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Disaster Preparedness of Local Government Units Along the Bicol River Basin and Mount Isarog National Park: Resilience Framework on Catastrophic Flooding

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Abstract: Catastrophic flooding presents interconnected social, economic, infrastructural, environmental, and institutional challenges that cannot be addressed through isolated disaster preparedness measures. This study assessed disaster preparedness initiatives and adaptive capacity among local government units (LGUs) and households in municipalities along the Bicol River Basin and Mount Isarog National Park in Camarines Sur, Philippines, during calendar year 2023. A sequential mixed-methods design was employed, integrating a structured questionnaire, key informant interviews, and unstructured interviews. The quantitative component involved 15 LGU respondents and 100 household respondents. Weighted means and Pearson's product-moment correlation were used to examine preparedness and adaptive capacity across five domains: social, economic, infrastructure, environmental, and institutional. Qualitative data were analyzed thematically and triangulated with quantitative findings.

The overall level of disaster preparedness was Moderately Competent (overall mean = 3.42), with social welfare preparedness obtaining the highest rating (3.89) and economic preparedness the lowest (3.05). Adaptive capacity was generally Competent (overall mean = 3.63), with social adaptive capacity ranking highest (3.86) and economic adaptive capacity lowest (3.43). For LGUs, social preparedness was significantly related to social adaptive capacity ($r = .383$, $p = .010$), while economic preparedness showed a highly significant relationship with economic adaptive capacity ($r = .451$, $p < .001$). Infrastructure, environmental, and institutional preparedness did not demonstrate statistically significant relationships with their corresponding adaptive capacities. Among households, social ($r = .606$), economic ($r = .626$), environmental ($r = .651$), and institutional ($r = .629$) preparedness were highly significantly related to adaptive capacity (all $p < .001$), whereas infrastructure preparedness was not significant ($r = -.050$, $p = .614$).

Qualitative findings revealed interconnected constraints involving misinformation and non-compliance, livelihood vulnerability, aging and inadequately maintained infrastructure, environmental degradation, and institutional and governance gaps. The study proposes an integrated five-domain resilience framework in which LGU-led programs, projects, and activities transform preparedness initiatives into measurable adaptive capacity through coordinated social, economic, infrastructure, environmental, and institutional interventions.

Keywords: *Disaster Preparedness; Adaptive Capacity; Catastrophic Flooding; Local Government Units; Household Resilience; Bicol River Basin; Mount Isarog; Resilience Framework.*

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I. INTRODUCTION

Flooding is one of the most consequential hazards affecting communities where river systems, low-lying settlements, and mountainous environments interact. In the Philippines, recurring typhoons and prolonged rainfall create conditions for severe flooding, while mountainous and environmentally degraded areas may experience flash floods and landslides. The Bicol River Basin and Mount Isarog National Park provide a particularly important setting for examining how local governments and households prepare for, respond to, and adapt to catastrophic flooding.

The study identifies the Bicol River Basin as approximately 3,771 km² and describes projected expansion of flood-prone areas during a 25-year return-period flood. It

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further identifies steep slopes, volcanic runoff, and deforestation around Mount Isarog as factors that increase exposure to flash flooding and landslides. These geographic and environmental conditions make disaster preparedness a critical responsibility of local government units (LGUs).

At the international level, disaster risk reduction is framed through the Sendai Framework for Disaster Risk Reduction 2015–2030, the Paris Agreement, and the Sustainable Development Goals. These frameworks emphasize understanding risk, strengthening governance, investing in resilience, and improving preparedness and adaptive capacity. In the Philippine context, Republic Act No. 10121 institutionalizes disaster risk reduction and management, while local planning and environmental governance responsibilities further shape the obligations of LGUs (Col, 2017; Serote, 2018; UNISDR, 2016; United Nations Office for Disaster Risk Reduction, 2023).

