



When Risks Collide: Compound Vulnerability to Natural Disasters, Market Fluctuations, and Pandemics – Insight from Enrekang, Indonesia

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Received : June 5, 2025
Revised : June 28, 2025
Published: June 30, 2025

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ABSTRACT

The vulnerability of agrarian communities to shocks, seasonality, and long-term trends is a complex challenge that requires holistic analysis. This study aims to analyze the dynamic interaction between the three dimensions of vulnerability (shock-seasonality-trend) in agrarian communities in disaster-prone areas, using a holistic approach that fills the gap in previous literature, which tends to be partial. Using a qualitative case study approach, data were collected through in-depth interviews (25 key informants), focus group discussions (4 sessions), and secondary document analysis. The findings reveal that: (1) Shocks such as natural disasters and disease outbreaks weaken economic resilience due to infrastructure damage and health costs; (2) Seasonal pressures (pest attacks, price fluctuations) increase income instability, exacerbated by dependence on monoculture and limited market access; (3) Long-term trends (droughts, climate change) threaten agricultural sustainability through extreme weather and declining land productivity. Community adaptation strategies include crop diversification, the formation of savings and loan groups, and the adoption of sustainable agricultural practices, but these are hampered by a lack of institutional and technological support. This study highlights the need for integrated policies that combine ecosystem-based mitigation, strengthening early warning systems, and climate resilience training programs. The study's implications contribute to the literature on multidimensional vulnerability and provide practical recommendations for achieving sustainable community resilience.

Keywords: vulnerability, resilience, agrarian communities, adaptation, climate change

INTRODUCTION

The convergence of multiple and interacting risks—ranging from natural disasters and market fluctuations to global health crises—has intensified the vulnerability of agrarian communities, particularly in the Global South. In rural areas where livelihoods depend heavily on seasonal agricultural production and fragile ecosystems, these compound stressors often generate cascading impacts that undermine household resilience, disrupt local food systems, and erode adaptive capacities. This phenomenon is increasingly evident in Enrekang, Indonesia—a highland agricultural region that has experienced recurring climate-related disasters, volatile commodity prices, and the multidimensional fallout of the COVID-19 pandemic. These overlapping crises have exposed the structural fragility of local livelihood systems and challenged the adequacy of prevailing vulnerability frameworks.

While existing literature has extensively addressed individual dimensions of vulnerability—such as climate change (IPCC, 2022), disaster risk (Hallegatte et al., 2017), and poverty (Adger, 2006)—there remains a critical

gap in understanding how these dimensions interact dynamically across time and space. Conventional approaches tend to isolate shocks, seasonal stressors, or long-term trends, overlooking the **synergistic and compounding nature** of vulnerability. This fragmented lens not only limits theoretical clarity but also constrains the formulation of effective, grounded policy responses (Tanner et al., 2015). Moreover, dominant models often adopt top-down, technocratic perspectives that marginalize local knowledge systems and informal adaptation strategies, which remain essential in data-scarce, hazard-prone rural contexts (Berkes & Ross, 2016).

Three analytical blind spots persist in the literature. First is the lack of integrated frameworks that account for the intersection of shock (e.g., extreme weather), seasonality (e.g., planting and harvest cycles), and trend (e.g., long-term climate shifts or economic decline) (Mbow et al., 2019). Second is the limited empirical attention to locally embedded adaptation practices—such as crop diversification, traditional early-warning signs, and communal risk-sharing networks. Third is the absence of temporally sensitive tools to capture the evolution of vulnerability and adaptive capacity over time (O'Brien et al., 2022).

This study addresses these gaps by conceptualizing vulnerability as a compound and cascading phenomenon, where risks do not occur in isolation but co-evolve and amplify one another through time and across systems. Anchored in a qualitative case study of agrarian communities in Enrekang, Indonesia, the research investigates how households perceive, experience, and respond to multiple, overlapping forms of vulnerability. Drawing on the Sustainable Livelihood Framework (DFID, 1999), the study integrates data from in-depth interviews, focus group discussions (FGDs), and secondary documents to trace how dynamic interactions between disaster events, market instability, and health crises shape livelihood strategies and resilience pathways.

