ISSN 3155-5977
Research Article

Social Vulnerability Assessment of Disaster Risks in Manay, Davao Oriental

Vincent Jay S. Padillo
Nympha E. Branzuela
Marvin A. Batiancela
Christopher V. Famor
Lorena L. Sabino

International Journal of Economics, Culture, and Sustainable Development Viewpoints
Vol. 1, No. 1, Art. 1, 2026

Correspondence: vjspadillo00644@usep.edu.ph
[1]Department of Science and Technology, Davao Oriental
[2-4]University of Southeastern Philippines
[5]University of the Philippines Los Baños

Abstract
This study examined the Social Vulnerability Index (SVI) of Manay, Davao Oriental, in relation to earthquake, landslide, and flooding hazards. Despite increasing exposure to multiple hazards, localized and integrated assessments of socio-economic and spatial drivers of vulnerability at the barangay level remain limited, resulting in gaps in disaster risk reduction and management (DRRM) planning. A mixed-methods approach was employed, using the Analytic Hierarchy Process (AHP) to determine indicator weights and Geographic Information System (GIS) techniques to map the spatial distribution of vulnerability. Quantitative data from survey respondents were triangulated with qualitative insights from key informant interviews (KII) and focus group discussions (FGDs). Results indicate that vulnerability is spatially heterogeneous and shaped by both environmental and socio-economic conditions. Lower SVI values were associated with higher adaptive capacity; barangays with lower SVI values had high adaptive capacity and resilience, whereas barangays with higher exposure and sensitivity had higher SVI. The barangay of San Fermin had the highest SVI value for earthquakes (0.9992), and the barangay of Manreza had the lowest (0.3132). For landslide hazards, San Fermin also had a very high vulnerability (0.965), while Manreza had a low vulnerability (0.318). For the flooding hazard, Central has a highly vulnerable score (0.7779), and Concepcion has a moderate score (0.548). Overall, 58% of the barangays evaluated had high SVI for earthquake, 69% were found highly vulnerable to landslides, and 33% were highly vulnerable to flooding. Barangays with high population density, hazard-prone locations, and limited resources consistently exhibited higher vulnerability. The findings highlight that social vulnerability is multi-dimensional, spatially clustered, and socially embedded, underscoring the need for integrated, place-based DRRM strategies.

Keywords
Social Vulnerability Index (SVI), Disaster Risk Reduction and Management (DRRM), Analytic Hierarchy Process (AHP), Geographic Information System (GIS), Multi-hazard Vulnerability Assessment

How to Cite
Padillo, V. J., Branzuela, N., Batiancela, M., Famor, C. V. F., & Sabino, L. (2026). Social Vulnerability Assessment of Disaster Risks in Manay, Davao Oriental. International Journal of Economics, Culture, and Sustainable Development Viewpoints, 1(1), Article 1. https://doi.org/10.64612/ijecsdv.v1i1.177

Received: 24 April 2026
Accepted: 15 June 2026
Published: 30 June 2026

Peer Review Statement
This article underwent a double-anonymous peer review process in accordance with the editorial policies of the journal. Both authors and reviewers remained anonymous throughout the review process.
Open Access Statement
This journal is a fully open-access, peer-reviewed journal. All articles are freely available online immediately upon publication without subscription or access fees.
Funding Statement
The authors received no financial support for the research, authorship, and/or publication of this article.
Conflict of Interest
The authors declared no conflicts of interest.
Data Availability Statement
The data supporting the findings of this study are available from the corresponding author upon reasonable request.
Author Contributions
The authors contributed to conceptualization, methodology, investigation, writing—original draft preparation, writing—review and editing, and supervision. The authors approved the final manuscript.
Ethics Statement
This study was conducted in accordance with ethical standards.

INTRODUCTION

Natural hazards continue to pose significant challenges to sustainable development because their impacts are determined not only by the magnitude of hazardous events but also by the vulnerability of the populations they affect. Contemporary disaster research recognizes that vulnerability is a multidimensional construct resulting from the interaction of exposure, sensitivity, and adaptive capacity rather than hazard occurrence alone (Adger, 2006; Intergovernmental Panel on Climate Change [IPCC], 2022). Consequently, communities exposed to similar hazards often experience markedly different disaster outcomes because of variations in socioeconomic conditions, governance, infrastructure, and institutional capacity. This shift from hazard-centered to vulnerability-centered disaster risk reduction has led to the widespread adoption of indicator-based assessment frameworks that integrate demographic, economic, environmental, and institutional dimensions of vulnerability (Birkmann et al., 2013; Cutter et al., 2003). The Social Vulnerability Index (SVI) has emerged as one of the most widely applied approaches for identifying communities requiring priority intervention because it captures the cumulative effects of social inequalities that influence disaster preparedness, response, and recovery (Fatemi et al., 2017). Likewise, strengthening adaptive capacity, social capital, and community resilience has become central to disaster risk reduction strategies because these factors substantially influence communities' ability to withstand and recover from hazard events (Aldrich & Meyer, 2015; Norris et al., 2008).

The Philippines is among the world's most disaster-prone countries because of its geographic location within the Pacific Ring of Fire and the Western Pacific typhoon belt. Communities are frequently exposed to earthquakes, flooding, landslides, and other hydro-meteorological hazards that threaten lives, livelihoods, and infrastructure. Although Republic Act No. 10121 institutionalized a proactive disaster risk reduction and management framework, local disaster assessments continue to focus primarily on hazard exposure while giving comparatively limited attention to the social conditions that influence vulnerability. This limitation is particularly evident in municipalities such as Manay, Davao Oriental, where mountainous terrain, coastal environments, and recurring extreme weather events expose communities to multiple hazards. Despite the availability of hazard maps and disaster preparedness plans, differences in demographic characteristics, socioeconomic conditions, institutional preparedness, and adaptive capacity continue to influence the severity of disaster impacts among barangays. These observations underscore the need to complement physical hazard assessments with comprehensive evaluations of social vulnerability to support more effective disaster risk reduction planning (UNDRR, 2019).

