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RESEARCH ARTICLE

Community-Based Flood Risk Adaptation Strategies in Mokola, Ibadan, Southwestern Nigeria

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ABSTRACT

The case of flooding is a constant occurrence in most developing economies, such as Nigeria, regarding environmental risk. In Mokola, Ibadan, the top-down approach of flood risk assessment has been a major occurrence, which does not take into consideration the local spatial knowledge, therefore resulting in poor adaptation strategies. The mixed-method cross-sectional design was adopted, which used quantitative surveys. The study population comprised 18500 residents, while a sample of 300 residents was selected through a stratified random sampling method. Structured questionnaires and participatory mapping exercises were used to gather data, which were supported by institutional sources of rainfall data and spatial data. Valid responses were obtained after screening and analyzed with Descriptive statistics, multiple regression, and one-way ANOVA in SPSS to produce flood susceptibility with spatial data. Results showed that 85% of residents had reported flooding, and involvement in mapping was associated with a significant increase in awareness and adaptive behaviour ($R^2 = 0.58$, $p < 0.001$). Furthermore, the level of adaptation responses was different in the zones of elevation, with the Mokola residents in lower elevations exhibiting higher levels of preparations ($F = 5.47$, $p < 0.01$). The findings confirm that participatory mapping enhances local resilience through the development of knowledge and spatial awareness of flood risks. It is concluded in the study that community-based adaptation is a diagnostic, as well as a behavioural, catalyst, and is the key to bridging the gap between scientific assessment and living experience. It advises flood management agencies to incorporate community mapping in normal planning and adaptation interventions to create zone-specific risk profiles so as to have fair and sustainable flood governance.

Keywords: *Adaptation; Community participation; Flood mapping; GIS; Urban resilience*

1. INTRODUCTION

Flooding is among the most frequent and devastating environmental risks in the world, which is menacing sustainable growth and human safety. Increased climate change, urbanization, and changes in land use have increased the frequency and severity of flood events and decreased the natural infiltration and storage capacity (Moon et al., 2024). Hydrological effects of excessive precipitation combined with an increase in impervious surfaces and drainage network deterioration have increased the exposure and susceptibility in most urban areas. It is especially problematic in developing countries where population expansion exceeds the development of infrastructure, and urban planning mechanisms are not able to comply with new hydrometeorological conditions (Bhanye, 2025).

In Africa, flood vulnerability has been enhanced by the fast rate of urbanization and the development of informal settlements. African cities are often flooded due to poor drainage systems, poor maintenance policies, and residential development that cuts into flood-prone areas (Gaisie & Cobbinah, 2023). Socio-economic limitations and weak community involvement in the process of risk assessment and adaptation are contributing factors to these structural inadequacies (Umar & Gray, 2023). As such, the risk of urban flooding on the continent is determined by both physical exposure and institutions as well as social factors that mediate adaptive capacity.

Flooding in Nigeria has been a very common environmental and developmental problem. It has caused major losses of thousands of households and neighborhood lives per year, and damages urban lives (Lucas, 2021; Oladokun & Proverbs, 2016). There have been recent geospatial investigations that have used remote sensing and hydrological models to outline flood-prone regions throughout the nation, both coastal and non-coastal settlements (Bello et al., 2024). Nevertheless, these methods typically work with data at coarse scales and with generalized models that do not sufficiently account for the risks of a community. The omission of local spatial information like knowledge about blocked drains, minor topographic depressions, or informal drainage paths generates a consistent discrepancy between technical flood maps and the lived experience of the residents. This loophole restricts the accuracy of risk evaluation and the efficacy of suggested adaptation strategies.

In the capital of Oyo State, Ibadan, flood risk has intensified as a result of unplanned urban development, heavy rainfall, and settlements in riverine lands. Recent floods, such as the destructive one in 2011, emphasize that the urban drainage structure and management systems are flawed, systemically (Egbinola et al., 2017). Ibadan Urban Flood Management Project and other projects have attempted to improve the infrastructure and emergency response; however, neighbourhoods like Mokola are still prone to frequent flooding. Lack of neighbourhood-based participatory risk mapping has limited knowledge of fine-scale vulnerabilities and the application of locally applicable adaptation strategies.