By grounding analysis in the lived experiences of farmers, local policymakers, and frontline health workers, this research foregrounds the contextual, temporal, and relational aspects of vulnerability—elements often missing in generalized risk assessments. Furthermore, the study links empirical findings to key levers of global policy, notably SDG 1 (No Poverty) and SDG 13 (Climate Action), offering practical insights for the design of inclusive, hybrid risk governance mechanisms that blend local knowledge with scientific early-warning systems (Surminski & Thielen, 2017).

In doing so, the study contributes not only to theoretical refinement—by advancing a compound-risk perspective—but also to policy innovation, by illuminating how rural communities in hazard-prone regions like Enrekang can be supported in navigating layered vulnerabilities in a volatile and uncertain world.

RESEARCH METHODS

Research Design

This study employs a qualitative case study approach (Yin, 2018) to examine the compound vulnerability of agrarian communities in Enrekang, Indonesia—an area characterized by recurrent natural disasters, economic volatility, and health-related shocks. The case study design enables an in-depth exploration of context-specific processes, perceptions, and adaptation strategies, particularly in settings where complexity and local knowledge are central to understanding systemic risk.

The research site was selected through purposeful sampling based on two criteria:

- High exposure to at least two types of vulnerability drivers—namely shocks (e.g., floods, pandemics), seasonal pressures (e.g., harvest cycles, labor migration), or long-term trends (e.g., soil degradation, price volatility);
- Primary economic dependence on small-scale agriculture, reflecting the community's structural sensitivity to environmental and market disturbances.

This context provides a fertile ground to investigate the interaction between multiple stressors and local coping mechanisms in a compound-risk landscape.

Data Collection

Data were collected between [insert months/years], using a triangulated multi-method strategy to enhance validity and depth:

1. In-depth Interviews

A total of 25 semi-structured interviews were conducted with key informants, including smallholder farmers, local government officials, and frontline health workers. Interview protocols were developed based on the Sustainable Livelihoods Framework (DFID, 1999), allowing exploration of livelihood

assets, institutional support, vulnerability contexts, and adaptive responses. Interviews were conducted in Bahasa Indonesia, recorded with consent, and later transcribed and translated.

2. Focus Group Discussions (FGDs)

Four FGDs were held with farmer groups and women's collectives to capture collective perspectives, social learning, and gendered experiences of vulnerability. The FGDs provided valuable insights into communal coping practices and intra-household dynamics that are often overlooked in individual interviews.

3. Document Analysis

Complementary secondary data were sourced from government agencies and local institutions, including disaster reports, climate records, and commodity price data from 2018–2023. These documents served to contextualize primary findings and track longitudinal risk trends.

Data Analysis

All data were analyzed using thematic analysis (Braun & Clarke, 2006), following a recursive six-phase process: familiarization, initial coding, theme development, theme refinement, interpretation, and reporting. The analysis was supported by NVivo 12 software to ensure systematic coding and data management.

Themes were inductively and deductively derived, with particular attention to identifying:

- Patterns of perceived vulnerability across economic, ecological, social, and institutional domains;
- Local adaptation strategies, both individual and collective, including indigenous knowledge and informal safety nets;
- Temporal dynamics of vulnerability, capturing how communities adjusted over time in response to recurring and overlapping shocks.

Data from interviews, FGDs, and document reviews were triangulated to enhance credibility and confirm the consistency of emerging insights.

Research Ethics

All research procedures adhered to ethical guidelines for research involving human participants. Informed consent was obtained verbally and in writing from all participants, following a clear explanation of the study's purpose, voluntary nature, and confidentiality measures. Participant identities were anonymized in all transcripts and reporting to protect privacy and minimize potential harm.

RESULTS AND DISCUSSION

Vulnerability Context Analysis

The context of vulnerability is a foundation that reflects various conditions and factors that make individuals, families, or communities more susceptible to external risks and pressures. Vulnerability can arise in various contexts, including economic, environmental, social, and political aspects. Factors that influence vulnerability can vary, but some elements that commonly contribute include. Economically, vulnerability can arise from job insecurity, low income, or dependence on a single source of livelihood, all of which can increase financial instability. The physical environment can also be a source of vulnerability, especially if the area is prone to natural disasters, climate change, or natural resource depletion. Sustainable livelihoods imply the need for stability, long-term resilience, and strength in the face of external shocks.

