291951.2015.1087422.

to pest and disease infestations[6]. Seasonal changes can affect commodity prices, production levels, and employment opportunities, ultimately impacting livelihood outcomes. The context of vulnerability can be identified through the perceived risks within a community [7]. Based on the above discussion, an analysis of the vulnerability of rainfed paddy farming households in Manyaran District, Wonogiri Regency, is necessary to understand the challenges faced and the strategies farming households employ to sustain their livelihoods.

RESEARCH METHODS

Location and Time of Research

This research was conducted from April to July 2024 in the Manyaran Sub-district, Wonogiri Regency, Central Java Province. The research location was determined purposively, considering that almost all residents of the Manyaran Subdistrict earn a living as rice farmers. In addition, the area of the main cultivated land is quite large, with an average area of 8000 m2.

Respondent selection technique

The unit of analysis used in this study was rice farming households in Manyaran Sub-district that also optimized their land by planting commodities other than rice. Respondents were selected by purposive sampling with a random sampling technique. Sugiyono [8]states that the minimum feasible sample size in research is between 30 and 500. It is known that Manyaran Sub-district consists of 7 villages; therefore, the number of respondents used in this study was six rice farmers who also planted commodities other than rice in each village. Thus, this number can already be said to represent the population.

Types, Sources, and Data Collection Techniques

The types of data used in this research are primary and secondary data. The types of data used in this research are primary and secondary. Primary data collection was conducted through primary data collection was conducted through interviews based on a prepared questionnaire containing respondent profile information and questions related to livelihood vulnerability adopted from the Intergovernmental Panel of Climate Change (IPCC) study. The livelihood vulnerability of rice farmer households can be determined using the LVI-IPCC formula in percentage form through the interpretation of three main components, namely exposure (social, economic, and ecological exposures), adaptive capacity (profile, socio-demographics, livelihood strategies, and social networks), and sensitivity (health, food, water) (Table 1) [9]. The formula was developed based on the

[6] Frank Ellis, "Rural Livelihood Diversity Developing Countries: Evidence Policy Implications", *Overseas Development Institute*, 40, 2000; Tanle.

[7] Ellis.

[8] Sugiyono, "*Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif*" (Alfabeta, 2015) <http://inatews.bmkg.go.id/new/eachevent.php?eventid=20140125121922&tab=1>.

[9] Micah B. Hahn, Anne M. Riederer, and Stanley O. Foster, "The Livelihood Vulnerability Index: A Pragmatic Approach to Assessing Risks from Climate Variability and Change-A Case Study in Mozambique", *Global Environmental Change*, 19.1 (2009), pp. 74–88, doi:10.1016/j.gloenvcha.2008.11.002; E. Gravitiani, S. N. Fitriana, and Suryanto, "Community

literature review on each main component and the practicality of collecting the required data through household surveys, interviews using questionnaires, and observations. Secondary data collection was conducted based on literature studies and reviewing documents relevant to the research objectives. This research was conducted using a quantitative approach, so respondents were selected by survey.

Analysis Method

The calculation of the Livelihood Vulnerability Index by Hahn[10] and the IPCC[11] is used to investigate and assess the livelihood vulnerability of rice farmers in the Manyaran subdistrict. The livelihood vulnerability index helps track vulnerability over time and geography, determine how vulnerability occurs, set priorities for vulnerability reduction tactics, and assess how well such tactics work. The livelihood vulnerability index in this study is calculated based on the weight of several components and sub-components of the pressure/exposure that farmers face from social, economic, and ecological dimensions. The use of livelihood methods, ownership of social networks, and sociodemographic data all contribute to the determination of adaptive capability. The factors of diet, hydration, and health influence sensitivity. Even though each primary component comprises multiple smaller components, each subcomponent contributes equally to the overall index. For each of the major components, a straightforward technique with equal weights was used. Every subcomponent needs to be normalized as an index since it is measured on a different scale. The equation took advantage of applied index standardization for this purpose. Different data units and scales are measured through standardization to get index values. The following formula is used to calculate the livelihood vulnerability composite index (LVI):

$$Index\ Sd = \frac{Sd - Smin}{Smax - Smin}$$

Remarks:
Sd = Sub Component Value
Smin = Minimum Value of Sub-Component
Smax = Maximum Value of Sub-Component
After normalizing the sub-component values, the value of each principal component is calculated by the following equation:

$$Md = \frac{\sum_i^n \text{Index Sd i}}{n}$$

Remarks:
Mad = Main Component Value
Index Sd I = Sub Component Value of Main Component