The primary problem that underpins the proposed study is that Mokola's adaptation planning and flood risk mapping are primarily top-down, with no integration of spatial data supplied by the community. As a result, flood risk assessments may not be able to identify places with microscale hazards, and the adaptation strategies may not be in line with the population' capacity for adaptation and socioeconomic reality. Flood management actions become less relevant, more erroneous, and less sustainable as a result of this lack of connectivity. This gap must be filled by creating a community-based method of mapping flood risk that combines participative local data with geographic analysis.

This study is both theoretical and practical. In academia, it has been adding to the growing discussion of participatory geospatial practices, community-based adaptation, and resilience to flooding in the city. The paper contributes to the research on the role of local data in formal flood modelling by means of incorporating community insights into scientific risk assessment and supporting overall adaptation planning. In practice, the research offers a replicable concept framework for defining high-risk micro zones and developing viable strategies of adaptation to these micro zones to decision-makers, planners, and local stakeholders. It is hoped that the findings will enhance institutional coordination, enhance the credibility of flood risk communication, and, more importantly, promote community involvement in disaster risk reduction that is more sustainable.

The research is guided by the following three specific objectives, which align directly with the study's methodology and findings: 1) to develop community-based flood risk maps for Mokola, Ibadan, by integrating local spatial knowledge (participatory mapping) with institutional geospatial data, 2) to examine the spatial variation of flood adaptation strategies adopted by residents across different elevation zones (Upper, Middle, and Lower Mokola), and 3) to assess the impact of participation in flood risk mapping on residents' flood risk awareness and their subsequent adoption of adaptive behaviours.

2. LITERATURE REVIEW

Flood risk mapping is the process of identifying and marking the areas that are susceptible to flooding at certain rainfall or water flow levels. It involves the systematic mapping of flood-prone areas and their spatial delineation. It measures potential impacts on people, infrastructure, and the environment by combining hazard, exposure, and vulnerability scales (Bello, 2024). According to the Intergovernmental Panel on Climate Change (IPCC, 2023), flood risk results from the interaction of climatic risks (such as excessive precipitation), the susceptibility of both natural and human systems, and their exposure. Therefore, by mapping the areas of interventions to be prioritized, the flood risk mapping can provide some scientific basis for decision-making.

Community-based flood risk mapping takes a step further and embraces the application of local and indigenous information to the geospatial framework. It enables residents to add spatial information about previous floods, obstructed drainage systems, or depressions they have in their area that might not be seen using satellite imagery or rough topography data (Petersson et al., 2020). Such mapping enhances the validity and legitimacy of the flood assessments by integrating participatory geographic information systems (PGIS) and current remote sensing to achieve this.

Adaptation strategies imply changes in the social, economic, and infrastructural systems due to the perceived or actual flood effects (IPCC, 2023). They may be structural, including levees, enhanced drainage and wetland restoration, or non-structural, including early warning systems, relocation and behaviour change programmes (Bhanye, 2025). Community-based mapping and adaptation have an interrelationship that is symbiotic; that is, participatory maps enhance risk awareness, locally available adaptation options, and adaptive capacity.

The Vulnerability Theory and Social-Ecological Systems (SES) Theory are the theories guiding this study. Vulnerability Theory, postulated by Cutter, Boruff, and Shirley (2003) and developed in recent adaptation studies, holds that risk has not only been increased by the strength of a hazard, but also is influenced by social, economic, and institutional circumstances that influence exposure and adaptive ability. Income, education, infrastructure, and governance are mediating factors of flood vulnerability. In this paper, the vulnerability theory gives a foundation to the analysis of the effect of community engagement and spatial awareness on the potential to anticipate, respond, and recover in case of flood occurrence among residents.

The concept of Social-Ecological Systems (SES) Theory considers both human and natural systems as co-evolving systems in which cohesion is based on feedback, learning, and self-organization (Folke, 2016). In the case of floods, the SES theory explains that community knowledge, environmental processes, and institutional mechanisms are dynamic. Placing the practices of flood adaptation by Mokola in this context, the paper will explore the power of participatory mapping as a means to enhance resilience through collective learning and adaptive management. These two theories share the assumption that participatory processes that are inclusive and knowledge-driven develop the ability of the community to cope with and adjust to hydrological risks.

