Global Journal of Engineering and Technology Advances
eISSN: 2582-5003
Cross Ref DOI: 10.30574/gjeta
Journal homepage: https://gjeta.com/

(RESEARCH ARTICLE)

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Assessing the effectiveness of nature-based solutions and the role of Community-Based solutions in mitigating flood disasters

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Global Journal of Engineering and Technology Advances, 2025, 24(03), 270-280

Publication history: Received on 05 August 2025; revised on 14 September 2025; accepted on 18 September 2025

Article DOI: https://doi.org/10.30574/gjeta.2025.24.3.0275

Abstract

Flooding is still a major urban problem that is exacerbated by climate change, rapid urbanization, inadequate urban planning, and poor governance systems. Studies have revealed that Nature-Based Solutions (NbS) and Community-Based Disaster Risk Reduction (CBDRR) have become cutting-edge approaches to enhancing flood resilience, especially in highly vulnerable areas such as Lagos. The purpose of this study is to evaluate the effectiveness of NbS and CBDRR strategies in reducing flood disasters and increasing adaptive capacity. A mixed-method approach was employed, and the study collected data from 384 residents in flood-prone areas in both Lagos and Ibadan, Nigeria, who were given structured questionnaires to gather quantitative data. Also, key informant interviews were conducted to collect data from local officials, community leaders, city planners, and NGO leaders.

The results of the study highlighted that although Lagos has more widely adopted NbS practices, such as retention basins and tree planting, both cities continue to struggle with a lack of institutional coordination and infrastructure. In Lagos, where government frameworks better support CBDRR methods like flood awareness programs and drainage clearing, community involvement was more substantial. Statistics revealed that there are connections between institutional support, public knowledge, and the perceived efficacy of both CBDRR and NbS; however, obstacles such as low technical capacity, lax enforcement, and insufficient funding efforts still exist. The study suggests specific initiatives for each city based on fundamental assistance in the areas of policy development, enhancing institutional cooperation, and long-term investment to upkeep green infrastructure. Ultimately, the study concluded that a synergistic combination of ecological innovation, community agency, and multi-level governance is needed to achieve urban flood resilience in these cities.

Keywords: Nature-Based Solutions (NBS); Community-Based Disaster Risk Reduction (CBDRR); Policy Development; Flood Resilience; Flood Mitigation; Disaster Risk Reduction

1. Introduction

Flooding is known to cause common and destructive natural disasters that affect metropolitan areas worldwide, exacerbated by climate change, rapid urbanization, inadequate land-use planning, and lax environmental regulation, which has resulted in a rise in flood-related accidents with far-reaching effects (Ademola et al., 2021; Alaran et al., 2025). In cities like Lagos and Ibadan, the frequency and intensity of floods have resulted in damage that includes displacement

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of families, destruction of infrastructure, and significant economic losses, placing immense pressure on government facilities, communities, and vulnerable populations (Adelekan, 2010; Douglas et al., 2008; Nkwunonwo, Whitworth, and Baily, 2020).

Poor urban design and inadequate infrastructure, particularly in areas with deficient drainage systems and poorly maintained water management equipment, are contributing factors that exacerbate the flood catastrophe. Over the years, conventional flood control techniques have mostly depended on engineering fixes like levees, concrete drainage systems, and specialized foundations made to divert or contain floodwaters (Wang et al., 2022; Rubinato et al., 2019). While these approaches were once considered adequate, they have often proven to be increasingly insufficient in the face of changing climatic conditions, rapid population growth, and urban sprawl (Gencer, 2013). As a result, a growing body of research is advocating for alternative, more sustainable approaches to flood management that work in tandem with natural processes and engage communities directly in the decision-making process (Hansamali et al., 2025; Feigin et al., 2023).

One such potential strategy is nature-based solutions (NbS). To address societal issues like disaster risk reduction and climate resilience, these solutions entail the sustainable management and utilization of natural systems (Cohen-Shacham et al., 2016). NbS includes initiatives that use nature's power to lower flood risks in the context of urban flood management. These include afforestation projects, wetland restoration, urban greening programs, and the installation of permeable surfaces that enable runoff to absorb and filter naturally (Kabisch et al., 2017). NbS has many co-benefits in addition to lowering the immediate dangers of floods, including better air quality, biodiversity conservation, and increased social well-being through the creation of green areas that allow communities to interact with their surroundings (Seddon et al., 2020).