Previous studies have demonstrated the value of Social Vulnerability Indices in identifying priority areas for disaster risk reduction by integrating multiple vulnerability indicators into composite measures (Aksha et al., 2019; Cutter et al., 2003; Rafieian et al., 2019). Recent advances have further emphasized the importance of combining multi-criteria decision analysis and Geographic Information System (GIS) techniques to improve the spatial representation of vulnerability and strengthen evidence-based planning (Ramli et al., 2021; Yin et al., 2024). Nevertheless, several research gaps remain. Empirically, localized assessments integrating demographic, socioeconomic, institutional, and resilience indicators at the barangay level remain limited in the Philippine context. Methodologically, many local studies rely on descriptive analyses or hazard susceptibility mapping without systematically weighting vulnerability indicators or validating findings through qualitative inquiry. Contextually, limited research has examined the multidimensional nature of social vulnerability in rural municipalities exposed simultaneously to earthquake, landslide, and flood hazards. These gaps constrain the ability of local governments to identify priority communities and allocate disaster risk reduction resources efficiently.

This study assessed the social vulnerability of selected hazard-prone barangays in Manay, Davao Oriental by integrating the Social Vulnerability Index, the Analytic Hierarchy Process (AHP), Geographic Information System (GIS)-based spatial analysis, household surveys, Key Informant Interviews, and Focus Group Discussions. Specifically, it examined the levels and spatial distribution of social vulnerability to earthquake, landslide, and flood hazards while identifying the socioeconomic, demographic, institutional, and resilience factors that contribute to disaster risk. By providing a localized and multidimensional assessment of vulnerability, the study offers empirical evidence to strengthen Climate and Disaster Risk Assessments, Comprehensive Land Use Plans, and Municipal Disaster Risk Reduction and Management Plans. Furthermore, the proposed framework contributes to disaster risk reduction literature by demonstrating the value of integrating quantitative and qualitative approaches to support evidence-based planning and enhance community resilience in multi-hazard environments.

METHODOLOGY

Design

This study employed a convergent mixed-methods research design to examine the social vulnerability of hazard-prone barangays in Manay, Davao Oriental. The design enabled the integration of quantitative and qualitative evidence to provide a comprehensive assessment of disaster vulnerability by combining statistical measurements with contextual insights from community stakeholders. The quantitative component involved the development of a Social Vulnerability Index (SVI), while the qualitative component generated explanatory evidence through Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). The convergence of both datasets during the interpretation phase facilitated methodological triangulation, thereby enhancing the credibility and comprehensiveness of the findings. A mixed-methods approach was considered appropriate because disaster vulnerability is a multidimensional construct shaped by demographic, socioeconomic, environmental, and institutional factors that cannot be adequately explained through a single methodological approach (Creswell & Plano Clark, 2018).

Locale and Participants

The study was conducted in selected hazard-prone barangays of Manay, Davao Oriental, Philippines, an area characterized by recurring earthquake, landslide, and flood hazards. The barangays were selected based on municipal hazard assessments

and their documented exposure to multiple natural hazards. Participants comprised household respondents, barangay officials, personnel from the Municipal Disaster Risk Reduction and Management Office (MDRRMO), and other stakeholders directly involved in disaster risk reduction and community governance. Household respondents were selected through purposive sampling using the following inclusion criteria: at least 18 years of age, permanent residency in the barangay for a minimum of five years, and sufficient knowledge of local disaster conditions. Key informants and FGD participants were likewise selected purposively because of their direct involvement in disaster preparedness, emergency response, and local planning. This sampling strategy ensured that participants possessed the contextual knowledge necessary to provide reliable and information-rich responses relevant to the objectives of the study.

Instruments and Collection

Primary data were collected through a structured survey questionnaire, semi-structured interview guides, and focus group discussion protocols, while secondary data were obtained from the Municipal Disaster Risk Reduction and Management Office, the Philippine Statistics Authority, the Mines and Geosciences Bureau, and the Philippine Institute of Volcanology and Seismology. The survey instrument was developed from established Social Vulnerability Index frameworks and measured indicators representing exposure, sensitivity, adaptive capacity, and resilience. Content validity was established through expert evaluation involving specialists in disaster risk reduction, environmental management, and research methodology. The instrument was subsequently pilot-tested among respondents with characteristics comparable to the target population to evaluate clarity, consistency, and reliability before full-scale implementation. Revisions were incorporated based on expert recommendations and pilot-testing results to improve the quality of the instrument. Qualitative data were collected through face-to-face interviews and focus group discussions using semi-structured guides that explored community experiences, disaster preparedness practices, institutional capacity, and perceived factors influencing social vulnerability.

