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Assessment of Multidimensional Flood-Resilience Indicators in Delta State, Nigeria

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Abstract

Flooding presents persistent environmental and socioeconomic risks in Delta State, Nigeria. This study assessed perceived flood-resilience indicators across physical, social, economic, environmental, and institutional and governance dimensions. A descriptive survey was conducted among building professionals, flood-management officials and residents. The stated sample comprised 192 building professionals, 40 flood-management officials and 385 residents (617 respondents). Data were collected using a structured questionnaire and summarised using mean ratings and rankings. Based on the item means reported in the paper, physical indicators received the highest average dimension score (4.06), followed by institutional and governance indicators (3.98), environmental indicators (3.97), social indicators (3.95), and economic indicators (3.89). Flood-resistant building designs had the highest reported item mean (4.22). Access to emergency financial support was the highest-rated economic item (3.97), while insurance coverage had the lowest reported item mean (3.80). These results represent respondents' perceptions of the importance of the indicators; they do not directly measure actual community resilience or establish statistically significant differences between dimensions. The study recommends that the Delta State Government and relevant institutions consider these perceived priorities in building regulation, land-use planning, environmental management, early-warning provision and post-flood recovery planning. Inferential hypothesis testing was not retained because the available tables do not establish that the analysis used respondent-level observations.

Keywords: Flood resilience; vulnerability; indicator assessment; Delta State; Nigeria.

I.0 INTRODUCTION

Flooding is a persistent environmental and socioeconomic challenge across many countries, causing loss of life, displacement, infrastructure damage, livelihood disruption and environmental degradation (Alderman et al., 2012; Umar & Gray, 2023). Flood risk is shaped by climatic conditions, intense rainfall, urbanisation, drainage capacity and land-use practices. These pressures have increased interest in approaches that complement conventional flood control with measures that help communities and the built environment withstand, adapt to and recover from flood events. Flood resilience provides this broader perspective by considering the capacity of interconnected systems to absorb disturbance, adapt and recover (Keating et al., 2017).

The assessment of flood resilience requires indicators capable of capturing the different dimensions of vulnerability. Physical indicators address the condition of buildings, drainage systems, flood-protection infrastructure, evacuation routes and emergency shelters. Social indicators reflect access to early warnings, community participation, social support networks and the protection of vulnerable

populations. Economic indicators capture financial preparedness, insurance, emergency assistance and the capacity to restore livelihoods. Environmental indicators address the conservation of wetlands, floodplains, forests and other natural systems that regulate water flows, while institutional and governance indicators concern flood-risk planning, disaster-management capacity, land-use regulation and preparedness. Considering these dimensions together provides a broader basis for understanding why some communities experience greater flood impacts than others and for identifying interventions that respond to their specific vulnerabilities.

Delta State, in Nigeria's Niger Delta region, is exposed to flooding associated with rainfall, drainage constraints, urban expansion, land-use change and climate-related pressures. Flood events have disrupted settlements, transport, agriculture, public infrastructure and commerce. The 2022 floods affected communities and transport corridors in the state, including sections of the Ughelli–Asaba highway (Ejem et al., 2023; Ikporukpo & Areola, 2023; United Nations Development Programme [UNDP], 2023). The cited studies and report provide contextual evidence of the flood event; the specific community-level claims should be retained only where the original sources directly confirm them. Flood vulnerability in Delta State therefore concerns not only physical exposure but also livelihoods, environmental conditions, access to assistance and institutional response.

The Nigeria Hydrological Services Agency published the 2022 Annual Flood Outlook to identify areas at risk and support preparedness (Nigeria Hydrological Services Agency [NIHSA], 2022). The manuscript also refers to temporary accommodation, relief materials, livelihood support, drainage improvements and erosion-control projects. These interventions should be described as verified actions only where a specific official report or project record can be cited. Recurrent flood impacts make it necessary to assess infrastructure alongside environmental protection, community preparedness, economic recovery and governance.

Understanding flood resilience in Delta State therefore requires more than identifying flood-prone locations or evaluating individual engineering interventions. It requires a context-sensitive set of indicators that captures the interacting dimensions of vulnerability and provides a basis for prioritising interventions. This study focuses on identifying and assessing such indicators, with the intention of informing flood-management decisions, strengthening resilience and supporting more sustainable responses to recurrent flooding in the state.