In addition to NbS, the effectiveness of community-based disaster risk reduction (CBDRR) initiatives in mitigating flood risks has also been highlighted. These methods place a strong emphasis on the active participation of local communities in the development, execution, and oversight of disaster risk reduction initiatives. These tactics promote a sense of local ownership by enticing community engagement, which is essential for guaranteeing the sustainability and long-term success of flood management programs (Twigg, 2009). Research from Nigeria's flood-prone areas indicates that communities are better able to lessen the effects of flooding and their overall susceptibility when they are given access to information, resources, early warning systems, and flood preparedness training (Ajibade, 2017). Community-based activities are an essential component of any comprehensive flood risk management strategy because this approach recognizes that local knowledge and involvement are crucial assets in the face of natural disasters.

With an emphasis on Lagos and Ibadan, this study aims to investigate the efficacy of community-based and nature-based strategies in reducing flood disasters. Flash floods are common in Lagos, a heavily populated coastal megacity, due to climate change, unchecked urban growth, and rising sea levels. In the meantime, deforestation and inadequate drainage systems exacerbate riverine flooding in Ibadan, an inland city (Adelekan, 2011; Eguavoen, 2020). By contrasting these two cities, the project hopes to draw attention to the distinct difficulties that each region experiences in managing flooding while investigating how community-based tactics and green infrastructure might be used to increase flood resilience. The goal of this research is to contribute to the larger objective of sustainable and climate-resilient urban development in coastal African cities by providing practical insights into how nature-based and community-driven approaches can be integrated into urban planning to enhance flood risk management in Nigeria.

1.1. Aim, objectives, and research questions of the Study

The purpose of this study is to appraise the effectiveness of nature-based solutions and the role of community-based approaches in mitigating flood disasters in Nigeria, using Lagos and Ibadan as case studies. The objectives of the study include: To examine the implementation and impact of nature-based solutions (e.g., green infrastructure, afforestation, and wetland restoration) in urban flood management in Lagos and Ibadan; To assess the role and effectiveness of community-based approaches in flood preparedness, response, and mitigation in the two cities; To identify the challenges and opportunities associated with integrating nature-based and community-based flood management strategies; To compare the flood risk governance frameworks and resilience outcomes between Lagos (coastal) and Ibadan (inland); To provide policy recommendations for improving flood risk reduction through sustainable and inclusive approaches. This would be achieved through the following research questions: What nature-based solutions have been implemented in Lagos and Ibadan, and how effective have they been in reducing flood risk? How do community-based flood mitigation efforts contribute to preparedness and resilience in both cities? What are the significant challenges limiting the successful implementation of nature-based and community-driven flood strategies? In what ways do the flood management experiences of Lagos and Ibadan differ, and what lessons can be drawn from

each? How can nature-based and community-based approaches be better integrated into Nigeria's urban flood risk governance framework?

1.2. Study Area

This study focuses on two major urban centers in Nigeria as the study area: Lagos and Ibadan. The two cities have faced severe flood-related challenges. However, they differ in their geographic and climatic contexts, providing a valuable comparative perspective for assessing nature-based and community-based flood mitigation strategies.

Lagos: Lagos, the commercial capital of Nigeria, is a coastal megacity located in the southwestern part of the country. Bordered by the Atlantic Ocean, Lagos lies between latitudes 6°23′N and 6°41′N and longitudes 2°42′E and 3°42′E (fig. 1). The city is characterized by a low-lying terrain, high population density, and rapid urbanization, which have made it particularly vulnerable to flash floods, coastal flooding, and storm surges (Adelekan, 2010). Frequent flooding in Lagos is often attributed to blocked drainage systems, unplanned settlements in floodplains, poor waste management, and rising sea levels associated with climate change. Over the years, the state government has attempted several mitigation measures, including drainage construction, canal dredging, and, more recently, green infrastructure projects. However, implementation challenges persist, especially in informal settlements.

