

Sectoral Vulnerability and Community Resilience in Flood-Prone Barangays of Pampanga: A Seven-Dimension Assessment for Disaster Risk Reduction and Engineering Management

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Abstract: Flooding remains a persistent disaster-risk concern in Pampanga, where community safety depends not only on flood-control infrastructure but also on the capacity of different sectors to access shelter, mobility support, livelihood continuity, social services, safety nets, governance, and integrated local systems. This study assessed sectoral vulnerability and community resilience in selected flood-prone barangays using seven-dimension focus group discussion (FGD) sticker-dot ratings generated through the 3C-SHIELD initiative, or Community-Centered Course on Strategic Hazard Interventions for Enhancing Local Development. The study applied a descriptive mixed-methods approach. Quantitative FGD ratings were consolidated by sector and dimension, while qualitative notes were interpreted to explain rating patterns. Results showed that persons with disabilities (PWDs) recorded the lowest overall perceived resilience rating, followed by men, indigenous peoples, and youth. Across the seven dimensions, income and livelihood was the weakest dimension, followed by shelter and living space and social services. Qualitative findings indicated that vulnerability was linked to damaged or uncomfortable housing, costly or difficult transport, disrupted income and harvest, uneven service reach, and irregular assistance in some areas. Higher ratings for social safety nets, governance, and local system integration suggest existing community support, but the findings also show the need for last-mile service targeting and sector-sensitive disaster risk reduction planning. The study contributes to interdisciplinary engineering research by translating participatory community ratings into planning evidence for evacuation access, shelter assessment, livelihood-resilience programming, service-delivery improvement, and localized DRRM engineering management in flood-prone barangays.

Keywords: Community resilience, disaster risk reduction, engineering management, flood-prone barangays, sectoral vulnerability.

1. Introduction

Flooding remains one of the most persistent disaster-risk problems in Pampanga because the province forms part of a

lowland and river-basin system repeatedly affected by monsoon rainfall, typhoons, drainage congestion, river overflow, and localized inundation. Studies on the Pampanga River Basin emphasize that flood characteristics are shaped by basin topography, land classification, riverine processes, and the exposure of low-lying communities [1]. In this setting, disaster risk reduction cannot rely only on physical flood-control structures. It also requires community-level evidence on who is most vulnerable, which resilience dimensions are weakest, and what planning inputs are needed for safer evacuation, shelter, mobility, livelihood continuity, service delivery, and local system coordination.

The National Disaster Risk Reduction and Management Plan emphasizes prevention, mitigation, preparedness, response, and recovery as interconnected responsibilities of national and local institutions [2]. International guidance on multi-hazard early warning systems also highlights the need for people-centered and inclusive warning chains that can reach vulnerable sectors and support timely action [3], [4]. For Pampanga, this means that flood resilience must be examined not only as a hydrologic or structural concern but also as an engineering-management challenge involving access networks, communication pathways, local services, and sectoral needs.

Digital and information-based approaches can improve flood-risk communication, but warnings and information are useful only when communities have the social and logistical capacity to act on them. National digitalization initiatives and hazard-information platforms show the value of digital tools in local planning and disaster communication [5], [6]. However, warning information does not automatically translate into safety if households lack transport, accessible evacuation spaces, income flexibility, or reliable local coordination. Engineering management, therefore, requires grounded evidence on how different community sectors experience vulnerability and

resilience under flood-prone conditions.

This study uses seven local resilience dimensions: shelter and living space, mobility and access, income and livelihood, social services, social safety nets, community governance, and local system integration. These dimensions are treated as practical planning indicators for flood-risk reduction and engineering-management decision-making. The study is also conceptually informed by the human security approach of the United Nations Development Programme, which emphasizes people-centered protection and empowerment [7]. However, the paper does not claim to measure the classical UNDP seven dimensions of human security. The empirical analysis remains grounded in the locally assessed FGD resilience dimensions and their application to flood-prone barangay planning.

The data used in this paper were generated through the 3C-SHIELD initiative, which means Community-Centered Course on Strategic Hazard Interventions for Enhancing Local Development. The initiative served as the field platform for obtaining community-based FGD ratings and qualitative notes in selected Pampanga barangays [8]. This paper does not evaluate the institutional performance or implementation success of the initiative; it uses the data strictly as academic evidence for sectoral vulnerability and community resilience assessment.

2. Conceptual Framework

The study is anchored on a sectoral vulnerability-resilience framework for disaster risk reduction and engineering management. The framework assumes that flood risk in barangays is shaped by sectoral characteristics, local resilience conditions, and planning response. Sectoral characteristics include the needs and capacities of youth, senior citizens, women, men, LGBTQ+ participants, PWDs, business-sector representatives, and IP participants. Local resilience conditions are represented by the seven FGD dimensions. Planning response refers to inclusive evacuation planning, service-reach improvement, livelihood support, shelter safety assessment, and community-based DRRM decision-making.