1.1 Statement of the Research Problem

Flooding continues to threaten settlements, infrastructure, agriculture and livelihoods in Delta State. The 2022 floods illustrate the scale of the problem, while existing flood warnings and response measures show that hazard information and emergency assistance are part of the state's response. The specific research deficiency addressed here is the lack of a clearly presented, context-specific assessment that brings physical, social, economic, environmental, and institutional and governance indicators together. Without such an assessment, decision-makers have limited evidence from this study on which indicators respondents consider most important. This research addresses that deficiency by ranking indicators based on questionnaire responses from building professionals, flood-management officials and residents. The results are measures of perceived importance, not direct measurements of the actual resilience of individual communities.

Flood management can be weakened when interventions address isolated problems without accounting for related conditions. Drainage improvements, for example, may have limited benefits where maintenance is poor, wetlands are degraded or development controls are not enforced. Early warnings may also be less useful when residents cannot access, understand or act on them. These examples

explain why the study considers physical, social, economic, environmental and institutional conditions together.

Settlement patterns, livelihood activities, infrastructure conditions and access to public support vary across Delta State. The study therefore assesses how respondents rate indicators across five dimensions, with the aim of informing priorities for planning and further assessment. Because the design relies on questionnaire perceptions, the results should not be interpreted as objective measurements of community resilience. The research problem is the absence, within the scope of this study, of a consolidated assessment of perceived flood-resilience indicators across the five dimensions in Delta State. This study addresses the problem by ranking the indicators using questionnaire ratings from three respondent groups.

Existing approaches to flood management recognise the importance of structural protection, drainage infrastructure, early-warning systems, emergency preparedness and environmental management. However, the assessment of flood resilience requires these interventions to be considered alongside the social, economic and institutional conditions that influence the capacity of exposed communities to prepare for, withstand and recover from flooding. An assessment that concentrates on a limited number of physical or engineering measures may not adequately capture the wider vulnerability of communities whose resilience is also shaped by livelihood security, social networks, environmental degradation, governance arrangements and access to emergency assistance.

The study contributes a context-specific descriptive ranking of indicators across five dimensions, based on ratings from building professionals, flood-management officials and residents. The results can inform the prioritisation of further assessment and planning, but they do not validate a composite resilience index or demonstrate the actual effects of individual indicators on flood outcomes. The contribution of the study lies in providing an empirically informed set of flood-resilient indicators relevant to the conditions of Delta State. By examining the dimensions together, the study offers a broader basis for understanding vulnerability than approaches that concentrate exclusively on flood-control infrastructure or emergency response. The assessment can support the prioritisation of interventions, guide the allocation of resources and help relevant institutions identify areas requiring improvement. It also provides a basis for developing a context-specific flood-management framework that connects infrastructure resilience with community preparedness, livelihood protection, environmental conservation and institutional effectiveness. The study's contribution is therefore both analytical, through the assessment of multidimensional indicators, and practical, through its potential to inform more integrated flood-resilience planning in Delta State.

1.2 Aim and Objectives of the Study

The aim of this study was to assess respondents' perceptions of flood-resilience indicators across the diverse dimensions of vulnerability in Delta State, Nigeria.

The specific objectives were to:

1. identify and rank perceived physical indicators associated with flood resilience in Delta State;
2. assess and rank perceived social indicators associated with preparedness and response to flooding;
3. assess and rank perceived economic indicators associated with financial preparedness, livelihood security and recovery;
4. identify and rank perceived environmental indicators relevant to flood exposure and natural flood mitigation; and

5. assess and rank perceived institutional and governance indicators associated with flood preparedness and risk management in Delta State.

1.3 Research Hypotheses

The study formulated the following null hypothesis:

H_{01}: There is no statistically significant difference in respondents' mean ratings across the five flood-resilience indicator dimensions. This hypothesis can only be tested using the respondent-level ratings for the indicators.

2.0 LITERATURE REVIEW

A. Concept of Flood Resilience

Flood resilience refers to the capacity of individuals, communities, infrastructure and institutions to withstand, adapt to and recover from flood-related disturbances while maintaining or restoring essential functions. The United Nations Office for Disaster Risk Reduction (UNDRR, 2017) defines resilience in terms of a system's ability to resist, absorb, accommodate, adapt to, transform and recover from the effects of hazards. Similarly, the Intergovernmental Panel on Climate Change (IPCC, 2022) conceptualises resilience as the capacity of interconnected social, economic and ecological systems to cope with disturbances while retaining the capacity for adaptation, learning and transformation. These definitions position flood resilience as a broader concept than flood prevention because they encompass preparedness, response, recovery and the ability to adapt to future risks.