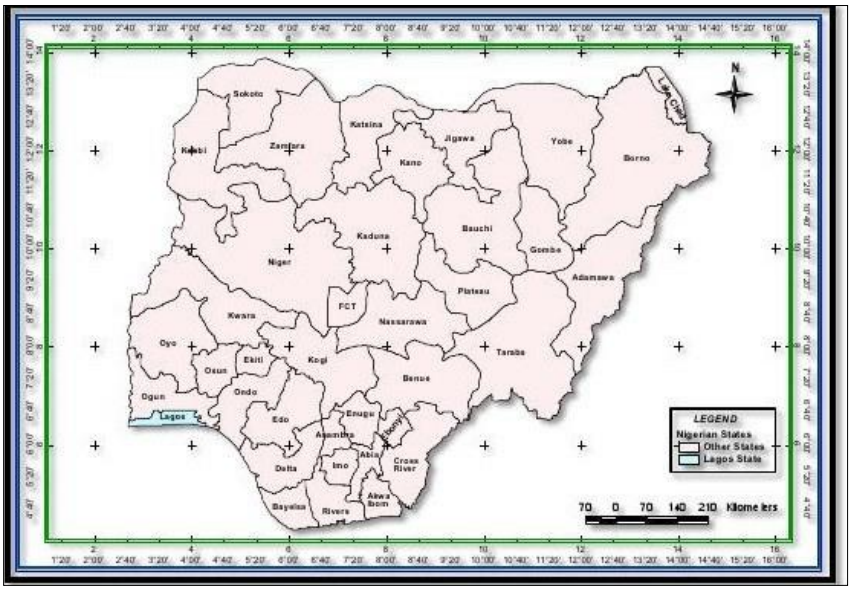


Figure 1 Map of Nigeria showing Lagos state

Ibadan: Ibadan, the capital of Oyo State, is located inland in southwestern Nigeria, approximately 120 kilometers north of Lagos. It lies between latitudes 7°15′N and 7°30′N and longitudes 3°45′E and 4°00′E (Fig. 2). Ibadan is the largest city in West Africa by landmass and has a unique topography, marked by hills and river valleys. The city has a long history of flooding, with one of the most devastating events occurring in 1980, known as the Ogunpa flood disaster. Despite numerous government interventions, the city remains highly flood-prone due to factors such as deforestation, unregulated urban development, and poor maintenance of drainage systems (Eguavoen, 2020). Flooding in Ibadan is primarily fluvial (river-based), as opposed to Lagos, and is frequently caused by the overflow of rivers like Ogunpa and Ona.



Figure 2 Map of Nigeria showing the location of Ibadan in Oyo state

The selection of Lagos and Ibadan provides insightful information about how ecological systems, urban design, and grassroots involvement interact. Lagos is a prime example of a rapidly modernizing urban area struggling with environmental extremes due to its vulnerability to flash floods and coastal erosion. However, Ibadan offers a different example, where land-use mismanagement and inadequate infrastructure continue to cause inland riverine floods. A more nuanced understanding of the effectiveness of community-based flood mitigation measures and nature-based solutions across Nigeria's various flood risk profiles can be gained by investigating both cities.

2. Data and methods

To provide a thorough understanding of the efficacy of community-based and nature-based flood mitigation initiatives in Lagos and Ibadan, this study uses a mixed-methods research methodology that combines qualitative and quantitative techniques. This design's justification is to combine detailed information from local stakeholders with numerical data on flood impacts and infrastructure interventions, enhancing the results with statistical patterns and contextual knowledge. (Creswell and Plano Clark, 2017). For quantitative data collection, the target population comprises residents of flood-prone communities, from which qualitative data were collected from local government officials, environmental NGOs, and urban planners in both Lagos and Ibadan. A multi-stage sampling technique is employed: Purposive sampling is used to select specific flood-prone communities in each city based on historical flood data (e.g., Ajegunle and Lekki in Lagos; Bere, Oke-Ado, and Bodija in Ibadan). Within selected communities, systematic random sampling is used to select households for survey administration. Key informants such as community leaders, officials from state environmental agencies, and representatives of community-based organizations are selected using snowball sampling for interviews. A total of 384 respondents were surveyed (192 per city), while 10 key informant interviews (KIIs) were conducted across the two cities.

Data collection involved both primary and secondary data. Primary data included: Structured questionnaires, which will collect quantitative data on household awareness, perceptions of flood risk, exposure to flood events, and evaluation of nature-based/community-based interventions. Semi-structured interviews were used to explore community preparedness strategies, policy implementation challenges, and perceptions of institutional support. Field observations were conducted to assess the physical presence and condition of green infrastructure, such as drainage systems, wetlands, and tree cover. Secondary data sources included Archival records on historical flood occurrences, urban planning and environmental policy documents from Lagos State and Oyo State ministries, reports from relevant agencies such as the Nigerian Meteorological Agency (NiMet) and the National Emergency Management Agency (NEMA), and those from NGOs like the HEDA Resource Centre.