Input	Process	Output
Sector groups; flood-prone barangay context; seven local resilience dimensions	Weighted rating analysis; sector-by-dimension comparison; qualitative interpretation	Sectoral vulnerability profile; DRRM and engineering-management planning priorities

Fig. 1. Conceptual framework of sectoral vulnerability assessment for flood-risk reduction and engineering management.

3. Materials and Methods

A. Research Design

The study employed a descriptive mixed-methods research design. Quantitative FGD sticker-dot ratings were used to summarize perceived resilience by sector and dimension, while qualitative notes were used to interpret the reasons behind the

scores. The design is appropriate for translating community perceptions into planning evidence for flood-prone barangays.

B. Locale, Participants, and Instrument

The study covered selected flood-prone barangays in Pampanga that participated in community-level 3C-SHIELD field activities. Participants represented key community sectors, including youth, senior citizens, women, men, LGBTQ+ participants, PWDs, business-sector representatives, and IP participants where applicable. The FGD instrument used a 1-to-10 participatory rating scale, where 1 represented the least favorable condition and 10 represented the most favorable condition. The seven dimensions assessed were shelter and living space, mobility and access, income and livelihood, social services, social safety nets, community governance, and local system integration [8].

C. Data Analysis

Sticker-dot ratings were encoded and summarized using weighted means, frequency counts, low-rating shares, moderate-rating shares, and high-rating shares. In this study, ratings from 1 to 3 were interpreted as low perceived resilience or high vulnerability, ratings from 4 to 7 as moderate perceived resilience, and ratings from 8 to 10 as high perceived resilience or lower relative vulnerability. Qualitative notes were organized by dimension and interpreted to explain recurring vulnerability conditions such as transport difficulty, livelihood disruption, uneven service reach, and housing concerns. No causal statistical inference was made because the data were participatory FGD ratings, not a randomized household survey.

D. Ethical Considerations

The researcher served as the Unit Lead of PSTO Pampanga, under which the 3C-SHIELD initiative was implemented. To minimize potential bias, the study does not evaluate the project implementation, institutional accomplishments, or partnership performance. The FGD data were used only for academic analysis of sectoral vulnerability and community resilience in selected flood-prone barangays. Community-level results were reported in aggregated form.

4. Results and Discussion

The consolidated sectoral ratings indicate that vulnerability is not evenly distributed across community groups. While most sectors reported moderate to high perceived resilience, differences emerged in overall mean ratings, low-rating shares, and weakest dimensions.

Table 1. Sectoral resilience and vulnerability profile. Source: Consolidated FGD rating dataset.

Sector	N	Mean	Low %	Interpretation
PWD	528	6.88	12.50	Moderate vulnerability
Men	609	7.14	7.72	Moderate vulnerability
IP	94	7.16	15.96	Moderate vulnerability
Youth	546	7.27	6.23	Moderate vulnerability
Business	560	7.43	6.79	Moderate vulnerability
Women	622	7.54	6.27	Lower relative vulnerability
Senior	619	7.68	6.14	Lower relative vulnerability
LGBTQ+	365	7.70	5.21	Lower relative vulnerability

Table 1 shows that PWD participants had the lowest overall mean rating (6.88), indicating a higher relative vulnerability compared with the other sectors. Men, IP participants, and youth also recorded moderate vulnerability. The result suggests that inclusive DRRM planning should not treat the community as a single uniform population. Instead, mobility, access, safety, livelihood, and service needs should be assessed by sector.

Table 2. Resilience dimension profile ranked by mean rating.

Source: Consolidated FGD rating dataset.

Rank	Dimension	N	Mean	Low %	Interpretation
1	Income and Livelihood	613	5.64	17.78	Moderate-to-high vulnerability
2	Shelter and Living Space	620	6.89	7.42	Moderate vulnerability
3	Social Services	597	7.07	7.20	Moderate vulnerability
4	Mobility and Access	621	7.85	2.42	Lower relative vulnerability
5	Social Safety Nets	603	7.87	4.15	Lower relative vulnerability
6	Community Governance	545	8.04	3.85	Lower relative vulnerability
7	Local System Integration	563	8.17	2.31	Lower relative vulnerability

Income and livelihood emerged as the weakest dimension across the combined dataset, with a mean rating of 5.64 and the highest low-rating share. This indicates that flood vulnerability in Pampanga is strongly connected to economic continuity. For farmers, micro-entrepreneurs, wage earners, and informal workers, flooding can disrupt harvest, transport to work, business operations, and household cash flow.

Table 3. Weakest resilience dimension by sector. Source:

Consolidated FGD rating dataset.