Livelihood Vulnerability Level in Northern and Southern Coastal Area of Java, Indonesia", *IOP Conference Series: Earth and Environmental Science*, 202.1 (2018), pp. 1–9, doi:10.1088/1755-1315/202/1/012050.

[10] Hahn, Riederer, and Foster.

[11] IPCC, "*Climate Change 2001: Impacts, Adaptation, and Vulnerability*", ed. by James J. McCarthy and others, 1st edn (Cambridge University Press, 2001).

N = The Number of Sub Components in the Main Component I

The last step is to determine the value of the vulnerability index of the farmer's livelihood using the following formula.

$$LVI = \frac{\sum_{i=1}^{n} \text{wmi. Mdi}}{\sum_{i=1}^{n} \text{wmi}}$$

Remarks:
LVI = Livelihood Vulnerability Index
Wmi = Weight of Sub-Component
Mdi = Main Component Value

This study calculates LVI using the IPCC method, which weights all relevant components equally. According to IPCC, vulnerability depends on exposure, system sensitivity, and adaptive capability. A different LVI calculation uses the IPCCC definition of vulnerability: the LVI-IPCC index. IPCC defines vulnerability as stress/exposure, adaptability, and sensitivity. Levels of vulnerability in LVI-IPCCd range from -1 to +1. LVI-IPCC is a proxy for climate change's impact on livelihoods. -1-(-0.4) signifies not vulnerable, -0.41-0.3 means moderately vulnerable, and 0.31-1 means severely vulnerable. LVI averages each component, while LVI-IPCC integrates three. A percentage computation of farmers' questionnaire responses was utilized to quantitatively describe rice farming households' adaption tactics in the Manyaran sub-district.

RESULT AND DISCUSSION

Rice farming in Manyaran District, Wonogiri Regency

On average, rice farmers in Manyaran District can only cultivate rice a maximum of twice a year. In general, the cropping pattern applied by rice farmers in Manyaran Subdistrict depends on the availability of water and capital. In the dry season, farmers irrigate their fields using the remaining water sources in the river, and some use water sources from boreholes. In the rainy season, farmers rely on the availability of rainwater and the overflow of the river's rising water discharge to irrigate their land. So, in the dry season, many farmers plant palawija or "*bero*" on their land, which means not planting any commodities.

Livelihood Vulnerability Index of Rice Farmers

Vulnerability is the tendency towards "vulnerability." [12]. Nissa et al [13]mentions three elements identified as vulnerability: shock, seasonality, and household dynamics. In relation to farming activities, the vulnerability faced by many farming households is related to seasonality. Changes due to exposure/pressure on a livelihood source can cause vulnerability in a community. The standardized sub-components results and the livelihood vulnerability index calculation for 42 rice farmer respondents in the Manyaran sub-district show that the level of vulnerability of farmers' livelihoods can be categorized as vulnerable. The scores for each component are shown in Table 1.

[12] Ellis.

[13] Zulfa Nur Auliatun Nissa, Arya Hadi Dharmawan, and Saharuddin Saharuddin, "Vulnerability Analysis of Small Fishermen's Household Livelihoods in Tegal City'", *Komunitas: International Journal of Indonesian Society and Culture*, 11.2 (2019), doi:10.15294/komunitas.v11i2.18583.