Analysis

Quantitative data were analyzed using descriptive statistics, the Analytic Hierarchy Process (AHP), and Geographic Information System (GIS)-based spatial analysis. Descriptive statistics summarized the demographic characteristics of respondents and the distribution of vulnerability indicators. The Analytic Hierarchy Process was employed to determine the relative weights of the vulnerability indicators through pairwise comparisons following the methodology proposed by Saaty (2008). Consistency ratios were evaluated to ensure the reliability of expert judgments before the weighted indicators were aggregated to compute the Social Vulnerability Index for each barangay. Geographic Information System techniques were subsequently applied to visualize the spatial distribution of vulnerability to earthquakes, landslides, and flooding, thereby facilitating the identification of high-priority areas for disaster risk reduction planning. Qualitative data were analyzed using thematic analysis, involving transcription, coding, categorization, and theme development. The quantitative and qualitative findings were integrated through triangulation to strengthen the validity of the interpretations and provide a more comprehensive understanding of the factors influencing social vulnerability.

Ethical Considerations

The study adhered to established ethical principles governing research involving human participants. Approval to conduct the research was obtained from the appropriate municipal authorities and participating barangays prior to data collection. All participants received a clear explanation of the objectives, procedures, potential risks, and expected benefits of the study before voluntarily providing informed consent. Participation was entirely voluntary, and respondents were informed of their right to withdraw at any stage without consequence. Confidentiality and anonymity were maintained by removing personal identifiers from all research records, while collected data were securely stored and used exclusively for academic and research purposes. These measures ensured the protection of participants' rights, privacy, and welfare throughout the research process.

RESULTS AND DISCUSSION

Table 1 presents the Social Vulnerability Index (SVI) of barangays exposed to earthquake hazards in the Municipality of Manay, Davao Oriental. The results reveal considerable spatial variation in earthquake vulnerability, indicating that disaster risk is not uniformly distributed across the municipality. Of the seventeen barangays assessed, ten were classified as highly vulnerable, five exhibited moderate vulnerability, and only two barangays fell within the low-vulnerability category. San Fermin recorded the highest SVI (0.9992), followed by Del Pilar (0.9984), Old Macopa (0.9757), and San Isidro (0.9587), whereas Manreza (0.3132) and Lambog (0.3246) demonstrated the lowest vulnerability levels. These findings indicate that earthquake vulnerability in Manay is influenced not solely by the presence of seismic hazards but by the interaction of demographic characteristics, socioeconomic conditions, institutional preparedness, and community resilience. This multidimensional pattern supports the conceptualization of vulnerability as a socially constructed condition arising from the interaction among exposure, sensitivity, adaptive capacity, and resilience rather than from hazard occurrence alone (Adger, 2006; Birkmann et al., 2013; IPCC, 2022). The exceptionally high vulnerability observed in San Fermin reflects the cumulative influence of demographic pressure, socioeconomic constraints, and institutional limitations that reduce the community's capacity to anticipate, respond to, and recover from earthquake events. Although earthquake exposure is relatively similar across the municipality, San Fermin is characterized by vulnerable population groups, limited access to essential public services, inadequate emergency infrastructure, and inconsistent implementation of disaster preparedness programs. Likewise, Del Pilar and Old Macopa exhibited extremely high SVI values because of the combined effects of livelihood dependence, informal housing, weak access to healthcare, and insufficient community preparedness mechanisms. The triangulated findings from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) further revealed deficiencies in emergency equipment, preparedness training, and disaster risk reduction implementation that constrain

institutional effectiveness during emergencies. These findings reinforce previous studies emphasizing that disaster losses are largely determined by adaptive capacity and governance quality rather than by hazard exposure alone (Brooks et al., 2005; Engle, 2011). Similarly, the MOVE framework explains that institutional effectiveness, access to resources, and governance structures substantially influence community vulnerability by shaping preparedness, response, and recovery capacities (Birkmann et al., 2013).

Conversely, the relatively low SVI values recorded in Manreza and Lambog demonstrate that stronger institutional support, better access to basic services, and higher levels of community participation can substantially reduce earthquake vulnerability despite continued seismic exposure. These barangays benefit from more cohesive social support systems, improved access to health and emergency services, stronger participation in Disaster Risk Reduction and Management (DRRM) activities, and relatively better preparedness mechanisms. Such conditions strengthen resilience by improving households' ability to cope with hazard impacts and recover following disaster events. These findings are consistent with resilience theory, which emphasizes that communities possessing stronger organizational capacity, social cohesion, and institutional support experience more effective disaster preparedness and faster recovery (Norris et al., 2008). Likewise, stronger social capital enhances cooperation, facilitates resource mobilization, and improves collective action during emergencies, thereby reducing overall vulnerability (Aldrich & Meyer, 2015). Overall, the findings demonstrate that earthquake vulnerability in Manay is fundamentally driven by social and institutional conditions rather than physical hazard exposure alone. Consequently, local disaster risk reduction strategies should prioritize strengthening adaptive capacity through improved public awareness, expanded emergency services, resilient infrastructure, inclusive governance, and sustained community participation to reduce vulnerability and enhance long-term resilience (UNDRR, 2019).