Sector	Weakest dimension	N	Mean
IP	Income and Livelihood	15	4.27
PWD	Income and Livelihood	81	5.17
Men	Income and Livelihood	93	5.19
Youth	Income and Livelihood	75	5.72
Business	Income and Livelihood	80	5.81
Women	Income and Livelihood	97	5.89
Senior	Income and Livelihood	98	5.98
LGBTQ+	Income and Livelihood	74	6.05

Table 3 confirms that income and livelihood was the weakest dimension for all sectors. The pattern suggests that flood-resilience programming should include livelihood continuity, emergency employment, recovery finance, market access, crop or business protection, and household income support. The engineering-management implication is that flood-risk planning should include not only physical protection but also continuity of livelihoods and essential services.

Table 4. Qualitative synthesis of FGD observations and engineering-management implications. Source: Consolidated qualitative FGD summaries.

Dimension	FGD observation	Planning implication
Shelter and living space	Concrete houses were noted in some areas, but some households reported damaged or uncomfortable housing during rains.	Use shelter-safety checks and prioritize vulnerable households for safer evacuation planning.
Mobility and access	Some communities were near town centers, while others reported costly or difficult transportation.	Review evacuation routes, transport support, and accessibility for PWDs.

		seniors, and low-income groups.
Income and livelihood	Participants mentioned sufficient income in some sectors, but also crop loss, no harvest, and irregular earnings.	Integrate livelihood recovery into DRRM planning and post-flood rehabilitation.
Social services and safety nets	Some participants reported assistance, vitamins, or educational support; others noted that services did not reach all puroks.	Improve last-mile service delivery and transparent distribution of assistance.
Governance and system integration	Some ratings suggested confidence in local systems, but comments pointed to uneven reach across puroks.	Strengthen barangay coordination, monitoring, and feedback mechanisms.

The qualitative notes reinforce the rating results. Shelter scores must be interpreted in relation to housing quality and actual flood exposure. Mobility ratings must be assessed with special attention to transportation cost, route accessibility, and the evacuation needs of PWDs and seniors. High governance or system-integration scores do not remove the need to check whether services reach every purok consistently. This is important because engineering-management decisions require reliable last-mile implementation, not only general community satisfaction.

The findings align with disaster-risk literature emphasizing that vulnerability is socially differentiated and locally produced. They also complement Philippine flood-risk studies, which highlight both the physical exposure of the Pampanga River Basin and the value of accessible hazard information for local governments and vulnerable communities [1], [6]. This paper extends these discussions by identifying sector-level concerns that should accompany flood information, warning dissemination, and localized DRRM engineering management.

5. Conclusion

The study concludes that flood vulnerability in Pampanga is not experienced uniformly across sectors. PWDs had the lowest overall perceived resilience, while income and livelihood was the weakest resilience dimension across all sectors. These results show that flood-resilience planning should go beyond general community preparedness and should incorporate sector-specific vulnerability evidence. From an engineering-management perspective, resilience planning for flood-prone barangays should address shelter safety, mobility and evacuation access, livelihood continuity, social-service reach, safety-net reliability, community governance, and local system integration.

The study recommends that barangay and municipal DRRM plans include sector-specific vulnerability profiles and seven-dimension resilience indicators. PWDs should be prioritized in accessible evacuation planning, communication support, transport assistance, and shelter suitability assessment. Livelihood-dependent sectors should be considered in flood recovery programs. LGUs and barangays should review evacuation routes, mobility barriers, service-delivery pathways, and last-mile assistance mechanisms. Future research may link FGD ratings with CRTS survey results, flood exposure maps, rainfall and water-level monitoring records, and barangay-level service data.

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B. Declaration on the Use of Artificial Intelligence Tools

The author acknowledges the use of an AI language model, ChatGPT, to assist in manuscript formatting, language refinement, organization of sections, and improvement of academic presentation. The AI tool was not used to fabricate data, alter empirical results, or replace the author's interpretation of the findings. All content, analysis, conclusions, and recommendations were reviewed, validated, and finalized by the author, who assumes full responsibility for the accuracy, integrity, and originality of the manuscript.

C. Appendix

Seven-Dimension FGD Resilience Rating Guide: The FGD instrument used a 1-to-10 participatory rating scale where 1 represented the least favorable condition and 10 represented the most favorable condition. The dimensions used in the study were shelter and living space, mobility and access, income and livelihood, social services, social safety nets, community governance, and local system integration.

3C-SHIELD Reference Note: 3C-SHIELD means Community-Centered Course on Strategic Hazard Interventions for Enhancing Local Development. In this paper, the initiative is cited only as the field platform through which the FGD resilience rating data and qualitative notes were generated. The study does not evaluate project implementation or partnership performance.

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