Data analysis techniques will be both quantitative and qualitative. Quantitative data from the questionnaire were analyzed using descriptive statistics (frequencies) and inferential statistics (Chi-square tests, correlation analysis, and regression models) to examine relationships between variables such as type of mitigation strategy and flood exposure. Qualitative data from interviews and field notes were analyzed using thematic content analysis, guided by Braun and Clarke's (2006) approach. Key themes included: perceptions of flood risk, effectiveness of interventions, institutional barriers, and community participation.

Validity and reliability. To ensure validity, the questionnaire was pre-tested in non-selected communities to refine question clarity and relevance. Triangulation of data sources (surveys, interviews, documents) will enhance reliability and internal consistency. Peer debriefing and respondent validation were applied during qualitative analysis. Ethical approval was obtained from a relevant institutional review board. Participation was voluntary, and informed consent was obtained from all respondents. Data is anonymized to protect the identities of participants.

3. Analysis and interpretation of results

This section presents the analysis of data collected from 384 respondents across flood-prone communities in Lagos and Ibadan, supplemented by insights from key informant interviews and focus group discussions. Both descriptive statistics (frequencies, means, and percentages) and inferential statistics (Chi-square tests and regression analysis) were used in line with the study's objectives.

Table 1 Socio-Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	198	51.6
	Female	186	48.4
Age	18–30	98	25.5
	31–45	152	39.6
	46 and above	134	34.9
Educational Status	No formal education	40	10.4
	Primary/Secondary	172	44.8
	Tertiary	172	44.8
Duration of Residence	<5 years	56	14.6
	5–10 years	142	37.0
	>10 years	186	48.4

Source: Author's field work, 2025

According to Table 1, the majority of respondents had lived in their communities for over five years, enhancing the reliability of their flood-related experiences.

Table 2 The Role of Nature-Based Solutions (NBS) in Reducing Urban Flood Risks

NBS Practice	Practiced	% Practicing
Tree planting/urban forestry	216	56.3%
Use of permeable pavements	105	27.3%
Wetland protection	88	22.9%
Green roofs/drainage buffers	62	16.1%

Source: Author's field work, 2025

From Table 2, 68% of respondents believed NbS significantly reduced flooding in their communities. 52% observed reduced water stagnation due to green spaces.

Table 3 Relationship between awareness of NbS and perceived effectiveness

Awareness of NbS	Perceived NbS as Effective	Perceived NbS as Not Effective	Total
Aware	105	18	123
Not Aware	21	35	56
Total	126	53	179

Source: Author's field work, 2025

$$\text{Chi-square } (\chi^2) = 26.7,\ p < 0.05$$

Table 3 shows the Chi-square test result ($\chi^2 = 26.7$, $p < 0.05$) which indicates a statistically significant relationship between the level of awareness of Nature-Based Solutions (NbS) and their perceived effectiveness in flood management. This means respondents who are aware of NbS—such as tree planting, rain gardens, green roofs, and wetland preservation—are more likely to perceive these interventions as effective in mitigating urban flood risks. While such solutions are only modestly implemented in the study areas, public trust in their potential remains high. This underscores the importance of awareness campaigns and public education in fostering acceptance and support for sustainable flood management practices.

Table 4 Effectiveness of Community-Based Disaster Risk Reduction (CBDRR) in Flood Preparedness

CBDRR Activity	Involved	% Involved
Community flood alerts/early warning	178	46.4%
Drainage cleaning campaigns	224	58.3%
Community mapping of flood zones	95	24.7%
Evacuation drills	66	17.2%

Source: Author's field work, 2025

From table 4, the perceived benefits: 60.4% of respondents felt community actions had reduced flood impacts. 44% agreed that CBDRR increased preparedness and saved property.

3.1. Regression Analysis

A multiple linear regression model was used to predict flood resilience level (dependent variable) using community participation, education level, and CBDRR training exposure as predictors:

$$\text{Flood Resilience} = \beta 0 + \beta 1(\text{Participation}) + \beta 2(\text{Education}) + \beta 3(\text{Training})$$

$$R^2 = 0.39;\ F\ (3, 380) = 81.4;\ p < 0.01$$

- Significant predictors: Participation ($\beta = 0.45$, $p < 0.01$), Training ($\beta = 0.31$, $p < 0.05$)

The regression analysis shows that community-based actions like flood alerts and sanitation drive significantly increase resilience. Participation and awareness programs are strong predictors of preparedness.