The social context impacts access to education, health services, and social support, while political factors may include lack of legal protection, conflict, or political instability. Community well-being and resilience levels also play an important role in determining vulnerability, as communities less able to cope with change or crisis may be more vulnerable to risk. Understanding the context of vulnerability is an important step in designing effective programs and policies to reduce vulnerability and increase community resilience. It also helps identify factors that can be intervened to improve the quality of life and well-being of individuals and larger communities.

Shock-Induced Vulnerability in Agrarian Communities

The findings from Enrekang, Indonesia, reveal that compound vulnerability to shocks—particularly natural disasters and infectious disease outbreaks—poses significant threats to agrarian livelihoods. Empirical data show that these events rarely occur in isolation; instead, they interact with seasonal pressures and long-term structural challenges, creating cascading effects that undermine community resilience.

In terms of natural disasters, the study site experienced recurrent hazards such as landslides, floods, droughts, and forest fires between 2018 and 2023. These events damaged critical infrastructure, disrupted agricultural activities, and triggered economic uncertainty. Landslides, often induced by intense rainfall on

deforested slopes, led to the destruction of homes and farmlands, while seasonal droughts undermined crop yields and reduced water availability. Flooding further exacerbated household displacement and livestock losses, and recurring forest fires threatened air quality and ecological stability. Despite the frequency of such hazards, the absence of early warning systems, limited disaster preparedness, and weak institutional coordination significantly magnified community exposure and sensitivity to these events. Local governments in Indonesia face challenges in implementing international disaster risk reduction agreements, such as AADMER, due to insufficient institutional capacity and commitment. Decentralization has increased the effectiveness of disaster management but has also led to regulatory inconsistencies and dependence on central government support, limiting the capacity of local institutions (Putra & Matsuyuki, 2019).

In parallel, human disease outbreaks—including COVID-19, smallpox, influenza, and pertussis—constituted an additional layer of acute vulnerability. The COVID-19 pandemic, in particular, revealed the fragility of local healthcare systems and disrupted both input supply chains and produce markets. The social distancing measures and mobility restrictions significantly reduced labor availability during peak agricultural seasons, compounding existing vulnerabilities. While previous mass vaccination efforts had controlled diseases like smallpox, recurrent outbreaks of influenza and respiratory infections continued to pose risks, especially for children and the elderly. The lack of widespread immunization coverage and public health infrastructure in remote areas intensified these risks.

Local stakeholders consistently identified institutional gaps, including inadequate public health response and minimal coordination between disaster management and agricultural agencies, as key factors exacerbating the impacts of these shocks. Furthermore, traditional coping strategies—such as reciprocal labor-sharing during floods or the use of herbal medicine during health crises—were frequently employed, but remain underrecognized in formal policy frameworks. These findings underscore the importance of rethinking vulnerability not as a static condition, but as a dynamic interplay of compound risks, which require integrated, context-specific responses. Natural disasters often trigger outbreaks of infectious diseases, exacerbated by inadequate health services and public awareness (Pascapurnama et al., 2017). Integrated health education is essential to reduce health risks, emphasizing the role of schools and community centers in disseminating health information (Pascapurnama et al., 2017).

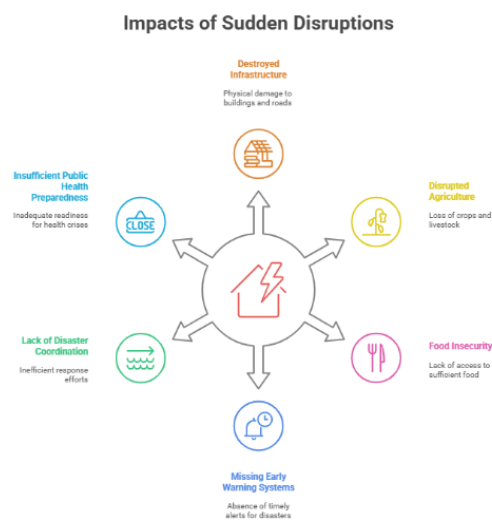


Figure 1. Impact of Sudden Disruptions

Seasonality

Seasonal vulnerability involves a number of challenges related to seasonal changes, and two significant aspects that have occurred at the study site are pest and disease attacks and fluctuations in agricultural commodity prices. During the agricultural season, crops and livestock are often vulnerable to pest and disease attacks that can damage harvests and agricultural resources. Pest infestations can cause significant losses for farmers and livestock breeders and often disrupt stable food supplies.

