Vulnerability and Resilience of Urban Informal Sector to Climate-Induced Flooding: A Case Study of Makoko

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ABSTRACT

Urban informal sector play a significant role in the sustenance of livelihoods especially in rapidly growing cities, yet they are highly vulnerable to the impacts of climate change, especially climate-induced flooding. This paper examines the vulnerability and resilience of the informal economic players in Makoko. Makoko is a low-income coastal area in Lagos, Nigeria. The community is built on partially on stilts over the Lagos Lagoon, and this seen in the complex intersection of environmental exposure, informal urbanization, and socioeconomic precarity. The study uses a mixed-methods approach, which is the combination of field surveys, in-depth interviews and direct observation. The study identifies the major drivers of vulnerability, these includes inadequate infrastructure, poor housing conditions, and lack of formal disaster support mechanisms. Despite these challenges, the paper provides localised resiliencies strategies like elevated housing designs, the use of canoes for mobility, strong social networks, and community-based adaptation practices. The findings shows that there is need for inclusive climate adaptation planning that sees the importance of and supports adaptive capacities of informal communities. It is important that to ensure long-term sustainability of such vulnerable urban sectors there is need to strengthen institutional engagement, improving infrastructure, and integrating local knowledge into urban resilience strategies.

KEYWORDS: Adaptation, Climate change, Flooding,Informal sectors, Vulnerability

INTRODUCTION

Urban informal settlements are a vital part of the livelihood system of fast developing cities, especially in the Global South. These settlements serve as spaces for economic productivity, socialization, and cultural identity, particularly in the case of low-income earners who rely on informal jobs to survive (Chen, 2014; ILO, 2018). In Nigeria, the informal sector plays an important role in job creation and the local economy, with over half of urban livelihoods in Lagos being comprised of the informal sector (Onwo andOhazulike, 2021). Although vital, these urban informal sectors are disproportionately vulnerablewhen it comes to the effects of climate change particularly climate-driven flooding that threatenshousing stability, income security, mobility, and health outcomes (Adelekan, 2016; IPCC, 2022).

Due to increasing rainfall intensity, rising sea levels, rising tidal levels, and reduced drainage capacity, flooding remains one of the most pervasive climatic problems in coastal Africa (Aderogba, 2012; IPCC, 2022). In Lagos, where the population growthintensified pressure on land, many low-income groups become displaced into ecologically vulnerable waterfronts, floodplains, and wetlands (Somorija, 2025). Makoko, a historiccoastal informal settlement, which is partly constructed on stilts above Lagos Lagoon is a classic example of this trend. Its settlement structure is known to be a complicated interface of informal housing construction, socioeconomic precarity, weak institutional presence, and limited infrastructural development (Lawanson et al., 2022).

Flooding in Makoko due to climate changes is gradually impacting informal economic actors whose economic activities rely on physical engagement with the lagoon environment; fishing, petty trading, boat transportation, and artisanal services. The occurrence of flooding destroys work tools, disrupt mobility, reduce working hours, destruction of goods, and loss of income. More importantly, informal workers do not have insurance, formal

social protection, or disaster-response systems, which exposes them to climate shocks to a large extent (Satterthwaite et al., 2020; UN-Habitat, 2021).

In spite of these weaknesses, communities like Makoko are also characterized by strong internal resilience capacities. They are expressed in locally-made architectural designs like high stilted house type, use of canoes to commute, community-based early warning mechanisms, and close social networks that support recovery upon occurrence of floods (Jouannic et al., 2024Douglas). These adaptive methods underscore the ability of informal communities to creatively restructure and innovate under the threat of climate even without being involved in formal planning frameworks.

This paper hence discusses the susceptibility and the resilience of informal economic participants in Makoko to floods caused by climatic conditions. Particularly, the paper will seek to:

1. Determine the significant sources of vulnerability among informal employees.
2. Explore the resilience mechanisms and coping mechanisms developed witihin the community.
3. Provide policy recommendations on inclusive climate adaptation that should consider the realities of informal settlements.