In recent times, global studies have begun to appreciate the importance of considering community participation in the process of evaluating flood risks. Petersson et al. (2020) have shown that participatory flood mapping enhances the calibration of the model and community preparedness, especially in data-limited settings. On the same note, Bullen & Miles (2024) examined co-produced maps separately as a potential solution in bridging the gap between official risk assessment and local perceptions, and found that co-produced maps build trust and enhance disaster governance.

(Bhanye, 2025) examined a total of fifteen community-based adaptation (CBA) projects in the Global South and established that participatory mapping and local monitoring that included multi-stakeholder collaboration resulted in more sustainable outcomes than top-down interventions. As highlighted by Gaisie & Cobbinah 2023), the context-specific adaptation planning in Accra relies on the incorporation of localized flood knowledge in the municipal plans.

Using a geospatial analysis of coastal flood susceptibility in Nigeria, Bello et al. (2024) confirmed that terrain, population density, and land-use intensity all had an impact on flood exposure. However, the researchers acknowledged that one of the study's shortcomings was the lack of community-level geographical information. Lucas (2021) and Oladokun & Proverbs (2016) looked at barriers to flood risk management in Nigerian cities and found that the main issues with resilience were a lack of public awareness, institutional coordination, and citizen participation. These findings align with Orimoogunje & Aniramu (2025) systematic analysis of flood resilience in Lagos, which emphasizes the lack of suitable community interaction despite the official recognition of its importance in policy.

Beyond Nigeria, Gnecco et al. (2024) showed in Italy that participatory mapping implied a substantial improvement in the design of sustainable urban drainage systems as it combines the preferences of the community with engineering models. Similarly, Moon et al. (2024) demonstrated that mixed techniques that integrate structural and non-structural tools such as participatory governance are critical to mitigate the risk of floods in the city. These papers substantiate the hypothesis that the combination of community-based mapping and official modelling creates more equitable and practical flood adaptation plans.

Although the use of participatory approaches is globally known, limited literature has been conducted to empirically evaluate how community-sourced mapping information has a direct effect on adaptive decision-making in sub-Saharan African urban areas. The majority of the studies are limited to big cities, and medium-sized inland cities such as Ibadan are not well represented.

The literature review indicates that there is a broad international agreement on the importance of community involvement in flood management, but gaps that exist in the urban research environment in Nigeria are critical. To begin with, not many studies have operationalized neighbourhood-level community-based flood risk mapping, where adaptation choices are the most urgent. The empirical evidence on the translation of such participatory mapping into quantifiable adaptation outcomes is extremely scarce. Studies on Ibadan, especially the Mokola neighbourhood, have not been conducted on how the local spatial knowledge can be systematically combined with geospatial analysis to guide adaptive planning. By filling these gaps, this study will help in advancing the theoretical understanding of participatory geospatial models as well as the practical aspects that can be done to enhance local flood resilience in Nigerian cities of Nigeria.

3. MATERIALS AND METHODS

Study Area

The geographical location of the study is the neighbourhood of Mokola in Ibadan, Oyo State, which entails the residential blocks, micro-drainages, and the publicly constructed infrastructure. The temporal focus is 10 years (2015-2024), the timeframe of the latest flood experience and reactions. The availability of data is a major constraint, especially when it comes to fine-resolution elevation models and continuous hydrological data. Participatory data collection may also be limited by the potential resistance of the residents to share personal flood experiences. Although the framework will be Mokola-specific, its methodological approach would be flexible to other urban settings around the country of Nigeria and in the sub-Saharan world in general