On the other hand, seasonal vulnerability at the study site in the form of fluctuations in agricultural commodity prices is another issue that arises during the harvest season and periods of abundant harvests. Agricultural commodity prices can plummet due to excessive supply, resulting in reduced income for farmers. This can sometimes cause economic hardship for agrarian communities, who depend on their harvests as their

primary source of income. Therefore, seasonal vulnerability to pest and disease attacks, as well as price fluctuations, underscores the importance of prudent mitigation and risk management efforts in agriculture, as well as livelihood diversification to reduce the economic risks associated with seasonal changes.

Stressors of Pest Infestation and Commodity Price Volatility

In addition to acute shocks such as natural disasters and epidemics, agrarian communities in Enrekang face chronic **stressors** that undermine their livelihood resilience—particularly **pest infestations** and **commodity price fluctuations**. These stressors, though often considered routine, compound vulnerability by gradually eroding household assets and weakening the capacity to recover from larger disruptions.

Pest infestation is a recurrent and pervasive challenge affecting key agricultural commodities in the region. Farmers reported **severe crop losses due to pest outbreaks**, especially during seasonal transitions or after prolonged droughts. Among the most destructive pests were *caterpillars*, which ravaged leafy crops such as shallots and vegetables; *brown planthoppers* that targeted rice and fruit-bearing plants; and the *coffee stem borer*, which significantly reduced yields and led to income loss among smallholder coffee producers. Rodents such as *rats* and larger wildlife including *wild boars*, *civets*, and *monkeys* also caused substantial damage to crops like salak, cocoa, and bananas. These animal pests not only destroyed standing crops but also increased replanting costs and disincentivized investment in perennial plants. In response, farmers relied heavily on **chemical-based pest control (PBK)** methods. While effective in the short term, this approach raised concerns over environmental degradation, health risks, and the emergence of pest resistance, pointing to a critical need for more sustainable and integrated pest management strategies.

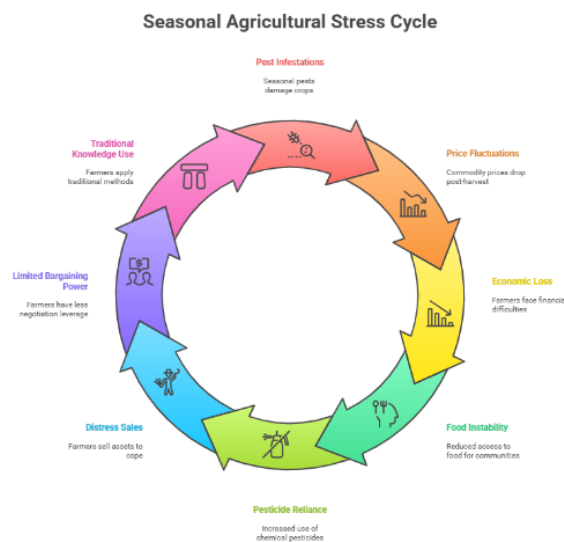


Figure 2. Seasonal Agricultural Stress Cycle

Simultaneously, commodity price volatility emerged as a key economic stressor that interacts with ecological pressures to deepen livelihood insecurity. Fluctuations in farm-gate prices—often driven by oversupply, erratic demand, or climate-induced production shifts—directly impacted household incomes. Farmers frequently encountered sharp price declines following harvest periods, resulting in distress sales and diminished returns on labor and capital investment. The problem was compounded by market asymmetry and intermediary monopolies, where traders exercised significant influence over price formation and often engaged in price manipulation or collusion. Price volatility is a normal market feature but has increased due to economic and environmental uncertainty (Tothova, 2011). Farmers experience income instability, especially those who depend on several commodities, which leads to depressed sales and reduced returns (Rapsomanikis & Sarris, 2006).

This left producers with little bargaining power and restricted access to price information. In cases where harvest quality declined—due to pest damage or erratic rainfall—producers received further price cuts, creating a feedback loop of declining productivity and profitability. Moreover, lack of access to formal credit aggravated the situation, as many smallholders could not absorb losses or invest in adaptive strategies such as crop diversification or value-added processing. Unpredictable rainfall and climate change worsened agricultural productivity, creating a feedback loop of declining profitability (Singh et al., 2020). Farmers reported that climate variability acted as a risk multiplier, increasing vulnerability to ecological and economic stressors (Singh et al., 2020).