Table 1
Social Vulnerability Index of Barangays Exposed to Earthquake Hazard

Vulnerability Category	Barangay	Social Vulnerability Index
Low (0.00–0.33)	Manreza	0.3132
	Lambog	0.3246
Moderate (0.34–0.66)	Concepcion	0.5482
	Zaragoza	0.5514
	Guza	0.6189
	San Ignacio	0.6289
	Holy Cross	0.6547
High (0.67–1.00)	Rizal	0.6701
	Mabini	0.6842
	Central	0.7793
	Cayawan	0.8662
	Taocanga	0.8709
	Capasnan	0.9335
	San Isidro	0.9587
	Old Macopa	0.9757
	Del Pilar	0.9984
	San Fermin	0.9992

Table 2 presents the mean levels of the four components comprising the Social Vulnerability Index (SVI) for earthquake hazards, namely exposure, sensitivity, adaptive capacity, and resilience. The findings indicate that earthquake vulnerability in Manay is shaped by the interaction of these dimensions rather than by physical exposure alone. Exposure (M = 0.44), sensitivity (M = 0.47), adaptive capacity (M = 0.58), and resilience (M = 0.49) all fall within the moderate vulnerability category, suggesting that while communities possess basic disaster preparedness mechanisms, they continue to face substantial challenges that limit their capacity to cope with and recover from seismic events. The relatively balanced distribution of these components demonstrates that earthquake vulnerability is multidimensional, arising from the combined influence of environmental exposure, demographic characteristics, socioeconomic conditions, institutional effectiveness, and community preparedness. This finding supports the vulnerability framework of the Intergovernmental Panel on Climate Change, which recognizes disaster risk as the product of interactions among exposure, vulnerability, and adaptive capacity rather than as a direct consequence of hazard occurrence alone (IPCC, 2022). The moderate exposure level indicates that although the municipality is situated within a seismically active region, the distribution of exposed populations and physical assets varies across barangays. Communities such as Central and San Ignacio exhibit relatively higher exposure because of their larger population densities and greater concentrations of vulnerable groups, including children, older adults, and persons with disabilities. These demographic characteristics increase evacuation complexity, emergency response requirements, and potential disaster losses during major earthquakes. Likewise, the moderate sensitivity level reflects the influence of socioeconomic conditions that increase the susceptibility of households to disaster impacts. Livelihood dependence, informal housing structures, limited healthcare facilities, and concentrations of socially vulnerable populations contribute to reduced household capacity to withstand earthquake-related disruptions. Similar observations have been reported in previous studies, which emphasize that demographic dependency, housing quality, and socioeconomic deprivation significantly increase disaster sensitivity by limiting households' ability to absorb and recover from hazard impacts (Cutter et al., 2003; Fatemi et al., 2017). Consequently, earthquake vulnerability cannot be adequately understood through hazard exposure alone but must also consider the social conditions that shape disaster consequences. Adaptive capacity and resilience likewise exhibited moderate mean levels, indicating that institutional support systems and

community recovery mechanisms are present but remain insufficiently developed to ensure effective disaster preparedness and rapid post-disaster recovery. While most barangays have established Disaster Risk Reduction and Management (DRRM) structures, hazard maps, and emergency response committees, the qualitative findings revealed uneven participation in preparedness activities, limited emergency equipment, inadequate financial resources, and inconsistencies in the implementation of disaster programs. These institutional limitations reduce communities' ability to transform available resources into effective preparedness and response actions. Nevertheless, the presence of evacuation centers, community organizations, and DRRM activities in several barangays demonstrates that local governments have established foundational mechanisms that can be strengthened through sustained investment and capacity-building initiatives. These findings are consistent with studies showing that adaptive capacity depends on institutional quality, governance effectiveness, and access to essential resources that enable communities to prepare for, respond to, and recover from disasters (Brooks et al., 2005; Engle, 2011). Furthermore, resilience theory emphasizes that strong social capital, community participation, and organizational capacity significantly enhance collective recovery by promoting cooperation, resource sharing, and coordinated disaster response (Norris et al., 2008; Aldrich & Meyer, 2015). Overall, the component analysis demonstrates that reducing earthquake vulnerability in Manay requires integrated interventions that strengthen institutional preparedness, expand access to emergency services, improve public awareness, reinforce resilient infrastructure, and enhance community participation to build long-term disaster resilience.

Table 2
Mean Levels of Social Vulnerability Components for Earthquake Hazard

Component	Mean	Interpretation
Exposure	0.44	Moderate
Sensitivity	0.47	Moderate
Adaptive Capacity	0.58	Moderate
Resilience	0.49	Moderate

Table 3 presents the Social Vulnerability Index (SVI) of barangays exposed to landslide hazards in the Municipality of Manay, Davao Oriental. The results reveal that landslide vulnerability is generally high, with nine of the thirteen assessed barangays classified under the high-vulnerability category, two exhibiting moderate vulnerability, and only two falling within the low-vulnerability category. San Fermin recorded the highest SVI (0.9645), followed by Old Macopa (0.9417), Zaragoza (0.8995), Taocanga (0.8581), and Cayawan (0.8290), whereas Manreza (0.3176) and Lambog (0.3202) demonstrated the lowest vulnerability levels. These findings indicate that landslide vulnerability is spatially concentrated in specific barangays where hazardous environmental conditions intersect with socioeconomic disadvantages and institutional limitations. The observed spatial variability supports the multidimensional concept of disaster vulnerability, which emphasizes that disaster impacts result from the interaction of exposure, sensitivity, adaptive capacity, and resilience rather than from physical hazards alone (Adger, 2006; Birkmann et al., 2013; IPCC, 2022). The extremely high vulnerability observed in San Fermin, Old Macopa, and Zaragoza reflects the cumulative influence of fragile housing conditions, livelihood dependence, limited access to public services, and inadequate institutional preparedness. Many households within these barangays rely heavily on agriculture and other climate-sensitive livelihoods that are highly susceptible to disruption following landslide events. In addition, the prevalence of informal housing, limited healthcare facilities, and insufficient emergency infrastructure increases the difficulty of evacuation, emergency response, and post-disaster recovery. The triangulated findings from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) further revealed that several upland communities continue to occupy environmentally unstable locations because of economic dependence, limited land availability, and accessibility constraints despite being aware of existing landslide risks. Weak implementation of land-use regulations, insufficient preparedness training, and limited emergency equipment further contribute to elevated vulnerability. These findings reinforce previous studies demonstrating that disaster vulnerability increases when communities possess limited adaptive capacity, weak governance systems, and constrained access to institutional resources necessary for effective disaster preparedness and recovery (Brooks et al., 2005; Engle, 2011). Likewise, communities residing in environmentally sensitive areas frequently remain exposed because socioeconomic realities limit opportunities for relocation and risk reduction (Gaillard & Pangilinan, 2010).