Despite these frameworks, the dissertation identifies persistent gaps between formal policy and actual implementation, particularly in early warning, inter-agency coordination, floodplain management, policy continuity, funding, and local accountability. These concerns are consistent with literature emphasizing that preparedness is shaped by behavioral, social, economic, infrastructural, environmental, and institutional conditions (Asih et al., 2023; Bakic et al., 2022; Manejar et al., 2018; Taghizadeh-Hesary et al., 2021).

Existing research also suggests that awareness does not necessarily translate into preparedness behavior. Paton (2020) emphasized cognitive and behavioral factors in preparedness, while Rogayan et al. (2020) documented differences between disaster awareness and actual preparedness in a Philippine community. Alcayna (2020) likewise identified limitations in the ability of Philippine households to translate risk awareness into concrete preparedness actions. Social capital, trust, education, and community participation further shape resilience outcomes (Bakic et al., 2022; Asih et al., 2023).

The literature reviewed in the study increasingly treats preparedness, adaptive capacity, and resilience as interconnected rather than separate components of disaster management. Adaptive capacity depends on the ability of communities and institutions to adjust to hazards and sustain recovery. Infrastructure and governance are likewise interdependent; infrastructure investment is most effective when accompanied by sound governance, planning, and maintenance (Asian Development Bank, 2022; Bixler et al., 2021; Taghizadeh-Hesary et al., 2021; Wang et al., 2022).

A gap remains in examining the relationship between LGU preparedness initiatives and household adaptive capacity within the specific context of the Bicol River Basin and Mount Isarog. The present study addresses this gap by integrating institutional and household perspectives and by using quantitative and qualitative evidence to develop a resilience framework for catastrophic flooding.

The study assessed disaster preparedness initiatives and adaptive capacity in five domains—social, economic, infrastructure, environmental, and institutional—and examined whether preparedness was significantly related to corresponding adaptive capacity. It further identified constraints and challenges encountered by LGUs and developed a resilience framework intended to apply to both LGUs and households.

II. METHODS

➢ *Research Design*

A sequential mixed-methods design was employed. The quantitative component used a descriptive-correlational approach to assess disaster preparedness initiatives and adaptive capacity, while qualitative interviews were used to identify constraints, challenges, and strategic inputs for the resilience framework. The integration of quantitative and qualitative findings enabled the study to interpret statistical patterns within the lived and institutional experiences of respondents.

➢ *Study Area and Respondents*

The study covered 15 municipalities associated with the Bicol River Basin and Mount Isarog National Park in Camarines Sur. Nine municipalities were identified along the Bicol River Basin: Bato, Nabua, Bula, Minalabac, Milaor, Camaligan, Gainza, Pamplona, and Libmanan. Six municipalities were identified along Mount Isarog: Tinambac, Goa, Tigaon, Ocampo, Pili, and Calabanga.

A total of 115 respondents participated in the quantitative component: 15 LGU respondents and 100 household respondents. LGU respondents were selected purposively based on their direct involvement in local disaster risk reduction and management, with Local Chief Executives as primary respondents and Municipal Disaster Risk Reduction and Management Officers serving as alternates when necessary. Household respondents were selected through simple random sampling using population data and Slovin's formula.

Table 1 Distribution of the Respondents

Respondent group	N	Percentage
LGU respondents	15	13.04%
Household respondents	100	86.96%
Total	115	100.00%

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➢ *Research Instruments*

Three complementary instruments were used: a structured questionnaire, a Key Informant Interview (KII) guide, and an unstructured interview guide. The questionnaire assessed preparedness and adaptive capacity across the five analytical domains. The KII and unstructured interview guides focused on constraints and challenges and on inputs for strengthening resilience. Expert review, pilot testing, instrument refinement, and triangulation were used to support validity, reliability, and credibility.