Collectively, the findings suggest that chronic stressors such as pest infestation and price instability not only disrupt food production systems but also constrain long-term adaptive capacity. These factors contribute to a state of entrenched vulnerability, wherein external shocks (e.g., climate disasters or pandemics) have disproportionately severe consequences. Addressing these challenges requires systemic interventions that go beyond emergency responses, including farmer-led pest surveillance, cooperative marketing, and inclusive pricing policies to stabilize livelihoods and reduce exposure to economic and ecological risk.

Trend Vulnerability

Trend vulnerability refers to the extent to which a trend or change in society or the environment can be influenced or disrupted by various factors that can lead to instability, uncertainty, or even regression. These trends can relate to various fields, including economics, politics, the environment, technology, and society. Trend vulnerability is often associated with imbalances in systems or societies, as well as their inability to respond to change quickly or effectively. Factors that can increase trend vulnerability include dependence on a single resource or factor, lack of cooperation between stakeholders, uncertainty in technological developments, or economic instability. Identifying and understanding trend vulnerabilities is an important step in efforts to reduce risks and increase resilience to future changes.

Trend vulnerabilities in the context of natural disasters in Indonesia have been the focus of several studies. Research indicates that coastal communities exhibit varying levels of vulnerability to disasters, with economic factors playing a significant role (Rahmi & Satria, 2015). Following the Lapindo mudflow disaster, affected residential areas still face moderate economic vulnerability, highlighting the need for strengthened economic mitigation policies (Ekawati & Sulistyowati, 2021). Factors influencing vulnerability to forest and land fires have been identified in South Kalimantan (Latifah & Pamungkas, 2013). In Sleman District, an analysis of vulnerability to landslides shows variations in vulnerability levels across subdistricts, with Kalasan Subdistrict having the largest highly vulnerable zone (Destriani & Pamungkas, 2013). These studies emphasize the importance of understanding vulnerability to enhance resilience to disasters.

In the context of modern agricultural dynamics, the results of this study indicate that agricultural communities in the study area are beginning to experience and respond to various transformational trends in the agricultural sector, which have a direct impact on food security and adaptation to risks. One of the main trends identified is a shift toward sustainable agriculture, where some farmers are beginning to adopt environmentally friendly practices such as the use of organic fertilizers, reduction of chemical pesticides, and land conservation. This is a strategic effort to maintain soil fertility and reduce ecosystem damage, which has contributed to food vulnerability.

Additionally, the agricultural technology revolution is beginning to penetrate rural areas, although its implementation remains limited. Farmers are gradually becoming familiar with technologies such as weather monitoring apps and social media for market access, though few have yet been able to utilize advanced technologies like drones or precision farming systems. On the other hand, increasing consumer awareness of functional and healthy foods, such as organic and non-GMO products, has created new opportunities for local farmers to adjust their production types and cultivation systems to meet market demand for more nutrition-conscious products—this is relevant to efforts to prevent stunting and improve family consumption quality.

Another emerging trend is urban agroforestry and vertical farming, particularly in suburban areas, which show great potential in bringing food production closer to consumers, reducing transportation emissions, and improving access to fresh food in urban environments. Furthermore, changes in agricultural policies, whether in the form of subsidies, regulations, or trade restrictions, are also beginning to influence farmers' production behavior. For example, some farmers complain about limited access to subsidized fertilizers and a lack of support for local commodities.

The impact of climate change has also become an integral part of contemporary agricultural trends that are recognized by the community. Extreme weather variability has prompted some farmers to adopt adaptation techniques, such as crop rotation, agricultural diversification, and more flexible planting patterns. Finally, partnerships in online trade show positive developments, with farmers beginning to market their products directly through digital platforms, cutting out distribution chains, and securing fairer prices and broader market access. Overall, these trends reflect a positive shift toward a more resilient, inclusive, and adaptive agricultural system in the face of future challenges, in line with the urgency of local food security, which is the main focus of this study.