This study is significant because it has added to the emerging literature on climate justice, city-resilience, and inclusive planning in African coastal cities. The responses of informal communities to climate-related flooding and the ways in which they experience it are crucial to creating the framework of adaptation strategy that would incorporate local knowledge base, decrease vulnerability, and ensure long-term sustainability (Ayers and Forsyth, 2009; UN-Habitat, 2021).

LITERATURE REVIEW

2.1 The Urban Informal Sector

Scholars have newly expressed interest in the urban informal sector since it is now the core of the socioeconomic activity of cities in the Global South. It is broadly defined as economic activities that do not involve any formal regulatory system and have low entry barriers, are flexible in nature, and do not have formal social protection (ILO, 2018). Survival is not the only need in informal employment in most African cities, but adominant mode of economic activity in cities. According to Chen (2014), informal economy services are important, and absorb labor that cannot be accommodated in the formal sector because of limited job opportunities and structural constraintsin the economy. The informal sector makes up a considerable percentage of the laborforce in Nigeria and particularly in Lagos, ranging from street trading and transportation to artisans and small-scale manufacturing. Lawanson and Olanrewaju (2021) claim that the industry is the core of economic resilience of the city as it provides the basis of livelihood continuity in an environment characterized by a high rate of population growth, economic disparities, and minimal formal employment. The informal sector is still marginalized systematically, despite being an important sector. Occupational hazards, unstable income, poor working conditions, and lack of institutional safety nets are common to workers. Sverdliket al. (2024) further elaborate that these vulnerabilities are further compounded by environmental risks since informal operators are usually involved in economic operations within inadequate infrastructures or in ecologically fragile spaceswhere the risk of climate-related disasters are high. Thus, the exposure to socioeconomic insecurity, coupled with environmental risks, forms a distinctive combination in informal workers in settlements like Makoko, so climate impact is especially devastating.

2.2 Climate-Induced Flooding in African Coastal Cities

Coastal flooding, which is one of the major environmental challenges in Africa, is as a result of climate. According to the Intergovernmental Panel on Climate Change (IPCC, 2022), all factors, including rising sea levels, increasing rainfall intensity, storm surges, and tidal fluctuations, are all expected to escalate, especially in low-lying coastal areas. The rapid urbanization in African metropolises has further led to increased settlement growth within terains that are prone to environmental hazards, such as wetlands, coastal fringes, and reclaimed lands. Kasim et al. (2021) emphasize that the lack of control in urban expansion, coupled with

inadequate drainage systems and weak environmental governance have contributed to the increase in frequency and severity of floods in urban cities such as Lagos, Accra, and Dar es Salaam. Flooding is a common occurrence in Lagos and it is caused by a combination of climatic, infrastructural, and anthropogenic factors. According to Adelekan(2016), heavy rainfall, lack of proper drainage maintenance, rising sea level, and land subsidence are some of the leading causes of frequent floods. These impacts are disproportionately experienced in informal settlements in marginal areas or low lands due to affordability. As Aderogba (2012) asserts, the concentration of vulnerable populations in flood-prone areas creates a cycle in which environmental hazards exacerbate poverty, while poverty in turn restricts access to safer, more resilient housing. In the case of waterfront communities like Makoko, they are further augmented by close reliance on tidal water and lack of automated flood control infrastructure.

2.3 Vulnerability in Informal Settlements

Exposure to the environment, socioeconomic deprivation and institutional neglect interact to contribute to vulnerability in informal settlements which is a profoundly structural phenomenon. The Pressure and Release model by Wisner et al. (2004) conceptualize vulnerability as a product of root causes, dynamic pressures, and unsafe conditions that puts individuals and communities at increased risk. Poor housing structures, overcrowding, tenure insecurity, lack of accessibility to basic services and poverty are all predisposing factors in informal settlements. Satterthwaite et al. (2020) claim that informal residents are frequently confined in conditions where the lack of social and infrastructural resources enhances the impact of even small-scale climatic events. This vulnerability landscape is especially severe in coastal communities. Olajide and Lawanson (2019) indicate that houses constructed on stilts in Makoko are vulnerable to erosion, tidal fluctuations, high wind, flooding caused by rainfall, and erosion. The settlement's informality manifested in its lack of official recognition, which restricts access to government infrastructure investment and interventions in case of disasters. The housing materials used by residents are usually makeshifts, which cannot withstand severe weather events. The socioeconomic aspects of irregular incomes, low savings, and lack of insurance make vulnerability worse as it inhibits shock-absorbing and loss-recovery capacities. O'Mahony and Roark (2023) also emphasizes that exclusion fromland rights and inadequate legal protection only increases insecurity of the residents, and they have to rely on self-help measures.