➢ *Data Collection and Analysis*

After obtaining permission from the concerned municipalities, the instruments were administered through face-to-face and online procedures. Quantitative responses were summarized using weighted means and interpreted according to the study's competence scales. Pearson's product-moment correlation was used to examine relationships between corresponding preparedness and adaptive-capacity domains. Interview data were transcribed, coded, and analyzed thematically. Themes were triangulated with survey findings and used to inform the proposed resilience framework.

III. RESULTS

➢ *Disaster Preparedness Initiatives*

The respondents' overall disaster preparedness was rated Moderately Competent (overall mean = 3.42). Social welfare preparedness was the strongest domain, while economic preparedness was the weakest. The social result indicates a relatively strong foundation in population readiness, social services, and community-oriented preparedness. Economic preparedness was weaker, reflecting limitations in financial and livelihood-related readiness. At the institutional level, LGU-NGO-PO linkages were among the stronger indicators, whereas legislative output of the Sangguniang Bayan was comparatively weaker.

Table 2 Disaster Preparedness Initiatives of the Respondents

Preparedness domain	Overall mean	Interpretation
Social welfare	3.89	Competent
Institutional	3.56	Competent
Environmental	3.32	Moderately Competent
Infrastructure	3.30	Moderately Competent
Economic	3.05	Moderately Competent
Overall	3.42	Moderately Competent

➢ *Adaptive Capacity*

Overall adaptive capacity was rated Competent (overall mean = 3.63). Social adaptive capacity ranked highest, while economic adaptive capacity ranked lowest. Education was the strongest indicator within social adaptive capacity, while communication of public health interventions was comparatively weaker. Infrastructure adaptive capacity was generally competent, although drainage and sewer systems were weaker than several other infrastructure indicators. Environmental adaptive capacity was competent but showed limitations in protected-landscape management. Institutional adaptive capacity was also competent, although land-use control was a comparatively weak area.

Table 3 Adaptive Capacity of the Respondents

Adaptive-capacity domain	Overall mean	Interpretation
Social	3.86	Competent
Environmental	3.64	Competent
Institutional	3.64	Competent
Infrastructure	3.59	Competent
Economic	3.43	Competent
Overall	3.63	Competent

➢ *Relationship Between Preparedness and Adaptive Capacity*

For LGUs, social and economic preparedness were significantly related to their corresponding adaptive capacities, while the other three domains were not statistically significant.

The results indicate that improvements in social and economic preparedness are directly associated with stronger adaptive capacity at the LGU level. This suggests that investments in education, community engagement, social awareness, livelihood protection, and financial readiness translate more readily into adaptive behaviors during disasters. Conversely, the absence of significant correlations in infrastructure, environmental, and institutional domains suggests that preparedness efforts in these areas, while present, may not immediately translate into adaptive outcomes. This may be due to limitations in implementation, maintenance, community integration, or the long-term nature of their impact, which is not immediately observable during disaster events.

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Table 4 LGU's Correlation between Disaster Preparedness and Adaptive Capacity

LGU domain	Pearson r	p-value	Interpretation
Social	.383	.010	Significant
Economic	.451	< .001	Highly significant
Infrastructure	.105	.440	Not significant
Environmental	.249	.067	Not significant
Institutional	.127	.368	Not significant

For households, four of the five domains showed highly significant positive relationships with adaptive capacity. Infrastructure was the only non-significant domain.

These indicate that households with stronger preparedness in social, economic, environmental, and institutional dimensions are significantly more capable of adapting to disaster conditions. Social networks, livelihood readiness, environmental awareness, and participation in institutional mechanisms directly enhance coping and recovery capacity. Conversely, infrastructure preparedness at the household level does not predict adaptive capacity, suggesting that the presence of physical structures alone does not determine how effectively households respond to flooding. Adaptive behaviors appear to be driven more by social organization, resourcefulness, environmental awareness, and institutional interaction rather than physical assets.