Conventional flood-management approaches have frequently emphasised structural interventions, including drainage systems, embankments, flood barriers and other protective infrastructure. Although these measures are important, their effectiveness may be limited where flood risk is influenced by inadequate maintenance, unplanned development, environmental degradation and insufficient institutional capacity. A resilience-based approach therefore combines structural interventions with non-structural measures such as early-warning systems, land-use regulation, community participation, environmental conservation and emergency preparedness. This integrated perspective is consistent with the Sendai Framework's emphasis on understanding disaster risk, strengthening disaster-risk governance, investing in risk reduction and enhancing preparedness for effective response and recovery (United Nations Office for Disaster Risk Reduction [UNDRR], 2015).

The assessment of flood resilience requires indicators that reflect the capacities and conditions influencing how communities experience and manage flood events. Osei-Kyei *et al.* (2025), in a systematic review of 35 publications, identified 77 flood-disaster resilience indicators and classified them into six categories: physical, institutional, social, psychological, ecological and economic. Their findings demonstrate the multidimensional character of resilience assessment and the need to consider indicators from different disciplinary perspectives.

For Delta State, this perspective is relevant because recurrent flooding affects the built environment, community welfare, livelihoods, natural ecosystems and the operations of public institutions. Flood resilience must therefore be understood through the combined influence of these conditions rather than through the presence of flood-control infrastructure alone.

B. Flood Vulnerability and Its Relationship with Resilience

Flood vulnerability refers to the physical, social, economic and environmental conditions that increase the susceptibility of individuals, communities, assets and systems to flood impacts (UNDRR, 2017). It

is influenced by the location of exposed populations and assets, their sensitivity to inundation, and their capacity to prepare for, cope with and recover from flooding. Consequently, communities exposed to similar flood hazards may experience different levels of damage because their infrastructure, household resources, social support systems and institutional arrangements differ.

Rufat et al. (2015) examined 67 flood-disaster case studies and found that demographic characteristics, socioeconomic status and health were prominent drivers of social vulnerability. Their review also identified risk perception and coping capacity as important considerations that were insufficiently represented in many vulnerability indicators. The authors emphasised that the influence of vulnerability factors varies according to the disaster stage and national context, supporting the need for locally appropriate indicator selection. Resilience and vulnerability are related but distinct concepts. Vulnerability identifies the conditions that increase the likelihood or severity of adverse impacts, whereas resilience concerns the capacities and arrangements that enable systems to manage disturbances, adapt and recover. A community may be highly exposed to flooding but possess strong warning systems, social networks and recovery resources. Conversely, a community with comparatively limited exposure may still experience serious consequences if drainage is inadequate, emergency support is inaccessible or institutional coordination is weak.

Moreira et al. (2021) reviewed 95 peer-reviewed studies on flood-vulnerability indices and found that existing assessments frequently emphasised socioeconomic characteristics while giving comparatively limited attention to coping and adaptive capacity. The review also identified shortcomings in sensitivity analysis, uncertainty assessment, validation and the treatment of changing vulnerability over time. These findings support the need for theoretically grounded, context-sensitive and empirically assessed indicators. In Delta State, the relationship between vulnerability and resilience is important because flood impacts may vary according to settlement characteristics, livelihood dependence, access to warnings, household resources and institutional support. An integrated assessment of flood-resilient indicators can help identify the capacities requiring attention and provide a basis for prioritising interventions.

C. Theoretical Review

i. Resilience Theory

Resilience Theory provides the theoretical foundation for examining the indicators that influence the capacity of communities to withstand, adapt to and recover from flooding. Holling (1973) distinguished engineering resilience, which emphasises the speed of recovery after disturbance, from ecological resilience, which concerns the capacity of a system to absorb disturbance without losing its essential functions. In flood management, resilience therefore involves both restoring damaged infrastructure and adapting communities to recurrent flood risks.