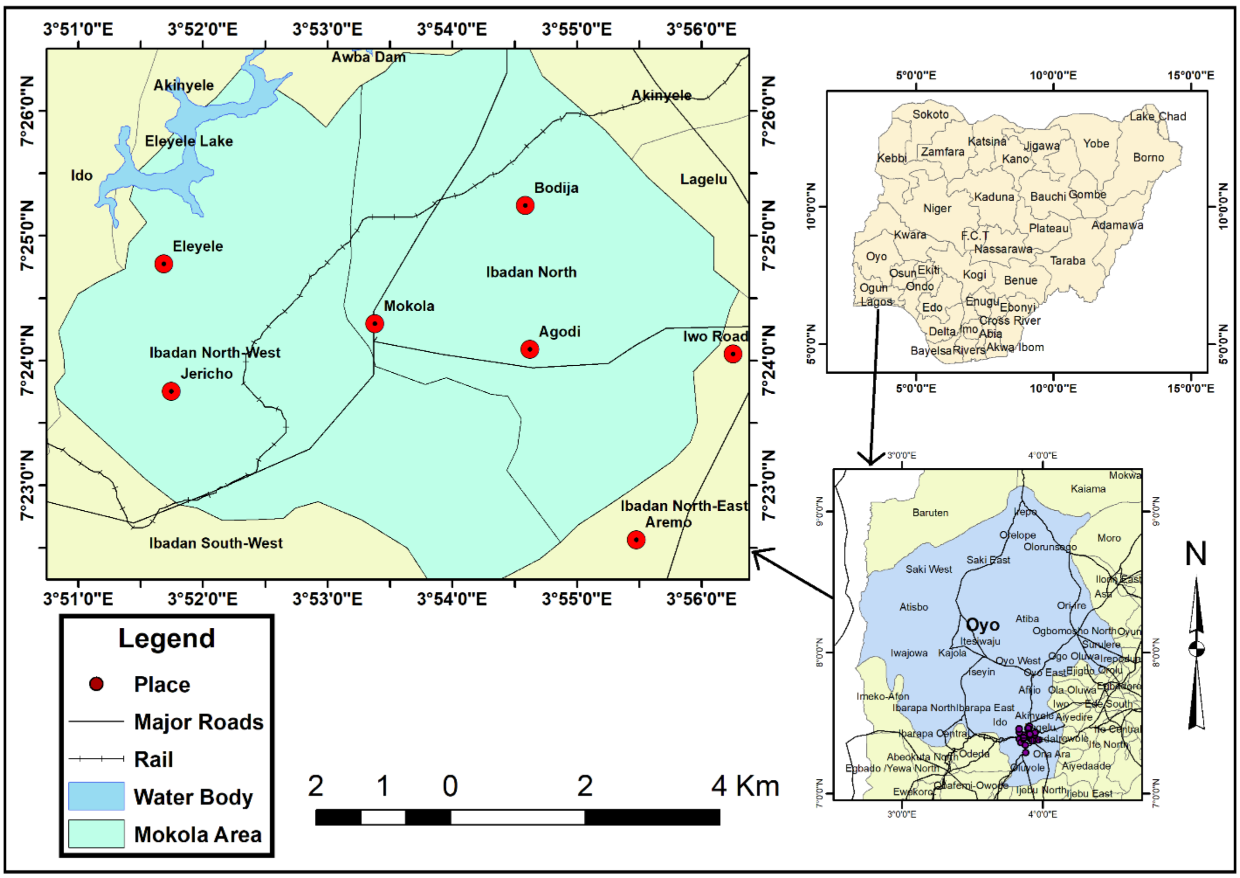

Figure 1. The Study Area (Source: Google Imagery Map, 2025)

Mokola is a high-density, mixed-use urban settlement. The land use is a complex matrix of residential buildings (ranging from colonial-era structures to modern apartments), commercial enterprises, and institutional facilities, including the Mokola Barracks and the dominating Mokola Flyover infrastructure. The high population density, estimated at over 18,500 residents for this study, exerts significant pressure on existing urban infrastructure. The unplanned expansion into setbacks and the lack of adequate setback enforcement have exacerbated flood risks, particularly in the lower elevation zones where low-income households are disproportionately located. The graphical illustration (Figure 2) presents the conceptual framework linking the research objectives to the ultimate goal of sustainable flood resilience.