2.4 Urban Resilience and Community-Based Adaptation

The concept of urban resilience has assumed a leading role in the modern discourse of climate governance, especially concerning vulnerable urban populations. According to Meerow et al. (2016), urban resilience refers to the capacity of urban systems, individuals, and communities to survive, adapt and transform when urban environments experience climatic and non-climatic stress factors. Resilience is a common feature of informal settlements, though it often arises spontaneously, through the actions of the community based on its historical context, social structures, and traditional knowledge. Douglasman and Mitlin (2021) observe that informal residents tend to create their resilience that offsets institutional failures and helps them to survive and reconfigure after a series of environmental shocks. The Community-Based Adaptation (CBA) can provide an effective framework of interpreting such responses developed locally. According to Ayers and Forsyth (2009), CBA focuses on participation, local knowledge and community ownership when developing adaptive strategies, which captures specific environmental and social contexts. Most informal coastal settlements have developed traditional building techniques, seasonal mobility strategies, communal savings clubs, and informal early warning measures serveas foundational adaptation mechanisms. CBA dynamics are represented by stilt housing, transport via canoes, mutual aid networks, and shared maintenance of wooden walkways are found in Makoko. These measures indicate a sort of resilience that has been highly engrained into the socio-cultural system of the community, but are still inadequate when facing more drastic climatic risks without complementary institutional support.

2.5 Empirical Studies on Waterfront Informal Settlements

Empirical research on informal settlements in waterfront gives invaluable understanding of their unique vulnerability and adaptive behaviors. Adelekan (2016) demonstrates that water-based communities in Lagos have been exposed to acute environmental risks because of their vulnerability to coastal hazards as well as lack

of inclusion in urban planning activities. Researches of other settlements in other cities like Accra and Dar es Salaem indicate high exposure to coastal erosion, tidal floods and degradation of infrastructures (Douglas et al., 2008). These hazards are exacerbated by informality of construction means, low diversification of livelihoods, and unavailability of disaster-response systems provided by the government. Olajide and Lawanson (2019) note that the social economic system of Makoko is based on fishing and boat transport, petty trade, and artisanal crafts, resulting in extreme reliance on lagoon resources, which renders the population of the settlement unusually vulnerable to ecological changes. According to Wizor, C andEmerueh(2020), the inability to invest in better housing or infrastructure adjustment is underpinned by governmental neglect and threats of eviction every now and then. These empirical views indicate that the waterfront settlers have special adaptive knowledge, which is constrained by structural factors that restrict their resilience and tend to entangle them in vulnerable cycles.

2.6 Sustainable Livelihoods Framework (SLF)

Sustainable Livelihoods Framework (SLF) was originally designed by Chambers and Conway (1992) and further expanded by DFID, provides a comprehensive perspective in which one may analyze the interactions of vulnerability, assets, institutions and livelihood strategies. According to the framework, livelihood outcomes are determined by access to five major capitals namely; human, natural, financial, physical, and social capital, and mobilization of these assets in response to external stresses and shocks. The SLF comes in handy especially in undersatnding livelihoods in informal urban settlements because it emphasizes how people navigate complex environments using both tangible and intangible resources.

In the context of Makoko, fishing skills, construction craftsmanship, and mobility knowledge represent human capital. The lagoon ecosystem is connected to natural capital, which provides both livelihood opportunities and environmental risks. The adaptive innovations influenced by local knowledge are manifested in physical capital, e.g. stilt housing and canoes. The social capital takes the form of close communal networks as well as informal associations that offer support during times of crisis. There is a lack of financial capital, and this leads to economic fragility. With the context of climate-related flooding placed in the context of vulnerability of the SLF, this paper can examine how environmental threats upset livelihoods and how informal workers leverage their resources to develop resilience despite structural limitations.