Resilience extends beyond physical protection to include social, economic, environmental and institutional capacities. The United Nations Office for Disaster Risk Reduction (UNDRR, 2017) describes resilience in terms of a system's ability to resist, absorb, accommodate, adapt to and recover from hazards. Similarly, Cutter et al. (2008) demonstrate that community resilience depends on interconnected social, economic, institutional, infrastructural and environmental characteristics. These perspectives support the assessment of flood resilience through multiple indicators rather than reliance on structural interventions alone.

The theory is relevant to Delta State, Nigeria, where recurrent flooding affects buildings, transportation, livelihoods and community infrastructure. Effective resilience requires flood-resistant buildings, efficient drainage, accessible early-warning systems, financial preparedness, environmental conservation, effective disaster-management institutions and appropriate land-use regulation. These

indicators reflect the multidimensional nature of flood vulnerability and resilience (Moreira et al., 2021; Osei-Kyei et al., 2025).

ii. Relevance of the Theories to the Study

Resilience Theory informed the classification of the questionnaire items into physical, social, economic, environmental, and institutional and governance dimensions. Physical items represent infrastructure and protection capacity; social items represent warning access, participation and support; economic items represent financial and livelihood recovery capacity; environmental items represent natural systems and land-use practices; and institutional items represent planning, agency effectiveness, enforcement and preparedness. The theory guides the categories but does not prescribe a universal indicator set or establish their relative importance in Delta State. The survey therefore reports respondents' ratings of context-specific indicators.

3.0 METHODOLOGY

A descriptive survey design was used to assess respondents' perceptions of flood-resilience indicators in Delta State, Nigeria. The questionnaire covered five dimensions: physical, social, economic, environmental, and institutional and governance. The design supports descriptive comparisons of perceived importance; it does not independently measure actual community resilience.

The study population comprised 192 building professionals, 40 flood-management officials and 6,646,022 residents, giving a combined population of 6,646,254. The professional group comprised 28 architects, 55 builders, 39 structural engineers and 70 civil engineers. The 40 officials were drawn from four organisations, with 10 selected from each: the Delta State Ministry of Environment, Delta State Emergency Management Agency, Delta State Ministry of Urban Development and the National Emergency Management Agency. The resident population figure is attributed in the original manuscript to the National Population Commission; the applicable census/projection year and original source should be confirmed before publication.

Cochran's (1977) formula was used to estimate the resident sample at a 95% confidence level, 5% margin of error and assumed population proportion of 0.5. The resulting target was 385 residents. The study included the 192 identified building professionals and 40 flood-management officials, producing a stated total sample of 617.

Purposive sampling was used to select building professionals and flood-management officials based on their professional knowledge and involvement in building or flood-management activities. Simple random sampling was reported for residents affected by flooding. The original manuscript does not identify the communities sampled, the number of residents selected from each community, the sampling frame, or the household-selection and within-household respondent-selection procedures. These details must be supplied from the field records; they cannot be reconstructed from the reported aggregate sample.

Data were collected using a structured questionnaire covering respondent characteristics, flood experience, awareness of flood-management policies, perceived policy effectiveness and ratings of indicators across the five dimensions. The analysis therefore concerns respondents' perceptions of indicator importance. Government policies, official reports and published studies were reviewed for contextual interpretation.

Face and content validity were assessed by the research supervisors and professionals with knowledge of building and flood management. A pilot study was also reported, and feedback was used to refine

the questionnaire. Internal consistency was assessed using Cronbach's alpha, with 0.70 identified as the minimum acceptable reference value (Gliem & Gliem, 2003). The original paper does not report the calculated alpha coefficient or the pilot-study sample and item set. The actual coefficient and these details must be inserted from the reliability output before submission; no value is inferred here.

Data were analysed in SPSS using frequencies and percentages for respondent characteristics and mean ratings and rankings for the indicators. The item mean was treated as a descriptive summary of ratings. Dimension-level scores reported in this revision are the arithmetic averages of the four published item means within each dimension; they are descriptive summaries of the published item means, not respondent-level composite scores. The available manuscript does not provide raw respondent-level data, details of missing-response handling, or the output needed to verify inferential assumptions. The ANOVA and Levene's test results were therefore removed rather than reported as valid respondent-level tests. Any inferential comparison should be restored only after reanalysis of the raw ratings using a model appropriate to the respondent groups and repeated ratings, with assumptions and exact p-values reported.