Table 1: Index of sub-component, main component, and total LVI of Rice Farmer in Manyaran District, Wonogiri Regency

Components	Sub Components	Value of Sub-Components	Main Components	Value of Main Components
Exposure	**Percentage**			
	Agricultural Land Affed By Flood/Drought	0,84	Ecology Exposure	0,81
	Rice has been attacked by pests/diseases that are difficult to handle	0,79		
	Percentage			
	Increased price of rice planting production costs	0,95	Economy Exposure	0,68
	Decrease in Harvest grains selling Price	0,40		
	Percentage			
	Conflict among farmers	0,10	Social Exposure	0,46
	Increasing Difficulty to find additional worker/farm labor	0,83		
Adaptive Capacity	**Percentage**			
	More than two family members are working	0,38	Human Capital	0,71
Adaptive Capacity	Completed nine years of compulsory education (Junior High School)	0,90		
	Your age is Less than 50 years old	0,64		
	Have other skills besides farming	0,90		
	Percentage			
	Have a regular buyer	0,60	Financial Capital	0,55
	Easy access to loans	0,62		
	Receive remittances from children for daily needs	0,10		
	Have other sources of income besides farming	0,90		
	Percentage			
	Agricultural equipment currently owned is sufficient	0,40	Physical Capital	0,55
	Have easy access to farming tools/equipment	0,69		
	Percentage			
	Relationships among households are getting along well	1,00	Social Capital	0,86
	Actively participates in group meetings	0,86		
	Get benefits after joining a farmer's group	0,71		
	Have alternative crop commodities	0,60	Natural Capital	0,60
	Own land ownership	0,52		
	Agriculture Land area >1500m	0,60		
	Sufficient water availability	0,67		

Components	Sub Components	Value of Sub-Components	Main Components	Value of Main Components
	Percentage			
	Difficult in accessing clean water	0,19	Water	0,26
	Fighting over rice water irrigation	0,33		
	Percentage			
	Rice harvest is sold to fulfill basic needs only	0,79	Food	0,87
Sensitivity	Rice harvest is set aside for personal consumption	0,93		
	Low Saving Ability	0,90		
	Percentage			
	A family member has a chronically ill	0,07	Health	0,44
	Have Health Insurance	0,81		
		LVI		**0,61**

Source: The results of the analysis from the primary data source

The level of vulnerability of rice farmers in the Manyaran District includes a vulnerable condition. It is known from the exposure index index that they face is quite high. Meanwhile, when viewed from their adaptive capacity, vulnerability is high. is indeed high. However, livelihood strategies or utilization of their adaptive capacity can still be said to be low, so the index value of their vulnerability is high.

The risk that farmers have to face is a lack of water during the dry season, which could potentially lead to crop failure. The vulnerability farmers feel due to drought in the dry season varies according to the socio-economic level of farming households. Farmer households experience the highest vulnerability due to high production prices and drought/flooding. Farmers in the Manyaran sub-district have limited capital, which is often borrowed. With these limitations, farmers cannot seek water from other sources (wells) to irrigate their land during the dry season (*gadu*). Farmers are also unable to bear the risk of crop failure. Therefore, many farmers cultivate their land only once a year, during the rainy season (*rendeng*).

The table presents an analysis of adaptive capacity in terms of financial, physical, social, and natural capital among rice farming households. The values indicate moderate adaptive capacity across all components, with financial and physical capital scoring 0.55, social capital 0.86, and natural capital 0.60. Social capital appears to be the most robust aspect, with high scores for household relationships and participation in group activities, highlighting the strong community bonds and support networks within the farming community. This suggests that collective action and cooperation among farmers could enhance resilience in facing external challenges, such as climate variability. Meanwhile, financial and physical capital show limitations, especially regarding access to remittances and agricultural equipment, which may hinder the farmers' ability to invest in more adaptive strategies.

These findings align with other studies that emphasize the importance of social capital in rural communities' adaptive capacity to climate change. For example, Adger [14]

[14] W Neil Adger, 'Vulnerability', *Global Environmental Change*, 16 (2006), pp. 268–81, doi:10.1016/j.gloenvcha.2006.02.006.

strong social networks and trust can facilitate resource-sharing and collective decision-making, which are critical for coping with environmental stressors. The tradition of gotong royong (mutual cooperation) and mutual trust in society were the most important values in reducing vulnerability [15]. On the other hand, the relatively lower scores for financial and physical capital reflect broader challenges smallholder farmers face in Indonesia, such as limited access to credit and modern farming[16]. Crop diversification and livelihood system diversification are strategies for reducing production risks caused by climate shocks [17].