3.2. Key Findings (from KIIs and FGDs)

Institutional support was rated as inconsistent in both cities. Lagos had better coordination through LASEMA; Ibadan had gaps in local authority preparedness. 64% of community leaders reported limited engagement by state institutions. This is also buttressed in table 5

Table 5 Institutional Support Ratings

Rating	Lagos (%)	Ibadan (%)
Very Supportive	24	11
Somewhat Supportive	42	29
Not Supportive	34	60

Source: Author's field work, 2025

Table 6 Cross-tabulation (CBDRR x Government Support)

Support Level	CBDRR Active (%)	CBDRR Inactive (%)
Supportive	82	18
Not Supportive	43	57

Source: Author's field work, 2025

Table 6 asserts that active governance and institutional frameworks enhance the success of community-based approaches; conversely, where such support is weak, participation declines.

Table 7 Barriers to the Implementation of NbS and CBDRR (Multiple responses allowed)

Reported Barrier	Frequency	Percentage (%)
Lack of funding	251	65.4
Weak institutional coordination	198	51.6
Low public awareness	178	46.4
Poor maintenance culture	132	34.4
Land-use conflict/urban encroachment	104	27.1

Source: Author's field work, 2025

Respondents overwhelmingly pointed to lack of funding and institutional gaps as significant constraints (Table 7). This suggests that while awareness and perceived benefits are high, structural and financial issues inhibit implementation.

3.3. Comparative Analysis: Lagos vs. Ibadan

A comparative statistical analysis was done to assess differences between Lagos and Ibadan in terms of: Level of community participation; Use of NbS practices; Institutional support ratings

Table 8 Comparative Analysis

Variable	Lagos Mean	Ibadan Mean	t-value	p-value
NbS Practices Score (0–5)	3.42	2.65	4.17	0.000
CBDRR Engagement (0–5)	3.81	3.03	3.58	0.001
Institutional Support	2.9	2.1	5.24	0.000

Source: Author's field work, 2025

Table 8 shows that all variables showed statistically significant differences ($p < 0.05$), indicating Lagos is performing better in all three areas- likely due to its larger budget, population density pressures, and stronger institutional frameworks.

Table 9 Correlation Analysis

Variable Pair	Correlation Coefficient (r)	Interpretation
NbS Awareness and Perceived Effectiveness	0.61	Strong Positive
CBDRR Participation and Preparedness Level	0.72	Strong Positive
Institutional Support and NbS Practice	0.47	Moderate Positive

Author's field work, 2025

To measure the strength and direction of relationships between key variables, Pearson's correlation was conducted: table 9 shows there are strong positive correlations between awareness and actual use/effectiveness of interventions. This confirms that knowledge, engagement, and support are interdependent pillars of resilience.

3.4. Flood Impact Reduction Index (FIRI) Score

A custom index that combines variables (Presence of green infrastructure (NbS), Community readiness scores (from questionnaire), Institutional responsiveness (from KIIs)) was used to score the study areas on resilience

- FIRI= (NbS×0.4+CBDRR×0.4+InstitutionalSupport×0.2)/5
- (If FIRI score ranges: 0.0–1.5: Low Resilience; 1.6–3.0: Moderate Resilience; 3.1–5.0: High Resilience)
- Lagos average score: 3.6 (High Resilience); Ibadan average score: 2.7 (Moderate Resilience)
- This scoring index offers a summarized view of how each city is performing.

3.5. Thematic Analysis Highlights from FGDs

The following are highlights from Gestate trees we planted last year helped water drain faster, but the government has not come back to maintain them." (Adekunle resident, Lagos). "We always clean the gutters ourselves. If we wait for the government, we will drown." (Yamato resident, Ibadan)

Table 10 Summary of Major Findings by Analysis

Analysis	Method(s) Used	Major Findings	Interpretation/Implication
The role of Nature-Based Solutions (NbS) in reducing flood risk	Descriptive stats, Chi-square test	56.3% of respondents practice tree planting; perceived effectiveness = 68%. Significant relationship between awareness and use of NbS (p<0.05).	NbS are moderately practiced and widely accepted; awareness enhances effectiveness.
The effectiveness of Community-Based Disaster Risk Reduction (CBDRR)	Descriptive stats, regression analysis	58.3% involved in drainage cleaning; regression shows participation and training predict resilience (R^2 = 0.39, p < 0.01).	Community efforts significantly enhance preparedness and mitigate flood impacts.
The moderating role of institutional support and governance	Cross-tabulation, key informant interviews (KIIs)	64% reported limited institutional support; Lagos outperforms Ibadan in coordination.	Institutional support strengthens both NbS and CBDRR outcomes; gaps reduce sustainability.
Barriers to NbS and CBDRR implementation	Multiple response analysis, thematic review	Top barriers: lack of funding (65.4%), institutional weakness (51.6%), low awareness (46.4%).	Structural and financial constraints are major obstacles despite positive community reception.
5. Comparison between Lagos and Ibadan in NbS/CBDRR effectiveness	FIRI Index and independent sample t-tests	Lagos had higher scores on all indices; its FIRI was 3.6, whereas Ibadan's was 2.7. Every difference was noteworthy (p < 0.05).	Lagos has superior governance, more integrated green practices, and more robust systems.