4.0 RESULTS AND DISCUSSION

Table 1: Mean Ratings of Flood-Resilient Indicators Encapsulating Diverse Dimensions of Vulnerability in Delta State

S/N	Statement	Building Professionals	Flood Officials	Residents	Mean	Rank	Dimension mean	Dimension rank
A.	**Physical Indicators**							
	Flood-resistant building designs	4.25	4.30	4.10	4.22	1st	4.06	1st
	Condition of flood protection infrastructure	4.10	4.20	3.95	4.08	2nd		
	Efficiency of drainage systems	4.00	4.10	3.90	4.00	3rd		
	Accessibility of evacuation routes and shelters	3.95	4.05	3.85	3.95	4th		
B.	**Social Indicators**							
	Access to early warning systems	4.10	4.20	3.95	4.08	1st	3.95	4th
	Community participation in flood preparedness	3.90	4.00	3.80	3.90	3rd		
	Strength of social networks	3.85	3.95	3.75	3.85	4th		
	Support for vulnerable populations (elderly, disabled)	4.00	4.05	3.90	3.98	2nd		
C.	**Economic Indicators**							
	Insurance coverage in flood-prone areas	3.80	3.90	3.70	3.80	4th	3.89	5th
	Government recovery funding	3.90	4.00	3.85	3.92	2nd		
	Access to emergency financial support	3.95	4.05	3.90	3.97	1st		
	Economic diversity in flood-affected communities	3.85	3.95	3.75	3.85	3rd		
D.	**Environmental Indicators**							
	Conservation of wetlands and floodplains	4.00	4.10	3.90	4.00	2nd	3.97	3rd
	Extent of upstream forest and vegetation cover	4.10	4.15	3.95	4.07	1st		
	Sustainable land-use practices	3.95	4.00	3.85	3.93	3rd		
	Health of natural flood mitigation systems (e.g., mangroves)	3.90	3.95	3.80	3.88	4th		
E.	**Institutional and Governance Indicators**							
	Existence of flood risk management plans	4.05	4.15	3.95	4.05	2nd	3.98	2nd
	Effectiveness of disaster management agencies	4.10	4.20	3.90	4.07	1st		
	Enforcement of land-use and zoning policies	3.90	4.00	3.85	3.92	3rd		

	Frequency of flood preparedness drills	3.85	3.95	3.80	3.87	4th		

Table 1 reports item mean ratings from building professionals, flood-management officials and residents. Dimension means were recalculated as the arithmetic average of the four published item means in each category. On this basis, physical indicators ranked first (4.06), institutional and governance indicators ranked second (3.98), environmental indicators third (3.97), social indicators fourth (3.95), and economic indicators fifth (3.89). These rankings describe the published item means and should not be interpreted as tests of statistically significant differences.

Physical indicators had the highest recalculated dimension mean (4.06). Flood-resistant building designs recorded the highest reported item mean (4.22), followed by flood-protection infrastructure (4.08), drainage efficiency (4.00), and access to evacuation routes and shelters (3.95). Respondents therefore rated building design and infrastructure as important considerations. The survey did not measure the actual performance of these features during a flood event.

Environmental indicators had a recalculated dimension mean of 3.97 and ranked third. Upstream forest and vegetation cover had a reported item mean of 4.07, followed by wetland and floodplain conservation (4.00), sustainable land-use practices (3.93), and natural flood-mitigation systems such as mangroves (3.88). These ratings represent perceived importance; they do not quantify the hydrological effect of these systems in the study area.

Institutional and governance indicators had a recalculated dimension mean of 3.98 and ranked second. Effectiveness of disaster-management agencies had a reported item mean of 4.07, followed by flood-risk management plans (4.05), land-use and zoning enforcement (3.92), and preparedness drills (3.87). The comparatively lower item ratings for enforcement and drills identify areas that respondents may consider for further attention.

Social indicators had a recalculated dimension mean of 3.95 and ranked fourth. Access to early-warning systems had a reported item mean of 4.08, followed by support for vulnerable populations (3.98), community participation (3.90), and social networks (3.85). The results suggest that respondents value accessible warnings and inclusive preparedness, while also identifying community participation and support networks as relevant considerations.