Table 5 LGU's Correlation between Disaster Preparedness and Adaptive Capacity

Household domain	Pearson r	p-value	Interpretation
Social	.606	< .001	Highly significant
Economic	.626	< .001	Highly significant
Infrastructure	-.050	.614	Not significant
Environmental	.651	< .001	Highly significant
Institutional	.629	< .001	Highly significant

The results partially supported the study hypothesis. The pattern is notable because the pathway from preparedness to adaptive capacity differed between institutional and household contexts. For LGUs, social and economic preparedness were the significant domains. For households, social, economic, environmental, and institutional preparedness were significantly related to adaptive capacity.

➢ *Qualitative Constraints and Challenges*

Thematic analysis identified interconnected constraints across the five domains. Social constraints included misinformation, weak adherence to early warnings, late evacuation, passive participation, mistrust, and social panic. Economic constraints included agricultural losses, disrupted markets, inflation, food insecurity, limited livelihood diversification, weak savings and capital, and constrained disaster budgets.

Infrastructure constraints included aging and substandard flood-control structures, poorly maintained drainage and canals, insufficient or overcrowded evacuation centers, impassable roads and bridges, clogged waterways, budget shortages, low design standards, and procurement delays. Environmental constraints included deforestation, watershed mismanagement, river siltation, wetland loss, poor waste management, and weak enforcement of environmental ordinances. Institutional constraints included weak interagency coordination, unclear mandates, limited MDRRMO staffing and training, political interference in relief distribution, weak land-use and building-code enforcement, and a reactive planning culture.

IV. DISCUSSION

The findings demonstrate that disaster preparedness and adaptive capacity are related but not interchangeable. The overall preparedness rating of 3.42 indicates that the study sites have established preparedness mechanisms, but these remain uneven across domains. Social welfare preparedness was the strongest domain, consistent with the relatively high social adaptive-capacity rating. This pattern reinforces the importance of education, information, training, social relationships, and community participation in resilience (Asih et al., 2023; Bakic et al., 2022; Paton, 2020; Rogayan et al., 2020).

Economic preparedness was the weakest preparedness domain and economic adaptive capacity was the weakest adaptive domain. Qualitative findings of livelihood disruption, agricultural losses, limited savings, weak diversification, and constrained recovery resources help explain this pattern. The result is consistent with literature emphasizing economic buffers, livelihood security, and financial resources as important components of adaptive capacity (Alcayna, 2020; Tendero, 2023; Wang et al., 2022).

The significant relationship between economic preparedness and adaptive capacity for both LGUs and households suggests that economic resources are not merely post-disaster recovery tools; they form part of the capacity to absorb and adapt to shocks. For LGUs, stronger economic preparedness may facilitate the delivery of programs and services, while for households, financial means and livelihood security provide resources for coping and recovery.

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The absence of a significant infrastructure relationship for either LGUs or households should not be interpreted as evidence that infrastructure is unimportant. Rather, it suggests that physical assets alone do not automatically translate into adaptive capacity. The qualitative findings show that infrastructure may be undermined by maintenance problems, budget constraints, procurement delays, inadequate design standards, and limited accessibility. This interpretation is consistent with research emphasizing the interaction between infrastructure quality and governance (Asian Development Bank, 2022; Bixler et al., 2021; Taghizadeh-Hesary et al., 2021).

The household finding that environmental preparedness had the strongest relationship with adaptive capacity is particularly important. It suggests that environmental awareness and stewardship may be closely associated with household adaptive behavior. The result is consistent with the study's broader emphasis on environmental management, land-use planning, watershed protection, and ecosystem-based approaches (Siringan, 2018; United Nations Office for Disaster Risk Reduction, 2023).

The institutional findings point to a distinction between the existence of institutions and their effective implementation. Although institutional preparedness and adaptive capacity were generally rated competent, the LGU correlation was not statistically significant. The qualitative evidence of coordination gaps, unclear mandates, staffing limitations, weak enforcement, and reactive planning provides a plausible contextual explanation. Previous work similarly emphasizes that disaster governance requires coordination, planning, institutional learning, and translation of formal policy into concrete action (Col, 2017; Domingo et al., 2018; Manejar et al., 2018; Serote, 2018).