STUDY AREA: MAKOKO

Makoko is the largest informal settlement in Lagos, Nigeria, which is situated along the Lagos Lagoon. Its stilt houses and water-based livingmake it often be referred to as the “Venice of Africa”, where it is estimated that there are 85,000-150,000 inhabitants, although the exact numbers are unknown because of its unofficial status (Gilbert & Shi, 2023). It has a land-based settlement and a water-based one constructed on wooden stilts and reached primarily by canoes (Olajide & Lawanson, 2019). The population is dependent on low-income informal livelihoods such as, fishing, canoe transport, petty trading, artisans, which help keep the household alive as well as the informal economy of Lagos in general (Adelekan, 2016). These are however jobs that are characterized by income insecurity and access to formal financial services. Overall, Makoko is very vulnerable to flooding as a result of heavy rainfalls, storm surges, and increased lagoon levels, which is worsened by climate change and the sea-level rise (IPCC, 2022). Exposure is aggravated by poor infrastructure and lack of formal systems of flood-control. The Lagos State Government does not formally recognize Makoko’s land claims, viewing the settlement as illegal. This has led to eviction and limited provision of infrastructure, services, or disaster support (Amnesty International, 2014). Consequently, community leaders and local networks have taken over the governance and administration of the environment. Despite these challenges, Makoko has strong social cohesion. The Egun, Ilaje and Yoruba ethnic groups maintain lagoon-based livelihoods and depend on community support networks and informal savings groups (Dodman and Mitlin, 2021). The settlement is therefore an indication of a combination of environmental exposure, informality of the economy, cultural strength and institutional weakness, and is therefore of much importance in the study of floods due to climate changes in informal cities.