Conversely, Manreza and Lambog exhibited the lowest SVI values despite being located within landslide-prone environments. Their comparatively lower vulnerability suggests that stronger community preparedness, better institutional support, and greater access to essential services can substantially reduce disaster risk even where physical hazards remain present. These barangays demonstrate relatively stronger community participation, more effective Disaster Risk Reduction and Management (DRRM) initiatives, and better access to evacuation facilities and basic public services, which collectively enhance local resilience. Such findings support resilience theory, which explains that communities possessing stronger organizational capacity, social cohesion, and institutional support are better able to anticipate, withstand, and recover from disaster events (Norris et al., 2008). Furthermore, stronger social capital promotes cooperation, trust, and collective action that facilitate emergency response and accelerate long-term recovery (Aldrich & Meyer, 2015). Overall, the findings indicate that landslide vulnerability in Manay is fundamentally shaped by socioeconomic and institutional conditions interacting with hazardous environmental settings. Consequently, local governments should prioritize risk-sensitive land-use planning, strengthen early warning systems, improve rural infrastructure, expand community-based disaster preparedness programs, and enhance livelihood diversification to reduce landslide vulnerability and promote sustainable community resilience (UNDRR, 2019).

Table 3
Social Vulnerability Index of Barangays Exposed to Landslide Hazard

Vulnerability Category	Barangay	Social Vulnerability Index
Low (0.00–0.33)	Manreza	0.3176
	Lambog	0.3202
Moderate (0.34–0.66)	Guza	0.5891
	Holy Cross	0.6547
High (0.67–1.00)	Rizal	0.6725
	Central	0.6836
	San Ignacio	0.6974
	Capasnan	0.7255
	Cayawan	0.8290
	Taocanga	0.8581
	Zaragoza	0.8995
	Old Macopa	0.9417
	San Fermin	0.9645

Table 4 presents the mean levels of the Social Vulnerability Index (SVI) components for landslide hazards, including exposure, sensitivity, adaptive capacity, and resilience. The results demonstrate that exposure remained at a moderate level (M = 0.41), while sensitivity (M = 0.70), adaptive capacity (M = 0.74), and resilience (M = 0.73) reached high levels. These findings indicate that landslide vulnerability in Manay is influenced more strongly by socioeconomic and institutional conditions than by physical exposure alone. Although many barangays are not characterized by extreme exposure to landslide-prone areas, the high levels of sensitivity reflect the presence of vulnerable demographic groups, dependence on hazard-sensitive livelihoods, inadequate housing quality, and limited access to essential services that collectively amplify disaster impacts. Likewise, the elevated adaptive capacity and resilience scores indicate that institutional mechanisms and community support systems are present but remain unevenly distributed across the municipality. This multidimensional pattern supports the conceptual framework of disaster vulnerability, which recognizes that hazard exposure alone cannot fully explain disaster risk without considering the social and institutional characteristics that shape communities' ability to prepare for, respond to, and recover from hazard events (Adger, 2006; Birkmann et al., 2013; IPCC, 2022). The moderate exposure level suggests that the geographic distribution of populations and settlements contributes to landslide risk but does not solely determine overall vulnerability. Several upland barangays are situated on steep slopes and environmentally unstable terrain; however, relatively lower population densities in some of these communities reduce the absolute number of exposed individuals compared with more densely populated barangays. Despite this moderate exposure, the high sensitivity level demonstrates that socioeconomic conditions substantially intensify disaster risk. Barangays characterized by numerous informal housing units, dependence on agriculture-based livelihoods, limited healthcare facilities, and large concentrations of children, older adults, and persons with disabilities are considerably more susceptible to landslide impacts. These conditions increase evacuation difficulty, reduce household coping capacity, and prolong post-disaster recovery. Similar findings have been reported in previous studies, which identified poor housing quality, livelihood dependence, demographic vulnerability, and inadequate access to health services as critical determinants of disaster sensitivity (Aksha et al., 2019; Cutter et al., 2003; Fatemi et al., 2017). Consequently, reducing landslide vulnerability requires interventions that address underlying socioeconomic inequalities in addition to structural hazard mitigation. The high mean levels of adaptive capacity and resilience present an important perspective on disaster preparedness within the municipality. Although many barangays have established Disaster Risk Reduction and Management (DRRM) committees, evacuation centers, hazard maps, and community support mechanisms, qualitative findings from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) revealed persistent gaps in implementation, preparedness training, emergency equipment, and early warning systems. This indicates that the existence of institutional structures does not necessarily guarantee effective disaster preparedness or operational readiness. Rather, institutional effectiveness depends on sustained investment, active community participation, adequate resource allocation, and continuous capacity-building initiatives. Communities with stronger social capital, higher participation in DRRM activities, and better access to public services demonstrated greater resilience despite exposure to landslide hazards, highlighting the protective role of institutional support and collective action. These findings are consistent with studies emphasizing that adaptive capacity is strengthened through effective governance, community engagement, and access to resources that enable households to anticipate, respond to, and recover from disasters (Brooks et al., 2005; Engle, 2011). Likewise, resilience theory recognizes that social cohesion, institutional trust, and community participation significantly improve recovery outcomes by facilitating cooperation, resource mobilization, and coordinated emergency response (Aldrich & Meyer, 2015; Norris et al., 2008). Overall, the component analysis demonstrates that reducing landslide vulnerability in Manay requires integrated strategies that combine risk-sensitive land-use planning, strengthened institutional capacity, expanded livelihood opportunities, resilient infrastructure, and sustained community-based disaster preparedness to enhance long-term resilience (UNDRR, 2019).