The study focuses on Mokola, a prominent neighbourhood located in the Ibadan North Local Government Area of Oyo State, Nigeria. Geographically, Mokola is situated approximately between latitudes 7°24'N and 7°25'N and longitudes 3°53'E and 3°54'E. It serves as a major nodal point in the Ibadan metropolis, connecting the older, indigenous parts of the city. The climate of the study area falls under the Tropical Wet and Dry climate (Köppen classification Aw), characterized by distinct wet and dry seasons. The wet season typically spans from March to October, with a double rainfall maxima regime peaking in July and September. Annual rainfall averages between 1,200mm and 1,500mm. The intensity of these rainfall events, combined with the high percentage of impervious surfaces due to urbanization, acts as the primary driver of the pluvial flooding events recorded in the area. Topographically, Mokola is characterized by an undulating terrain, dominated by the "Mokola Hill," which serves as a watershed. The elevation ranges significantly, creating distinct hydraulic gradients.

Research Design

The research design used a cross-sectional approach based on mixed methods utilising quantitative surveys of flooding on both spatial and social dimensions of flooding in Mokola in Ibadan. This method was appropriate to evaluate the flood-prone regions and the response of communities to these disasters at a single time (Creswell & Creswell, 2023). The sample size was projected to contain about 18,500 residents consisting of household heads and business owners based on the stratified random sampling of upper, middle, and lower Mokola so that there would be equal representation.

Study Population

The population of study comprised approximately 18,500 residents of Mokola, Ibadan, Oyo State, Nigeria. The population included household heads, business owners, and women residing within the Upper, Middle, and Lower Mokola communities. The respondents were selected using stratified random sampling to ensure adequate representation of all flood-risk zones. These residents were considered appropriate because they had direct experience of recurrent flooding and were knowledgeable about local flood risks and adaptation practices. A sample size of 300 respondents was determined using the Taherdoost (2017) sample size formula for a finite population at a 95% confidence level and 5% margin of error. Although the calculated sample size was approximately 392 respondents, 300 respondents were selected because of time, financial, and logistical constraints. A sample of 300 is considered statistically adequate for a large population with descriptive statistics, multiple regression, and one-way ANOVA.