The sensitivity analysis presented in the table highlights key vulnerabilities in rice farming households related to water, food, and health. Food sensitivity shows a high score (0.87), emphasizing that rice harvests are primarily used for subsistence, with low savings capacity (0.90) limiting financial resilience. This indicates that households depend highly on rice yields to meet basic needs, leaving little room for economic flexibility. Water sensitivity, on the other hand, is moderate (0.26), with some households facing difficulties in accessing clean water (0.19) and occasional disputes over water for irrigation (0.33). Theconflict occurred when water was shared between rice cultivation and other utilizes, particularly for domestic uses such as drinking water and washing, as well as other uses by hydropower and other crops[18]. Health sensitivity is relatively lower (0.44), with most households having access to health insurance (0.81), although chronic illness remains a

[15] Zhifei Liu, Qianru Chen, and Hualin Xie, "Influence of the Farmer's Livelihood Assets on Livelihood Strategies in the Western Mountainous Area, China", *Sustainability (Switzerland)*, 10.3 (2018), doi:10.3390/su10030875; Endah Saptutyningsih, Diswandi Diswandi, and Wanggi Jaung, "Does Social Capital Matter in Climate Change Adaptation? A Lesson from Agricultural Sector in Yogyakarta", Indonesia', *Land Use Policy*, 95.August 2019 (2020), p. 104189, doi:10.1016/j.landusepol.2019.104189; Zhang Qin and others, "Livelihood Vulnerability of Pastoral Households in the Semiarid Grasslands of Northern China: Measurement and Determinants", *Ecological Indicators*, 140.December 2021 (2022), p. 109020, doi:10.1016/j.ecolind.2022.109020; Arifah and others, "Livelihood Vulnerability of Smallholder Farmers to Climate Change: A Comparative Analysis Based on Irrigation Access in South Sulawesi, Indonesia", *Regional Sustainability*, 3.3 (2022), pp. 244–53, doi:10.1016/j.regsus.2022.10.002.

[16] Michael Woolcock and Deepa Narayan, "Social Capital: Implications for Development Theory, Research, and Policy", *World Bank Research Observer*, 15.2 (2000), pp. 225–49, doi:10.1093/wbro/15.2.225.

[17] Imran Khan and others, "Farm Households' Risk Perception, Attitude and Adaptation Strategies in Dealing with Climate Change: Promise and Perils from Rural Pakistan", *Land Use Policy*, 91.August 2019 (2020), p. 104395, doi:10.1016/j.landusepol.2019.104395; Jinyu Shen and others, "Household Livelihood Vulnerability to Climate Change in West China", *International Journal of Environmental Research and Public Health*, 19.1 (2022), doi:10.3390/ijerph19010551.

[18] Chuong Van Huynh and others, "Drought and Conflicts at the Local Level: Establishing a Water Sharing Mechanism for the Summer-Autumn Rice Production in Central Vietnam", *International Soil and Water Conservation Research*, 7.4 (2019), pp. 362–75, doi:10.1016/j.iswcr.2019.07.001.

minor issue (0.07). This pattern of high food sensitivity aligns with findings by hardy[19], which suggest that food security is a critical dimension of vulnerability in agricultural communities, particularly in regions affected by climate variability.

LVI-IPCC for rice farmer households in the Manyaran District, Wonogiri Regency

Meanwhile, the component index of LVI based on the IPCC (Intergovernmental Panel on Climate Change) approach is an alternative method developed by LVI as a proxy for community vulnerability caused by climate change. The LVI-IPCC score for rice farming households in the Manyaran sub-district can be seen in Table 2.