Table 4
Mean Levels of Social Vulnerability Components for Landslide Hazard

Component	Mean	Interpretation
Exposure	0.41	Moderate
Sensitivity	0.70	High
Adaptive Capacity	0.74	High

Component	Mean	Interpretation
Resilience	0.73	High

Table 5 presents the Social Vulnerability Index (SVI) of barangays exposed to flood hazards in the Municipality of Manay, Davao Oriental. The results indicate that flood vulnerability is unevenly distributed across the six flood-prone barangays, with two barangays classified as highly vulnerable and four exhibiting moderate vulnerability. Central recorded the highest SVI (0.7779), followed by Del Pilar (0.6819), while San Ignacio (0.6446), Holy Cross (0.6201), Zaragoza (0.5647), and Concepcion (0.5482) were categorized as moderately vulnerable. These findings demonstrate that flood vulnerability is influenced not only by the geographic occurrence of flooding but also by demographic composition, socioeconomic characteristics, infrastructure conditions, and institutional capacity. The spatial variation observed among the barangays supports the multidimensional perspective of disaster vulnerability, which recognizes that hazard impacts arise from the interaction of exposure, sensitivity, adaptive capacity, and resilience rather than from flood exposure alone (Adger, 2006; Birkmann et al., 2013; IPCC, 2022).

The high vulnerability observed in Central reflects the combined effects of demographic concentration, livelihood dependence, and institutional limitations that increase disaster risk. Central contains one of the largest concentrations of children, older adults, and persons with disabilities, together with relatively high population density and numerous households dependent on climate-sensitive livelihoods. These demographic characteristics increase evacuation complexity, place greater demands on emergency response systems, and prolong recovery following flood events. Furthermore, portions of the barangay are situated in low-lying areas and near river systems where floodwaters frequently accumulate during periods of intense rainfall. Although disaster management mechanisms are present, limitations in drainage infrastructure, emergency facilities, and preparedness programs continue to increase vulnerability. These findings are consistent with previous studies emphasizing that demographic dependency, settlement concentration, and inadequate infrastructure substantially increase disaster losses because they reduce households' ability to cope with and recover from hazard events (Cutter et al., 2003; Fatemi et al., 2017). Similarly, communities located within environmentally sensitive areas often experience recurring flood impacts because settlement expansion continues in hazard-prone locations due to economic necessity and accessibility considerations (Gaillard & Pangilinan, 2010).

Del Pilar likewise demonstrated high flood vulnerability because socioeconomic and institutional factors amplify the effects of physical exposure. Although the barangay possesses an operational disaster warning system, limited healthcare facilities, inadequate evacuation infrastructure, and dependence on agriculture-based livelihoods constrain emergency response and post-disaster recovery. Flooding frequently disrupts income-generating activities, reduces household financial capacity, and delays community recovery. In contrast, Concepcion, Zaragoza, Holy Cross, and San Ignacio recorded comparatively lower SVI values despite continued exposure to flood hazards. These barangays benefit from relatively stronger community participation, improved access to health services, more active Disaster Risk Reduction and Management (DRRM) initiatives, and better institutional support, which collectively reduce overall vulnerability. Such findings support resilience theory, which emphasizes that communities possessing stronger social capital, organizational capacity, and institutional effectiveness demonstrate greater ability to prepare for, withstand, and recover from disasters (Norris et al., 2008). Likewise, stronger community cooperation and governance systems enhance collective action, facilitate resource mobilization, and improve long-term recovery outcomes (Aldrich & Meyer, 2015). Overall, the findings indicate that flood vulnerability in Manay is fundamentally shaped by the interaction of environmental exposure and social conditions that influence community preparedness, response, and recovery. Consequently, local flood risk reduction strategies should prioritize resilient infrastructure, improved drainage systems, protection of vulnerable population groups, strengthened institutional capacity, livelihood diversification, and sustained community participation to reduce flood vulnerability and enhance long-term resilience (Brooks et al., 2005; UNDRR, 2019).

Table 5
Social Vulnerability Index of Barangays Exposed to Flood Hazard

Vulnerability Category	Barangay	Social Vulnerability Index
Moderate (0.34–0.66)	Concepcion	0.5482
	Zaragoza	0.5647
	Holy Cross	0.6201
	San Ignacio	0.6446
High (0.67–1.00)	Del Pilar	0.6819
	Central	0.7779

Table 6 presents the mean levels of the Social Vulnerability Index (SVI) components for flood hazards, namely exposure, sensitivity, adaptive capacity, and resilience. The findings indicate that exposure (M = 0.45), sensitivity (M = 0.46), adaptive capacity (M = 0.59), and resilience (M = 0.53) all fall within the moderate vulnerability category. These results suggest that flood vulnerability in Manay is not determined exclusively by the municipality's physical exposure to flooding but by the interaction of demographic characteristics, socioeconomic conditions, institutional preparedness, and community recovery capacity. The relatively balanced distribution of the four components demonstrates that flood risk is multidimensional, with each dimension contributing to the overall vulnerability profile of the assessed barangays. This finding supports the conceptual framework of the Intergovernmental Panel on Climate Change, which defines vulnerability as the interaction among exposure, sensitivity, and adaptive capacity rather than as a direct consequence of hazard occurrence alone (IPCC,

2022). Likewise, contemporary disaster research emphasizes that disaster impacts become more severe when environmental hazards intersect with social and institutional vulnerabilities (Adger, 2006; Birkmann et al., 2013).