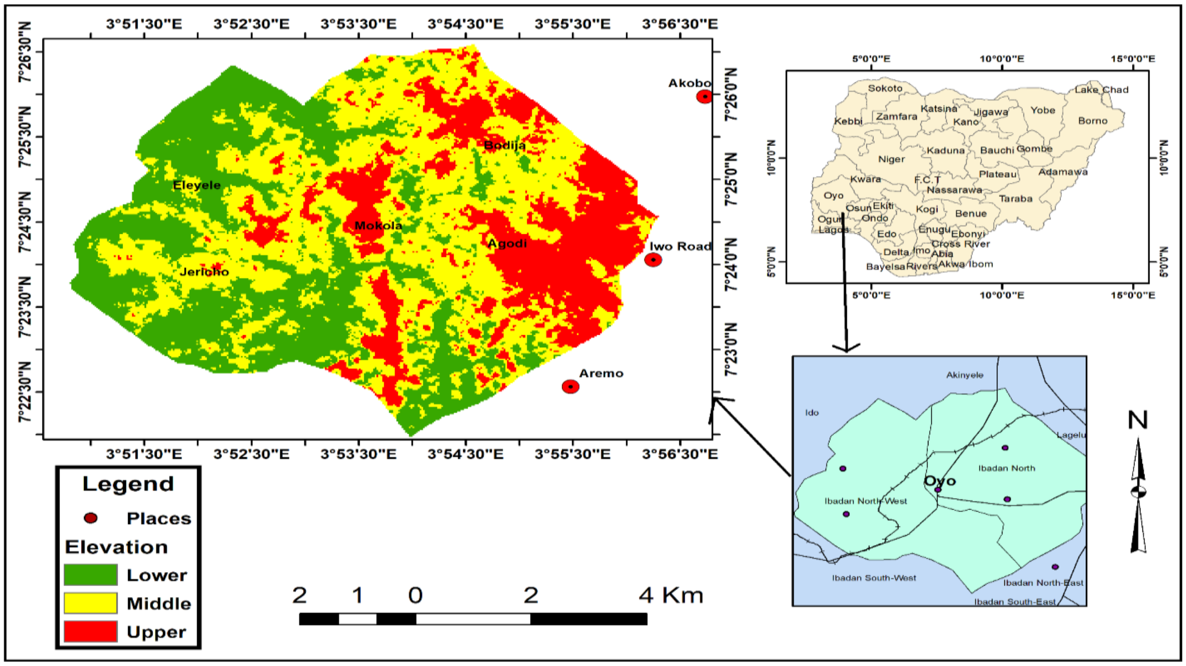

Figure 2. Spatial distribution and elevations

Data Sources and Data Collection

Primary data were gathered by use of a structured questionnaire on flood experiences and adaptation practices, where the residents indicated flood-prone areas on printed satellite images. The Nigerian Meteorological Agency, the Ibadan Urban Flood Management Project, and the United States Geological Survey were used to access secondary data such as rainfall records and satellite imagery (2015-2025). The statistical analysis of quantitative data was done with SPSS version 26 on descriptive statistics, regression, and ANOVA. The combined analysis has given a clear picture of the dangers of floods at the local level and informed the design of community-based adaptation plans (Bello et al., 2024; Bhanye, 2025).

4. RESULTS AND DISCUSSION

To study the community-based involvement in flood risk and adaptation strategies, multiple regression analysis was conducted. Three hundred (300) questionnaires were administered to Mokola, Ibadan residents. This was an appropriate approach that offered adequate coverage to the upper, middle, and lower sections of the community.

Table 1. Summary of respondents' characteristics (n = 300)

Variable	Category	Frequency	Percentage (%)
Gender	Male	192	64.0
	Female	108	36.0
Age	18–30 yrs	98	32.7
	31–50 yrs	163	54.3
	Above 50 yrs	39	13.0
Education	Primary/none	74	24.7
	Secondary	145	48.3
	Tertiary	81	27.0
Flood experience	Yes	291	97.0
	No	09	03.0
Adaptation practice adopted	Yes	276	92.0
	No	24	08.0

The descriptive findings depict that flood exposure is common in Mokola since 85 percent of the respondents had encountered flooding in the last five years. The moderate degree of adaptive behaviour is associated with the high percentage of residents who claimed to have performed at least one of the aforementioned adaptation measures, primarily the clearing of drainage, building elevation, and the establishment of runoff channels. The average score of flood awareness ($M = 4.12$, $SD = 0.61$) indicates that a majority of the residents are aware of the risks of floods, whereas the average score of adaptation readiness ($M = 3.86$, $SD = 0.72$) shows that most residents have a positive response capacity, although it is limited by income and infrastructure factors.

Table 2. Regression analysis of flood and adaptation practices

Predictor	β	t-value	Sig. (p)
Community mapping participation	0.41	7.84	0.000
Flood awareness	0.32	6.27	0.001
Household exposure	0.18	3.94	0.012
Constant	—	—	—

Model summary: $R^2 = 0.58$, $F (3, 338) = 71.6$, $p < 0.001$

The Regression model explains 58 percent of the variation in adaptation behaviour. The most significant positive influence was community involvement in flood mapping ($b = 0.41$, $p < 0.001$), then the flood awareness ($b = 0.32$, $p < 0.01$). This means that the residents of the areas that participate in defining areas at risk of flooding are more inclined to undertake structural or behavioural adaptations, which ensures the role that participatory mapping plays in terms of the information source and a motivational factor to resilience. The test to evaluate whether there were significant spatial differences in adaptation was a one-way ANOVA to identify whether there were significant differences in the responses of adaptation at the various elevations.

In addition, to test for the adaptation strategies by elevation zones in the Mokola area of Ibadan, Nigeria, the ANOVA table shows the following.

Table 3. ANOVA test on adaptation strategies by elevation zone

Source	SS	Df	MS	F	Sig.
Between groups	7.63	2	3.82	5.47	0.004
Within groups	235.48	339	0.69	---	---
Total	243.11	341	---	----	---

The ANOVA finding ($F = 5.47$, $p = 0.01$) shows that there is a significant difference in the adaptation practices in the three elevation zones. Lower Mokola residents who were at a greater risk were more active in the proactive actions of building embankments and maintaining drainage outlets.