Economic indicators had a recalculated dimension mean of 3.89 and ranked fifth. Access to emergency financial support had a reported item mean of 3.97, followed by government recovery funding (3.92), economic diversity (3.85), and insurance coverage (3.80). The ratings identify financial assistance and recovery funding as perceived priorities, while insurance coverage received the lowest item mean in this dimension.

The recalculated dimension means range from 3.89 to 4.06. This relatively narrow descriptive range indicates that respondents rated items across all five dimensions as important. Because the means are derived from the published item means rather than respondent-level composite scores, the ordering should be treated as descriptive only. The study cannot establish whether differences between dimensions are statistically significant without reanalysis of the original respondent-level ratings.

Table 2 presents the group mean summary for the five categories of indicators as derived from Table 4.3. The results show that the mean ratings for all indicators are fairly high, ranging from 3.88 to 4.15, suggesting that respondents generally agreed that all five indicators are relevant in assessing flood resilience in Delta State. Table 3 presents the descriptive statistics summary for the five categories of indicators. Among the groups, Physical Indicators recorded the highest mean value of 4.15, followed by Environmental Indicators (4.03) and Institutional Indicators (4.00). These were closely followed by

Social Indicators (3.97) and Economic Indicators (3.88). The narrow spread of mean values (from 3.88 to 4.15) suggests a generally consistent perception among respondents regarding the importance of all indicators in enhancing flood resilience.

The standard deviation values are low across the indicators (ranging from 0.075 to 0.126), implying limited variability in the responses. Similarly, the 95% confidence intervals fall within a narrow band, further confirming the closeness of respondents' ratings across the five indicators. This pattern of responses suggests that, although all indicators were rated as important, physical measures such as flood-resistant building design and efficient drainage systems were perceived as slightly more significant to flood resilience than economic or social measures.

4.1 Discussion of Findings

The findings indicate that flood resilience in Delta State is influenced by interconnected physical, environmental, institutional and governance, social, and economic factors. The prominence of physical indicators, followed by environmental and institutional indicators, suggests that respondents consider structural protection, ecosystem management and effective governance important for reducing flood vulnerability. This finding supports Moreira et al. (2021), whose systematic review of flood vulnerability indices demonstrates the importance of multidimensional approaches to assessing flood risk. It also aligns with Cutter et al. (2008), who conceptualized community resilience as a place-based condition shaped by interactions among infrastructure, social characteristics, economic resources, institutions and environmental conditions. The findings therefore suggest that strengthening flood resilience in Delta State requires a coordinated approach rather than reliance on isolated flood-control measures.

The physical dimension emerged as the most prominent category, with flood-resistant building designs identified as the leading indicator. This finding highlights the importance of integrating flood-risk considerations into building design, construction materials, site selection and development planning. In flood-prone communities, buildings designed without adequate consideration of local hydrological conditions may be more susceptible to structural damage, water intrusion and disruption of occupancy. The importance attached to flood-protection infrastructure and drainage systems further indicates that building-level interventions need to be supported by functional public infrastructure. This interpretation is consistent with the broader disaster-resilience perspective of the United Nations Office for Disaster Risk Reduction (UNDRR, 2015), which emphasises reducing existing disaster risk and preventing the creation of new risks through appropriate planning and investment. The findings suggest that flood resilience in Delta State should combine resilient building practices with the maintenance of drainage networks, protection infrastructure and accessible evacuation facilities.

Environmental indicators ranked prominently, particularly the extent of upstream forest and vegetation cover and the conservation of wetlands and floodplains. This finding highlights the perceived importance of natural systems in managing floodwater and reducing exposure. Vegetation can influence infiltration and surface runoff, while wetlands and floodplains can provide temporary water storage under appropriate conditions. The findings support the argument that flood management should integrate ecosystem protection with engineered interventions. The Intergovernmental Panel on Climate Change (IPCC, 2022) recognises ecosystem-based adaptation and the protection of natural systems as relevant approaches to managing climate-related risks, although their effectiveness depends on local environmental and hydrological conditions. In Delta State, where flooding affects settlements, infrastructure and livelihoods, environmental planning should therefore address wetland degradation, vegetation loss and inappropriate development in flood-prone areas. The relatively lower rating assigned to natural flood-mitigation systems also points to the need to give these systems greater consideration in flood-management planning.