The moderate exposure level indicates that although many barangays are not permanently subjected to severe flooding, they remain susceptible because of their proximity to rivers, drainage systems, floodplains, and low-lying landscapes where floodwaters accumulate during periods of heavy rainfall. Communities such as Central and San Ignacio exhibit relatively high exposure because they combine flood-prone geographic settings with large concentrations of vulnerable populations, including children, older adults, persons with disabilities, and households dependent on climate-sensitive livelihoods. These demographic conditions increase evacuation requirements, complicate emergency response operations, and heighten the potential for disaster losses. Similarly, the moderate sensitivity level reflects the influence of socioeconomic conditions that reduce household coping capacity. Dependence on agriculture and other flood-sensitive livelihoods, informal housing, limited healthcare services, and vulnerable demographic composition contribute to increased susceptibility when flood events occur. Previous studies have consistently demonstrated that population characteristics, livelihood insecurity, housing quality, and socioeconomic deprivation significantly influence disaster sensitivity because they determine the ability of households to absorb shocks and recover following hazard events (Cutter et al., 2003; Fatemi et al., 2017). Consequently, reducing flood vulnerability requires addressing both physical exposure and the underlying social conditions that amplify disaster impacts.

Adaptive capacity and resilience likewise recorded moderate mean levels, indicating that while institutional mechanisms for disaster preparedness and recovery are present, they remain unevenly implemented across the municipality. Most barangays have established Disaster Risk Reduction and Management (DRRM) committees, hazard maps, evacuation facilities, and community-based preparedness initiatives; however, qualitative evidence from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) identified persistent limitations in preparedness training, emergency equipment, early warning systems, resource allocation, and public participation. These institutional gaps reduce the effectiveness of existing disaster management systems and constrain the ability of communities to respond efficiently during flood emergencies. Nevertheless, barangays with stronger community participation, greater access to healthcare facilities, more active DRRM programs, and stronger social support systems demonstrated relatively better preparedness and recovery capacity. These findings are consistent with previous research emphasizing that adaptive capacity depends on effective governance, institutional quality, access to resources, and sustained community engagement that enable households to anticipate, prepare for, and recover from disasters (Brooks et al., 2005; Engle, 2011). Likewise, resilience theory recognizes that social capital, collective action, and community cooperation significantly strengthen disaster recovery by facilitating resource mobilization, institutional coordination, and long-term adaptation (Aldrich & Meyer, 2015; Norris et al., 2008). Overall, the component analysis demonstrates that reducing flood vulnerability in Manay requires integrated interventions that strengthen institutional capacity, improve drainage and flood-control infrastructure, expand early warning systems, enhance public awareness, diversify livelihood opportunities, and increase community participation in disaster risk reduction. Such comprehensive strategies will improve adaptive capacity and resilience while promoting sustainable and disaster-resilient communities (UNDRR, 2019).

Table 6
Mean Levels of Social Vulnerability Components for Flood Hazard

Component	Mean	Interpretation
Exposure	0.45	Moderate
Sensitivity	0.46	Moderate
Adaptive Capacity	0.59	Moderate
Resilience	0.53	Moderate

Conclusion and Recommendations

This study demonstrated that social vulnerability to earthquake, landslide, and flood hazards in the Municipality of Manay, Davao Oriental is shaped by the complex interaction of environmental exposure, demographic characteristics, socioeconomic conditions, adaptive capacity, and community resilience. The findings revealed substantial spatial disparities in vulnerability among barangays, with San Fermin, Old Macopa, Central, Del Pilar, and other hazard-prone communities consistently exhibiting the highest Social Vulnerability Index (SVI) scores across multiple hazards. Although physical exposure contributed to disaster risk, the results established that vulnerability was predominantly influenced by social and institutional factors, including livelihood dependence, informal housing, vulnerable population groups, limited access to health and emergency services, and uneven implementation of Disaster Risk Reduction and Management (DRRM) programs. By integrating the Social Vulnerability Index (SVI), Geographic Information System (GIS) analysis, the Analytic Hierarchy Process (AHP), Key Informant Interviews (KIIs), and Focus Group Discussions (FGDs), the study provided a comprehensive and empirically grounded assessment of disaster vulnerability that extends beyond conventional hazard mapping. These findings reinforce contemporary vulnerability frameworks, which conceptualize disaster risk as a dynamic interaction among exposure, sensitivity, adaptive capacity, and resilience rather than as a consequence of hazard occurrence alone (Adger, 2006; Birkmann et al., 2013; IPCC, 2022). Beyond its empirical findings, the study contributes to disaster risk reduction scholarship by demonstrating the value of integrating spatial analysis, multicriteria decision-making, and qualitative inquiry in local-level vulnerability assessments. The proposed methodological framework offers a replicable approach that can support evidence-based planning, disaster risk prioritization, and resource allocation in hazard-prone local government units. The results further highlight that sustainable disaster resilience requires investments not only in structural mitigation measures but also in strengthening institutional capacity, community participation, governance

effectiveness, and social protection systems. Consequently, disaster risk reduction policies should prioritize risk-sensitive land-use planning, resilient infrastructure development, inclusive public services, livelihood diversification, and community-centered preparedness initiatives that address the underlying drivers of vulnerability. These integrated strategies will enable local governments to transition from reactive disaster response toward proactive resilience building, thereby contributing to the achievement of the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals, and broader climate adaptation and resilience agendas.