Author's field work, 2025

4. Conclusion

Using Lagos and Ibadan as case studies, this study investigated how well Nature-Based Solutions (NbS) and Community-Based Disaster Risk Reduction (CBDRR) mitigate urban flood disasters in Nigeria. The study has presented strong evidence that both NbS and CBDRR strategies are essential for enhancing urban flood resilience through a mixed-methods approach that combines surveys, interviews, and statistical analyses.

The results showed that while community-led preparedness initiatives, like awareness campaigns and local drainage maintenance, constitute the cornerstone of grassroots flood mitigation, tree planting, green buffers, and drainage desilting are some of the most used NbS measures. Statistics tests showed a strong correlation between flood risk reduction, institutional support, and community involvement. Compared to Ibadan, Lagos demonstrated greater efficacy in adopting both NbS and CBDRR because of its superior infrastructure in virtually every way and its robust governance structures.

But the study also pointed up important obstacles that stand in the way of these interventions' full implementation, such as a lack of finance, poor institutional coordination, and low public awareness. These obstacles highlight the pressing need for a more multi-level, integrated governance strategy in which state agencies, urban planners, and local communities work together productively.

In the end, this study proves that community empowerment and ecological knowledge are essential components of the road to sustainable flood resistance in Nigerian cities. Without institutional commitment, policy support, and robust community structures, nature-based initiatives are insufficient on their own. Therefore, improving participatory disaster planning, increasing investment in NbS, and filling up systemic governance gaps continue to be essential to promoting urban climate adaptation throughout Nigeria.

Recommendations

Lagos and Ibadan must implement focused and coordinated initiatives to enhance the effectiveness of Nature-Based Solutions (NbS) and Community-Based Disaster Risk Reduction (CBDRR) mechanisms, considering the study's findings. Although community readiness initiatives and green infrastructure in Lagos are comparatively well-developed, their long-term efficacy is hampered by a lackluster maintenance culture and disjointed institutional coordination. The Lagos State Government should create a centralized Flood Resilience Coordination Unit to bridge these gaps, coordinating the efforts of organizations such as LASEMA, LASPARK, and LASEPA, and increasing funding for the maintenance of urban trees, retention basins, and green buffers. Furthermore, Community Development Associations (CDAs) need to be officially included in local governance procedures to close the gap between grassroots involvement and top-down policy frameworks. Stricter enforcement of zoning and environmental restrictions is another way to strengthen efforts to conserve ecologically vulnerable areas, such as wetlands and natural drainage channels.

Conversely, Ibadan has more fundamental issues, such as inadequate funding for NbS infrastructure, a lack of public awareness, and weakened institutional frameworks. The creation of ward-level community-based flood management committees and providing them with resources, training, and instruments for proactive flood response should be top priorities for the Oyo State Government. To increase public knowledge of flood hazards and environmentally friendly alternatives, these local disaster units can collaborate with educational institutions, places of worship, and civil society organizations. With technical support from organizations like the Nigerian Institute of Social and Economic Research (NISER), Ibadan's urban planning should be refocused to include green areas and urban forestry in its master plan. Additionally, starting community-led initiatives like rain gardens and tree-lined avenues can increase resilience and promote local control over climate adaptation initiatives.

The institutionalization of NbS and CBDRR through legislative and policy changes that formally acknowledge these approaches in state-level environmental and disaster management frameworks is urgently needed in both cities. To create training materials on NbS integration and participatory disaster governance for community leaders, engineers, and urban planners, governments should collaborate with international development organizations. Establishing Local Flood Resilience Hubs with disaster response kits and early warning systems can improve local coordination and preparedness even more. The degree to which ecological knowledge is successfully integrated with empowered citizen action and robust institutional support will ultimately determine the level of sustainable flood resistance in Nigeria's metropolitan centers.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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