The results indicate that the participatory flood risk mapping technique greatly improves the local adaptation capacity. This confirms the Vulnerability Theory, which suggests that the elimination of risk is not only based on exposure but also on social and mental abilities that influence adaptive behaviour. Mapping participation can make households more resilient by raising their level of knowledge and spatial awareness to make informed choices regarding protections. The findings also concur with the Social-Ecological Systems Theory, where interactions between humans and the environment induce resilience by means of feedback and learning. Community mapping provided a bridge between the lives of the residents and the environmental information, enhancing the social and ecological aspects of the system.

The findings of this study provide critical insights into the role of community engagement in urban flood resilience, directly addressing the three research objectives outlined earlier. Addressing the first objective on developing community-based flood risk maps, the study successfully integrated local spatial knowledge with institutional geospatial data to create high-resolution vulnerability maps. By allowing residents to identify micro-level hazards, such as specific blocked drains and informal runoff paths. The resulting maps offered a level of granularity that remote sensing alone could not achieve. This outcome aligns with the findings of Petersson et al. (2020) in Dar es Salaam, who demonstrated that participatory mapping is essential for comprehensive modelling in data-scarce environments. The integration of community knowledge bridged the gap between "official" risk assessments and the lived reality of Mokola residents, validating the hybrid approach as a more robust method for urban flood mapping.

Regarding the second objective on the spatial variation of adaptation strategies, the ANOVA results ($F = 5.47$, $p = 0.01$) confirmed that adaptation behaviour is not uniform but varies significantly across elevation zones. Residents in Lower Mokola, who face the most immediate physical risks, demonstrated a higher frequency of proactive structural adaptations, such as constructing embankments. In contrast, residents in Upper and Middle Mokola relied more on reactive or maintenance-based strategies. This spatial differentiation supports Bello et al. 2024), who posited that topography is a primary determinant of flood vulnerability and subsequent response in Nigerian coastal and inland cities. It implies that a "one-size-fits-all" policy is ineffective; instead, intervention strategies must be tailored to the specific risk profiles of each elevation zone.

In relation to the third objective on the impact of participation on awareness and behaviour, the regression analysis ($R^2 = 0.58$, $p < 0.001$) provided strong empirical evidence that involvement in the mapping process is a significant predictor of adaptive behaviour. The act of mapping itself served as an educational intervention, increasing residents' flood risk awareness and prompting them to take ownership of their safety. This finding corroborates Bhanye (2025) and the Social-Ecological Systems (SES) Theory, suggesting that participatory processes do more than just gather data—they build social capital and institutional memory. The strong correlation between participation and adaptation underscores that resilience is not merely a product of infrastructure, but of the social learning and empowerment that occurs when communities are actively involved in diagnosing their own risks.

5. CONCLUSION

This paper explored participatory mapping of community-based flood risk mapping and flood adaptation techniques in Mokola, Ibadan, to find out how participatory mapping affects local adaptation and the distribution of adaptation based on elevation areas. The findings indicated that the involvement of residents in mapping increased their level of awareness about the risks of floods and the implementation of prevention measures. Regression analysis proved that community participation was a strong predictor of adaptive behaviour, and ANOVA proved that there were spatial differences in the adaptation, with the Mokola residents portraying lower preparedness. These results confirm the Vulnerability and Social-Ecological Systems theories because participatory mapping improves knowledge and resilience in the sense that it connects the local experience to the spatial information.

The research finds that community-based flood risk mapping is not only a technical but also a behavioural tool that enhances the strength of adaptation by basic learning and decision-making on a local basis. It shifts flood management from a top-down paradigm to a hybrid approach that is based on local realities. This work recommends that community-based mapping should be implemented as a regular planning process by the flood management agencies. Local participation will enhance the accuracy of spatial data, generate awareness, and foster long-term adaptation practices. The response actions must be location-specific and the needs of lower Mokola area drainage rehabilitation and flood barriers, whereas the upper area should be concerned with runoff and waste management to minimize the effects downstream.

6. COMPETING INTEREST

None to declare

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