Table 2: LVI-IPCC for Rice farmer Households in the Manyaran District, Wonogiri Regency

Main Component	Value of Sub-Component	Weight of Component Values	Main Component Value	Category
Exposure	**1,95**	**6**	**0,33**	
Ecology	**0,81**	2		**Highly vulnerable**
Economy	0,68	2		
Social	0,46	2		
Adaptive Capacity	**3,26**	**17**	**0,19**	
Human	0,71	4		**Medium Vulnerable**
Financial	0,55	4		
Physical	0,55	2		
Social	0,86	3		
Natural	0,60	4		
Sensitivity	**1,58**	**6**	**0,26**	
Food	0,87	3		**Medium Vulnerable**
Water	0,26	2		
Health	0,44	2		
LVI-IPCC			**0,04**	**Medium Vulnerable**

Source: The results of the analysis from the primary data source

The table presents the LVI-IPCC (Livelihood Vulnerability Index based on the IPCC approach) for rice farmer households in Manyaran District, Wonogiri Regency. The results indicate that exposure has a high vulnerability score (0.33), primarily due to significant ecological challenges (0.81). This suggests that rice farming households are particularly susceptible to environmental changes and climate-related risks, consistent with findings from research indicating that agricultural communities in Indonesia are highly vulnerable to climate variability [20]. On the other hand, adaptive capacity has a moderate score of 0.19, with social capital being the strongest component (0.86), reflecting strong community ties and cooperation among farmers. However, the financial

[19] P. Y. Hardy and others, 'Strengthening the Resilience of Small-Scale Fisheries: A Modeling Approach to Explore the Use of in-Shore Pelagic Resources in Melanesia', *Environmental Modelling and Software*, 96 (2017), pp. 291–304, doi:10.1016/j.envsoft.2017.06.001.

[20] Ktut Murniati and Abdul Mutolib, 'The Impact of Climate Change on the Household Food Security of Upland Rice Farmers in Sidomulyo, Lampung Province, Indonesia', *Biodiversitas*, 21.8 (2020), pp. 3487–93, doi:10.13057/biodiv/d210809.

and physical aspects show moderate vulnerabilities, limiting the farmers' ability to invest in adaptive strategies.

Sensitivity shows a value of 0.26, with food being the most vulnerable component (0.87), indicating a high dependency on rice yields for subsistence. These results align with rural farming community studies, which often highlight that food security is closely tied to livelihood sustainability [21]. Overall, the LVI-IPCC score of 0.04 places rice farming households in a medium vulnerability category, suggesting that while adaptive capacity exists, the high exposure to ecological changes and the sensitivity of food systems create significant challenges for long-term livelihood resilience.

The vulnerability index was higher for the exposure and sensitivity components than for the adaptive capacity. As this is the basis for controlling vulnerability and implementing adaptation measures, Ehsan's statement[22] that households with limited adaptive capacity will find it difficult to cope with the negative effects of climate risks is consistent with this conclusion. It may be said that farmers who have a high exposure value and a low adaptive capacity are more vulnerable to the negative effects of climate change and are hence more susceptible to its occurrence.

The overall LVI-IPCC index score is 0.04, indicating that the livelihood of rice farming households in the Manyaran District is moderately vulnerable to ecological exposure, a consequence of climate change. In contrast, the LVI score is 0.61, which, on a scale of -1 to +1, is closer to +1. This suggests that the livelihood vulnerability of rice farming households in the Manyaran sub-district is classified as highly vulnerable. Thus, it can be concluded that the livelihood of these farmers is vulnerable based on the pure LVI index and the IPCC vulnerability formula, both of which lead to the same interpretation: the livelihood of rice farming households in the Manyaran sub-district is in a vulnerable condition. This is due to the high exposure index (very vulnerable) and the low adaptive capacity, which places their adaptation efforts in the medium vulnerability category. Additionally, sensitivity to exposure remains lower than their adaptive capacity. This is supported by farmers' statements in the Manyaran sub-district, who mentioned that their primary occupation is rice farming. Since their skills are largely agricultural, and their primary asset is their farmland, they are inclined to sustain their agricultural livelihoods, even though extreme weather events frequently result in losses. One farmer stated:

> "*Wong kene iso ne tani, modal garapan lemahe dewe nek diusaha ke tenan yo ono hasile masio gur nandur setahun ping pindo tapi nek dipikir akhir akhir iki pari saiki yo wis blug, mergone ra nutup antarane modal produksi karo hasil panenane, gabahe wong tani nek didol gur dituku murah*." (SKR

"People here can farm, and their capital is just their land. If they work hard, there will be results, even though they only plant twice a year. However, if you think about it, recently,

[21] Christophe Béné and others, 'When Food Systems Meet Sustainability – Current Narratives and Implications for Actions', *World Development*, 113 (2019), pp. 116–30, doi:10.1016/j.worlddev.2018.08.011.