The research findings indicate that community food security based on local agriculture still faces various complex structural and ecological challenges, particularly during drought seasons and the increasingly evident impacts of climate change. Drought conditions, characterized by prolonged dry spells, pest infestations, price fluctuations, and rising production input costs such as fertilizers and pesticides, create critical conditions that directly disrupt agricultural productivity and household food availability. Prolonged drought not only causes a decline in crop production but also reduces water availability for livestock and households, ultimately affecting

family consumption quality and health. When commodity prices plummet drastically amid minimal harvests, farmers face severe economic difficulties, even bearing the risk of crop failure. In this situation, pest attacks become increasingly destructive, as water-deficient crops become more susceptible to disease. Additionally, the surge in fertilizer and pesticide prices forces farmers to reduce usage or even stop using them altogether, further worsening harvest yields and accelerating land degradation.

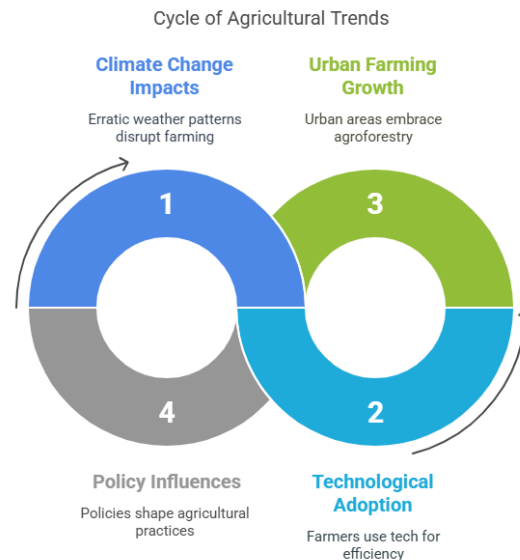


Figure 3. Cycle of Agricultural Trends

These conditions are exacerbated by the impact of climate change, which is increasingly being felt by farming communities. Climate change is a global challenge that requires immediate action and collaboration from various parties, including governments, scientists, farmers, and the wider community. Appropriate mitigation and adaptation measures can help reduce the impact of climate change on agriculture and maintain food security. Unpredictable weather patterns—such as rainy seasons arriving too early or too late—make it difficult for farmers to plan effective planting schedules. This uncertainty increases the risk of repeated crop failures and directly threatens household food availability. Global warming also affects crop growth, with extreme temperatures causing stress on plants and altering the biological cycles of pests and diseases. Prolonged and recurring droughts make farmers increasingly dependent on limited water sources, while intense rainfall in a short period of time risks causing flooding and erosion.

This situation has a direct impact on reducing access to healthy and nutritious food at the household level, which in turn increases the risk of malnutrition and stunting in children. In addition, reduced agricultural activity during the dry season has led to limited employment opportunities in rural areas, exacerbating the socio-economic conditions of the community. Therefore, to ensure the sustainability of food security based on local agriculture, integrated adaptive measures are needed, including enhancing farmers' capacity to adapt to climate change, strengthening local institutions, protecting agricultural product prices, and providing social support for vulnerable groups during droughts. These findings underscore the importance of building a climate-resilient agricultural system that can withstand economic risks, as well as strengthening the local foundation as the cornerstone of food security and stunting prevention.

CONCLUSION

This study confirms that the vulnerability of agrarian communities is multidimensional, influenced by complex interactions between shocks, seasonality, and long-term trends. Key findings show that: Shocks (natural disasters, epidemics) not only disrupt economic stability but also reveal inequalities in access to mitigation resources, such as resilient infrastructure or health services. Seasonal fluctuations (pests, commodity prices) expose risky dependencies on monoculture systems and unfair supply chains, where farmers are the most vulnerable players in the price game. Climate change exacerbates vulnerability through increased crop failure and weather uncertainty, requiring radical transformation of conventional agricultural practices.

Although communities develop locally-based adaptation strategies—such as crop diversification and social

institutions—their effectiveness is often limited by a lack of policy and technological support. Therefore, policy recommendations should include: (1) An integrated approach combining disaster risk management, commodity price stabilization, and climate adaptation programs; (2) Empowering local institutions to strengthen community capacity for long-term planning; (3) Affordable technological innovations, such as water-efficient irrigation systems and digital pest monitoring. This study emphasizes that reducing vulnerability requires interventions that are not only reactive but also proactive in building systemic resilience. Further research could test intervention models based on these findings in different geographical contexts.

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