The findings underscore the need for local government units, Disaster Risk Reduction and Management (DRRM) Offices, and other relevant agencies to institutionalize Social Vulnerability Index (SVI)-based planning as a core component of disaster governance. Barangays identified as highly vulnerable, particularly San Fermin, Old Macopa, Central, Del Pilar, and similarly vulnerable communities, should be prioritized for targeted interventions, including the enhancement of early warning systems, evacuation infrastructure, emergency response resources, community-based preparedness programs, and capacity-building initiatives. The integration of SVI and Geographic Information System (GIS) outputs into Comprehensive Land Use Plans (CLUPs), Local Disaster Risk Reduction and Management Plans (LDRRMPs), Comprehensive Development Plans (CDPs), and Local Climate Change Action Plans (LCCAPs) is likewise recommended to strengthen evidence-based decision-making and optimize resource allocation. Furthermore, inter-agency collaboration among local governments, national agencies, educational institutions, civil society organizations, and local communities should be strengthened to improve institutional coordination, public awareness, and long-term disaster resilience. Future investigations should expand the methodological scope of vulnerability assessment by incorporating additional indicators related to climate change adaptation, ecosystem services, governance quality, social capital, public health, and economic resilience while employing higher-resolution geospatial datasets and advanced spatial analytical techniques. Longitudinal studies are recommended to examine temporal changes in vulnerability and evaluate the long-term effectiveness of disaster risk reduction interventions. Comparative assessments involving multiple municipalities, provinces, or regions would further strengthen the external validity and generalizability of the proposed framework. Finally, future research should explore the application of emerging technologies, including artificial intelligence, remote sensing, machine learning, and real-time geospatial monitoring systems, to support dynamic vulnerability assessment, predictive disaster modeling, and adaptive governance. Such directions will contribute to the development of more robust, data-driven, and policy-responsive disaster risk reduction strategies that are responsive to evolving environmental and societal challenges.

References

Adger, W. N. (2006). Vulnerability. Global Environmental Change, 16(3), 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Aksha, S. K., Juran, L., Resler, L., & Zhang, Y. (2019). An analysis of social vulnerability to natural hazards in Nepal using a modified Social Vulnerability Index. International Journal of Disaster Risk Science, 10, 103–116. https://doi.org/10.1007/s13753-018-0192-7

Aldrich, D. P., & Meyer, M. A. (2015). Social capital and community resilience. American Behavioral Scientist, 59(2), 254–269. https://doi.org/10.1177/0002764214550299

Birkmann, J., Cardona, O. D., Carreño, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., & Welle, T. (2013). Framing vulnerability, risk and societal responses: The MOVE framework. Natural Hazards, 67, 193–211. https://doi.org/10.1007/s11069-013-0558-5

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global Environmental Change, 15(2), 151–163. https://doi.org/10.1016/j.gloenvcha.2004.12.006

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. Social Science Quarterly, 84(2), 242–261. https://doi.org/10.1111/1540-6237.8402002

Cutter, S. L., & Finch, C. (2008). Temporal and spatial changes in social vulnerability to natural hazards. Proceedings of the National Academy of Sciences, 105(7), 2301–2306. https://doi.org/10.1073/pnas.0710375105

Engle, N. L. (2011). Adaptive capacity and its assessment. Global Environmental Change, 21(2), 647–656. https://doi.org/10.1016/j.gloenvcha.2011.01.019

Fatemi, F., Ardalan, A., Aguirre, B., Mansouri, N., & Mohammadfam, I. (2017). Social vulnerability indicators in disasters: Findings from a systematic review. International Journal of Disaster Risk Reduction, 22, 219–227. https://doi.org/10.1016/j.ijdrr.2016.09.006

Gaillard, J. C., & Pangilinan, M. L. C. J. (2010). Participatory mapping for raising disaster risk awareness among the youth. Journal of Contingencies and Crisis Management, 18(3), 175–179. https://doi.org/10.1111/j.1468-5973.2010.00607.x

Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, adaptation, and vulnerability: Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009325844

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. American Journal of Community Psychology, 41(1–2), 127–150. https://doi.org/10.1007/s10464-007-9156-6

Rafieian, M., Korrat, I., & Nadi, S. (2019). Spatial analysis of social vulnerability to earthquake hazards in urban areas. Sustainability, 11(18), 4914. https://doi.org/10.3390/su11184914

Ramli, M. W. A., Alias, N. E., Mohd Yusof, H., Yusop, Z., & Taib, S. M. (2021). Development of a local integrated disaster risk assessment framework for Malaysia. Sustainability, 13(19), 10792. https://doi.org/10.3390/su131910792

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. International Journal of Services Sciences, 1(1), 83–98. https://doi.org/10.1504/IJSSCI.2008.017590

United Nations Office for Disaster Risk Reduction. (2019). Global assessment report on disaster risk reduction. United Nations. https://doi.org/10.18356/5f8f4f2f-en

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. Ecology and Society, 9(2), 5. https://doi.org/10.5751/ES-00650-090205

Yin, H., Xiang, Y., Lei, Y., & Xu, J. (2024). Analysis of social vulnerability to earthquake disasters in mountainous areas: A case study of sixteen cities along the fault zone in Sichuan Province, China. Sustainability, 16(15), Article 6479. https://doi.org/10.3390/su16156479