[22] Sofia Ehsan, Rawshan Ara Begum, and Khairul Nizam Abdul Maulud, 'Household External Vulnerability Due to Climate Change in Selangor Coast of Malaysia', *Climate Risk Management*, 35.December 2021 (2022), p. 100408, doi:10.1016/j.crm.2022.100408.

rice yields have drastically declined because the production costs no longer match the harvest results. When farmers sell their paddy, it is bought at a low price."

Farming Adaptation Strategy

Rice farmers in Kecamatan Manyaran, Kabupaten Wonogiri, have successfully adapted to environmental vulnerabilities and sustained their livelihoods by shifting from traditional rice cultivation to alternative horticultural crops. This adaptation is driven by the challenges posed by mountainous terrain and frequent water shortages. The farmers have adopted a strategy of cultivating multiple crops simultaneously—rice, long beans, and chili—due to horticultural crops' lower production costs and faster harvest cycles than rice. This diversification enhances economic resilience by providing quicker cash flow, enabling farmers to meet daily needs while maintaining a sustainable capital cycle.

In addition to crop diversification, implementing efficient irrigation practices has been crucial. Farmers have constructed water storage facilities near their fields to ensure a reliable water supply throughout the growing season. The role of farmer groups (kelompok tani) in Kecamatan Manyaran has been instrumental in disseminating agricultural knowledge and techniques. These groups facilitate the diffusion of innovative farming practices and provide valuable resources, such as equipment, supplies, and capital, which are especially beneficial for small-scale farmers. The effectiveness of these groups in knowledge dissemination and resource mobilization highlights their role in enhancing social capital and community resilience.

Social capital theory emphasizes the importance of social networks, norms, and trust in facilitating collective action and resource access [23]. In this context, the farmer groups function as a network that strengthens social ties among members, enhancing their collective ability to address agricultural challenges. The presence of such groups not only facilitates the exchange of information and techniques but also improves access to essential resources and support systems. This collective approach aligns with research suggesting that social capital can significantly contribute to rural development and agricultural productivity by fostering collaboration and mutual support among farmers [24]

Moreover, utilizing low-cost irrigation solutions, such as water storage systems, complements findings that decentralized irrigation methods can effectively support smallholder farmers in semi-arid regions [25]. By integrating these strategies, farmers in Manyaran demonstrate that alternative cropping and efficient irrigation management, supported by robust farmer groups, can enhance resilience and reduce vulnerability in rural communities facing environmental stress. The successful adaptation of these strategies underscores the potential for community-based approaches to sustain livelihoods and promote agricultural sustainability amidst changing climatic conditions.

[23] Robert D. Putnam, 'Project Report Social Capital and Public Affairs', *Buletin of the American Academy of Arts and Science*, 47.8 (1994), pp. 5–19.

[24] Jules Pretty and Hugh Ward, 'Social Capital and Environment', *World Development*, 29.3–4 (2001), pp. 209–27, doi:10.1159/000149889.

[25] Douglas Kibirige, Ajay S. Singh, and Lovemore M. Rugube, 'Small-Scale Irrigation and Production Efficiency among Vegetable Farmers in the Eastern Cape Province of South Africa: The DEA Approach', *Journal of Agricultural Studies*, 7.1 (2019), p. 149, doi:10.5296/jas.v7i1.14564.

CONCLUSION

Based on the calculations in this study, the livelihood vulnerability index (LVI) for rice farming households in Manyaran District, Wonogiri Regency, is 0.61, indicating a high level of vulnerability. According to the LVI-IPCC approach, their livelihoods also fall into the medium vulnerability category with an index of 0.04. The findings reveal that these households are vulnerable to decreased production, crop failure, frequent droughts, increasingly arid farmland, reduced water sources, and pest outbreaks. Farmers have adapted by practicing intercropping, crop rotation, planting drought-resistant varieties, and maintaining irrigation channels.