Institutional and governance indicators were also important, particularly the effectiveness of disaster-management agencies and the existence of flood-risk management plans. These findings indicate that resilience depends partly on the capacity of public institutions to coordinate preparedness, response and recovery activities. However, the relatively lower ratings for land-use policy enforcement and the frequency of preparedness drills suggest that formal plans and institutional structures may not be sufficient unless they are translated into practical action. This interpretation is consistent with the Sendai Framework for Disaster Risk Reduction, which identifies disaster-risk governance, investment in risk reduction and preparedness as key priorities for reducing disaster losses (UNDRR, 2015). For Delta State, the findings highlight the need for effective coordination among relevant ministries and emergency-management agencies, consistent enforcement of development regulations, and regular preparedness exercises involving communities and other stakeholders.

The social dimension highlighted access to early-warning systems and support for vulnerable populations as important indicators of flood resilience. This suggests that the ability to anticipate flooding and obtain timely, understandable warnings is central to household and community preparedness. The importance of supporting older people and persons with disabilities also demonstrates the need for inclusive emergency planning, particularly where evacuation and access to relief services may be difficult. Rufat et al. (2015), in their review of social vulnerability to floods, show that flood impacts are shaped not only by exposure but also by differences in people's resources and capacity to respond. The present findings reinforce this perspective by indicating that social resilience requires accessible warning systems, inclusive preparedness arrangements and community-level support. The comparatively lower ratings for community participation and social networks suggest that opportunities remain to strengthen collective preparedness and local cooperation.

Economic indicators received the lowest relative ranking among the five dimensions, although respondents still considered them relevant to flood resilience. Access to emergency financial support and government recovery funding were the most highly rated economic indicators, while insurance coverage received the lowest rating within the category. This pattern suggests that immediate financial assistance and public recovery resources are perceived as more prominent mechanisms for coping with flood impacts than formal insurance arrangements. Economic resources influence the ability of households to repair damaged property, replace lost assets, restore livelihoods and recover after flooding. The findings therefore support the need to integrate financial preparedness and recovery mechanisms into flood-resilience planning. They also point to the potential value of investigating the accessibility, affordability and awareness of insurance products among households and property owners in flood-prone communities. These interpretations are consistent with the multidimensional approach advocated by Moreira et al. (2021), which recognises the relevance of socioeconomic characteristics in understanding flood vulnerability.

The study collected ratings from building professionals, flood-management officials and residents. However, the available tables do not provide sufficient respondent-level results to verify whether the groups differed systematically. Future reporting should compare these groups using the original ratings and a suitable statistical model, while considering their different roles and experiences.

Study Limitations

The study relies on questionnaire-based perceptions and does not directly measure the physical performance of buildings, drainage systems, ecosystems or institutions during flood events. The reported sampling description does not identify the sampled communities, the distribution of residents across communities, or the household-selection procedure. The calculated Cronbach's alpha coefficient is also absent from the available manuscript. Further, the raw respondent-level data were not available for verification of missing responses, statistical assumptions or the hypothesis test. These limitations restrict the findings to descriptive rankings of the item means reported in the paper.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study assessed respondents' perceptions of indicators associated with flood resilience across five dimensions in Delta State, Nigeria. Based on arithmetic averages of the published item means, physical indicators received the highest dimension score, followed by institutional and governance, environmental, social and economic indicators. Flood-resistant building design was the highest-rated individual item, while access to emergency financial support was the highest-rated economic item. These findings identify perceived priorities for planning; they do not establish the actual resilience of communities or the causal effects of the indicators. The originally reported ANOVA could not be retained because its tables indicate item-level observations rather than the 617 respondents, and the raw data needed for valid reanalysis were not supplied.

5.2 Recommendations

The Delta State Government, local planning authorities and relevant professional bodies should consider the high ratings for flood-resistant building design, drainage and flood-protection infrastructure when reviewing building regulations and maintenance priorities. The Delta State Ministry of Environment and relevant environmental agencies should protect wetlands, floodplains, vegetation and natural drainage corridors through land-use planning and environmental regulation. The Delta State Emergency Management Agency and other responsible emergency agencies should maintain accessible early-warning and evacuation arrangements, including support for older people and persons with disabilities. Government authorities should review the accessibility of emergency financial assistance and recovery funding and assess barriers to affordable flood insurance. These recommendations are based on respondents' perceptions and should be evaluated against flood-event, infrastructure and community-level evidence.

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