Taken together, the results support a multidimensional understanding of resilience. Preparedness becomes adaptive capacity when resources, knowledge, behavior, infrastructure, environmental stewardship, and institutions interact effectively. This supports the study's Integrated Adaptive Resilience perspective, which brings together adaptive governance, risk perception and motivation, and social learning. The resulting framework is therefore not a single intervention but a coordinated system of interventions across the five domains.

V. INTEGRATED RESILIENCE FRAMEWORK FOR CATASTROPHIC FLOODING

The proposed resilience framework is organized around five interconnected domains: social, economic, infrastructure, environmental, and institutional. The framework positions LGUs as key enablers that translate preparedness initiatives into adaptive capacity through policy, budgeting, infrastructure investment, environmental management, DRRM institutionalization, and partnerships with communities and other organizations.

Table 6 Resilience Framework for Catastrophic Flooding

Domain	Priority resilience direction
Social	Risk communication, education, drills, inclusive participation, public-health communication
Economic	Livelihood diversification, emergency financing, financial inclusion, savings and recovery support
Infrastructure	Drainage rehabilitation, evacuation-center improvement, risk-informed infrastructure, maintenance
Environmental	Watershed rehabilitation, ecosystem-based approaches, land-use enforcement, waste and siltation management
Institutional	DRRM institutionalization, stronger ordinances, MDRRMO capacity, coordination, monitoring and accountability

The framework is intended to operate as a continuous cycle. LGUs and communities assess preparedness and adaptive capacity, identify domain-specific gaps, implement targeted programs, monitor outcomes, and revise interventions based on observed results. The approach therefore treats resilience as an ongoing governance and learning process rather than a one-time disaster project.

VI. CONCLUSION

The study concludes that disaster preparedness initiatives among the participating LGUs and households are present but uneven across the five domains. Social welfare preparedness represents the strongest preparedness area, while economic preparedness remains the principal weakness. Overall adaptive capacity is competent, with social capacity emerging as the strongest and economic capacity as the weakest.

The hypothesis that disaster preparedness is significantly related to adaptive capacity was partially supported. At the LGU level, significant relationships were observed only in the social and economic domains. Among households, significant relationships were observed in social, economic, environmental, and institutional domains, but not infrastructure.

The findings demonstrate that preparedness does not automatically become resilience. Its translation into adaptive capacity depends on behavioral, economic, infrastructural, environmental, and institutional conditions. Consequently, catastrophic-flood resilience requires synchronized action by LGUs and households across the five domains.

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POLICY AND PRACTICAL IMPLICATIONS

- Institutionalize community-based DRRM education, risk communication, and regular evacuation drills.
- Strengthen household economic resilience through livelihood diversification, emergency livelihood assistance, financial inclusion, and financial-literacy initiatives.
- Prioritize drainage, flood-control, evacuation-center, road, bridge, water-system, and other critical infrastructure improvements together with maintenance and risk-informed design.
- Integrate ecosystem-based disaster risk reduction through watershed rehabilitation, reforestation, wetland protection, siltation control, waste management, and environmental enforcement.
- Strengthen MDRRMO staffing and training, interagency coordination, land-use enforcement, DRRM ordinances, monitoring, and proactive planning.
- Institutionalize monitoring and evaluation so improvements in preparedness can be assessed against changes in adaptive capacity.
- Ensure meaningful household participation because the household findings show strong relationships between social, economic, environmental, and institutional preparedness and adaptive capacity.

LIMITATIONS

The study was limited to the selected municipalities within the Bicol River Basin and Mount Isarog study areas and to data collected during calendar year 2023. It included 15 LGU respondents and 100 household respondents. The use of purposive sampling for LGU respondents and simple random sampling for households means that the two respondent groups represent different sampling approaches. The correlations should therefore be interpreted as associations rather than causal effects.

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