This research extends to the literature on climate change-vulnerable people and livelihoods. These findings can help local governments construct climate risk assessments to support poor and sharecropper farmers who depend on agriculture. Government investments in drought-resistant rice, integrated pest control, and early warning systems are crucial to sustainable livelihood options. For drought resistance, downstream irrigation infrastructure must be improved. Given the effects of climate change and the COVID-19 pandemic on livelihood strategies, food, and health, future research should disaggregate household vulnerability to discover context-specific determinants.

ACKNOWLEDGMENTS

We would like to thank the Institute for Research and Community Service of the National Development University Veteran Yogyakarta (LPPM UPN Veteran Yogyakarta) for the 2024 internal research and community service grant program that has funded this research with the 2024 novice lecturer research program scheme with contract number 120/UN62.21/DT.07.00/2024

BIBLIOGRAPHY

Adger, W Neil, ‘Vulnerability’, *Global Environmental Change*, 16 (2006), pp. 268–81, doi:10.1016/j.gloenvcha.2006.02.006

Arifah, Darmawan Salman, Amir Yassi, and Eymal Bahsar Demmallino, ‘Livelihood Vulnerability of Smallholder Farmers to Climate Change: A Comparative Analysis Based on Irrigation Access in South Sulawesi, Indonesia’, *Regional Sustainability*, 3.3 (2022), pp. 244–53, doi:10.1016/j.regsus.2022.10.002

Béné, Christophe, Peter Oosterveer, Lea Lamotte, Inge D. Brouwer, Stef de Haan, Steve D. Prager, and others, ‘When Food Systems Meet Sustainability – Current Narratives and Implications for Actions’, *World Development*, 113 (2019), pp. 116–30, doi:10.1016/j.worlddev.2018.08.011

BPS, *Harvested Area, Productivity and Production of Paddy by Province*, 2023

BPS Kabupaten Wonogiri, *Kabupaten Wonogiri Dalam Angka 2020*, 2020

BPS Provinsi Jawa Tengah, ‘Provinsi Jawa Tengah Dalam Angka 2023’, *Badan Pusat Statistik Provinsi Jawa Tengah*, 2023, pp. 1–1006

Ehsan, Sofia, Rawshan Ara Begum, and Khairul Nizam Abdul Maulud, ‘Household External Vulnerability Due to Climate Change in Selangor Coast of Malaysia’,

Climate Risk Management, 35.December 2021 (2022), p. 100408, doi:10.1016/j.crm.2022.100408

Ellis, Frank, 'Rural Livelihood Diversity Developing Countries: Evidence Policy Implications', *Overseas Development Institute*, 40, 2000

Gravitiani, E., S. N. Fitriana, and Suryanto, 'Community Livelihood Vulnerability Level in Northern and Southern Coastal Area of Java, Indonesia', *IOP Conference Series: Earth and Environmental Science*, 202.1 (2018), pp. 1–9, doi:10.1088/1755-1315/202/1/012050

Hahn, Micah B., Anne M. Riederer, and Stanley O. Foster, 'The Livelihood Vulnerability Index: A Pragmatic Approach to Assessing Risks from Climate Variability and Change-A Case Study in Mozambique', *Global Environmental Change*, 19.1 (2009), pp. 74–88, doi:10.1016/j.gloenvcha.2008.11.002

Hardy, P. Y., C. Béné, L. Doyen, and D. Mills, 'Strengthening the Resilience of Small-Scale Fisheries: A Modeling Approach to Explore the Use of in-Shore Pelagic Resources in Melanesia', *Environmental Modelling and Software*, 96 (2017), pp. 291–304, doi:10.1016/j.envsoft.2017.06.001

Van Huynh, Chuong, Catharien Terwisscha van Scheltinga, Ty Huu Pham, Non Quoc Duong, Phuong Thi Tran, Linh Hoang Khanh Nguyen, and others, 'Drought and Conflicts at the Local Level: Establishing a Water Sharing Mechanism for the Summer-Autumn Rice Production in Central Vietnam', *International Soil and Water Conservation Research*, 7.4 (2019), pp. 362–75, doi:10.1016/j.iswcr.2019.07.001