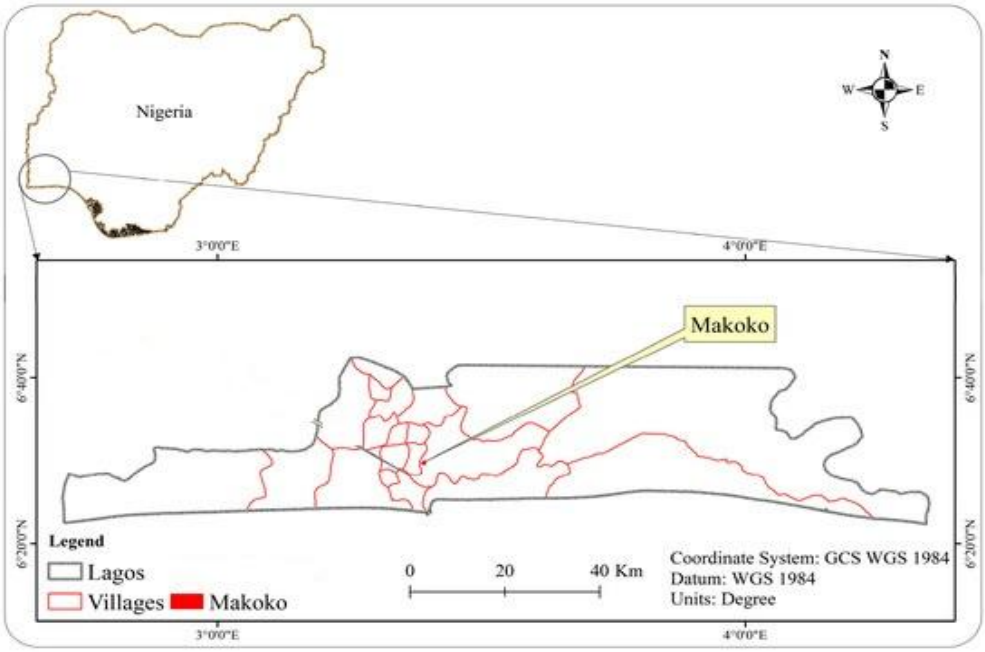

Figure 1: Map of Lagos showing Makoko

METHODOLOGY AND ANALYSIS

The research design of this study was strictly quantitative research design to measure the vulnerability and the resilience of informal economic actors within Makoko to climate-induced flooding. The method enabled systematic quantification of exposure, livelihood effects, infrastructural shortfalls and coping strategies, generating empirical vulnerability and resiliency patterns (Creswell, 2014). The data was gathered using a structured, pretested questionnaire that included demographics, and housing, exposure to floods, severity of the impact, livelihood disruption, infrastructure, challenges, institutional support, and resilience measures. The population was informal workers in land and water-based areas of Makoko, including fishermen, traders, canoe operators and artisans. There were differences between the zones which were captured by stratified sampling technique. Households were randomly sampled in each stratum and one of the adult informal workers at household randomly selected. The sample size was reasonable due to proportional and statistically valid representation. Face-to-face interviews conducted by trained local assistants improved accuracy and comprehension. Data was then coded and analyzed with SPSS where descriptive statistics were used to summarize the characteristics of the respondents and patterns of vulnerability (frequencies and percentages). Ethics were followed: the participation was voluntary, the respondents were not only informed about their rights, but also confidentiality was ensured, no identifying information was gathered (Bryman, 2016).

3.1 Demographic Characteristics of Respondents

The demographic profile showed that economically active adults (25-44 years) are predominant in the informal economic activities in Makoko. Males were a little bit more represented and this was because they were dominant in highly mobile and intensive livelihood activities that required physical effort like fishing and canoe transportation. The respondents were highly vulnerable economically with a large percentage of low education and majority of them having monthly incomes lower than N60,000.

Table 1 Demographic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	118	59.0
	Female	82	41.0
Age	18–24	24	12.0

	25–34	76	38.0
	35–44	68	34.0
	45–54	26	13.0
Education	No schooling	38	19.0
	Primary	64	32.0
	Secondary	78	39.0
Monthly Income	<₦30,000	72	36.0
	₦30–60k	84	42.0
	₦61–90k	30	15.0
Residence	Water-based	110	55.0
	Land-based	90	45.0

Source: Field Survey, 2025

3.2 Exposure to Flooding

A large proportion of those surveyed reported frequent flooding with over fifty percent experiencing flooding more than thrice a year. The water-based section had the highest levels of severity because of tidal variations. The dominant cause of flooding was heavy rainfall compounded by inadequate drainage.

Table 2 Flood Exposure Patterns

Variable	**Category**	**Frequency**	**Percentage (%)**
Flood frequency	1 time	18	9.0
	2–3 times	62	31.0
	4–5 times	70	35.0
	> 5 times	50	25.0
Severity	Low	14	7.0
	Moderate	80	40.0
	High	106	53.0
Main cause	Rainfall	94	47.0
	Tidal rise	64	32.0
	Blocked drainage	42	21.0

Source: Field Survey, 2025

3.3 Housing and Infrastructure Conditions

The Makoko housing structures are highly vulnerable. More than half of the respondents resided in wooden stilt houses and only a small proportion of the respondents had access to functional drainageinfrastructure. Often, walkways and access routes would become inaccessible due to flooding.

Table 3 Housing and Infrastructure

Indicator	Category	Frequency	**Percentage (%)**
Building material	Wood	112	56.0

	Concrete	46	23.0
	Mixed	42	21.0
House elevation	Not elevated	68	34.0
	Slightly elevated	66	33.0
	Highly elevated	66	33.0
Functional drainage	Yes	38	19.0
	No	162	81.0
Road condition in floods	Passable	22	11.0
	Difficult	64	32.0
	Impassable	114	57.0

Source: Field Survey, 2025

3.4 Impact of Flooding on Livelihoods

There were significant economic consequences of flooding. Most of them reported a decrease in working hours and mobility, as well as income loss. Damage to work toolswas also especially widespread among fishing families.

Table 4 Livelihood Impacts

Indicator	Category	Frequency	Percentage (%)
Flood reduces ability to work	Agree	136	68.0
	Strongly agree	40	20.0
Income loss frequency	Never	10	5.0
	Sometimes	68	34.0
	Often	78	39.0
	Always	44	22.0
Damage to tools	Yes	122	61.0
Flood increases household expenses	Agree	142	71.0

Source: Field Survey, 2025

3.5 Access to Institutional Support

Institutional support levels were critically low. There was reported near absence of government aid or financial services in the time of floods.