IPCC, *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, ed. by James J. McCarthy, Osvaldo F. Canziani, Neil A. Leary, David J. Dokken, and Kasey S. White, 1st edn (Cambridge University Press, 2001)

Khan, Imran, Hongdou Lei, Irshad Ali Shah, Imad Ali, Inayat Khan, Ihsan Muhammad, and others, 'Farm Households' Risk Perception, Attitude and Adaptation Strategies in Dealing with Climate Change: Promise and Perils from Rural Pakistan', *Land Use Policy*, 91.August 2019 (2020), p. 104395, doi:10.1016/j.landusepol.2019.104395

Kibirige, Douglas, Ajay S. Singh, and Lovemore M. Rugube, 'Small-Scale Irrigation and Production Efficiency among Vegetable Farmers in the Eastern Cape Province of South Africa: The DEA Approach', *Journal of Agricultural Studies*, 7.1 (2019), p. 149, doi:10.5296/jas.v7i1.14564

Kusumo, Rani Andriani Budi, Gema Wibawa Mukti, and Anne Charina, 'Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis Livelihood Diversity of Rainfed Wetland Rice Farmer Households (Case Study in Kroya Sub-District, Indramayu District)', *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, 10.1 (2024), pp. 1208–16

Liu, Zhifei, Qianru Chen, and Hualin Xie, 'Influence of the Farmer's Livelihood Assets on Livelihood Strategies in the Western Mountainous Area, China', *Sustainability (Switzerland)*, 10.3 (2018), doi:10.3390/su10030875

Murniati, Ktut, and Abdul Mutolib, 'The Impact of Climate Change on the Household Food Security of Upland Rice Farmers in Sidomulyo, Lampung Province, Indonesia', *Biodiversitas*, 21.8 (2020), pp. 3487–93, doi:10.13057/biodiv/d210809

Nissa, Zulfa Nur Auliatun, Arya Hadi Dharmawan, and Saharuddin Saharuddin, 'Vulnerability Analysis of Small Fishermen's Household Livelihoods in Tegal City', *Komunitas: International Journal of Indonesian Society and Culture*, 11.2 (2019), doi:10.15294/komunitas.v11i2.18583

Pretty, Jules, and Hugh Ward, 'Social Capital and Environment', *World Development*, 29.3–4 (2001), pp. 209–27, doi:10.1159/000149889

Putnam, Robert D., 'Project Report Social Capital and Public Affairs', *Buletin of the American Academy of Arts and Science*, 47.8 (1994), pp. 5–19

Qin, Zhang, Xue Haili, Lan Xiao, Dai Luwei, Wang Bojie, Cui Fengqi, and others, 'Livelihood Vulnerability of Pastoral Households in the Semiarid Grasslands of Northern China: Measurement and Determinants', *Ecological Indicators*, 140.December 2021 (2022), p. 109020, doi:10.1016/j.ecolind.2022.109020

Saptutyningsih, Endah, Diswandi Diswandi, and Wanggi Jaung, 'Does Social Capital Matter in Climate Change Adaptation? A Lesson from Agricultural Sector in Yogyakarta, Indonesia', *Land Use Policy*, 95.August 2019 (2020), p. 104189, doi:10.1016/j.landusepol.2019.104189

Shen, Jinyu, Wei Duan, Yuqi Wang, and Yijing Zhang, 'Household Livelihood Vulnerability to Climate Change in West China', *International Journal of Environmental Research and Public Health*, 19.1 (2022), doi:10.3390/ijerph19010551

Sugiyono, *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif Dan R&* (Alfabeta, 2015) <http://inatews.bmkg.go.id/new/eachevent.php?eventid=20140125121922&tab=1>

Tanle, Augustine, 'Towards an Integrated Framework for Analysing the Links between Migration and Livelihoods', *Norsk Geografisk Tidsskrift*, 69.5 (2015), pp. 257–64, doi:10.1080/00291951.2015.1087422

Woolcock, Michael, and Deepa Narayan, 'Social Capital: Implications for Development Theory, Research, and Policy', *World Bank Research Observer*, 15.2 (2000), pp. 225–49, doi:10.1093/wbro/15.2.225