Table 5 Institutional Support

Indicator	Category	Frequency	Percentage (%)
Received government assistance	Yes	12	6.0
	No	188	94.0
Access to credit	Yes	38	19.0
	No	162	81.0

Access to emergency relief	Yes	8	4.0
	No	192	96.0

Source: Field Survey, 2025

3.6 Resilience and Coping Mechanisms

The adaptation techniques of residents to this disaster include elevating houses, using canoes, and mobilizingsocial support networks, which are primarily based on self-help. Formal adaptation mechanisms were still largely absent.

Table 6 Coping/Resilience Indicators

Indicator	Category	Frequency	Percentage (%)
Elevated their homes	Yes	102	51.0
Use canoe in floods	Yes	150	75.0
Receive social support	Yes	134	67.0
Self-rated resilience	Low	44	22.0
	Moderate	96	48.0
	High	60	30.0

Source: Field Survey, 2025

DISCUSSION OF FINDINGS

The findings of this study demonstrate that in Makoko, informal economic actors have multi-layered pattern of vulnerability and resilience due to exposure to the environment, socioeconomic deprivation, and weak institutional support. The results indicate how flooding caused by climate intersects with structural inequalities to create both short-term and long-term livelihood problems. In line with the existing literature, informal settlements become vulnerable to cumulative failures of environmental, economic, and governance systems (Adelekan, 2016; Satterthwaite et al., 2020). According to the demographic profile, the most vulnerable group to climate risks are young and middle-aged adults who are engaged in informal work, which aligns with the results of Chen (2014), who demonstrated the insecure nature of informal work. The education level of the respondents is low because they follow trends of other African informal settlements where low education means less livelihood diversification, thus lower adaptive capacity (Meagher, 2010). The large proportion of low-income earners justifies the claims that poverty increases climate sensitivity due to limitation in resilient housing and protective investments (Olajide and Lawanson, 2019). Exposure to floods is high and majority of the respondents indicated that they were flooded every year. This indicates that Lagos is overall vulnerable to tidal waves, heavy rain, and poor drainage (Aderogba, 2012; Adelekan, 2016). Spatial variations of exposure especially in the water based area highlights that location exacerbates risk, in line with Douglas et al. (2008). The focus of the respondents on heavy rains and high tide is consistent with climate projections of increasing rainfall intensity and rising sea level along the coast of the West Africa region (IPCC, 2022). One of the greatest predictors of vulnerability was housing and infrastructural conditions. Most of the respondents stay in wooden structures that are not properly elevated, which validates the sustainable livelihoods approach that physical capital is the main focus of resilience (Chambers and Conway, 1992). Weak or absent drainage systems also increase the effect of floods and mobility challenges, which supports the argument of Satterthwaite et al., (2020) that the lack of infrastructures increases climate risks. Livelihood impacts were severe: mass loss of income, reduced ability to work, destruction of equipment, and increased household expenses. These patterns are reminiscent of research indicating that informal workers especially fishermen and canoe operators are extremely vulnerable to environmental interference (Lawanson and Olanrewaju, 2021; Adelekan, 2016). There was little institutional backing, which is in line with the reported laxity of governance in Makoko (Gilbert & Shi 2023; UN-Habitat, 2021). People depend rather on self-help mechanisms and social

networks and this demonstrates high levels of social resilience (Ayers and Forsyth, 2009; Dodman and Mitlin, 2021). However, low self-rated resilience indicates that such measures are not adequate as the severity of floods is growing. In general, vulnerability in Makoko is structurally entrenched but negotiated on a daily basis through local coping strategies. However, unless there is better infrastructure, durable-housing, livelihood-provisions and inclusive climate-regulation, the efforts of the communities cannot resolve the growing risks of the climate.

CONCLUSION

This paper has explored the resilience and vulnerability of Makoko's informal economic actors to flooding caused by climate change in a quantitative manner. Results indicate that the residents are highly affected by frequent flooding caused by heavy rainfalls, tides, poor drainage, and poor housing structures. These environmental hazards intersect with low income, education, and reliance on livelihoods based on climatic conditions, which leads to significant livelihood disturbance and material losses. Makoko's residents do not give up in face of these challenges, as elevated housing, canoe-powered transport, and strong social networks are the indicators of indigenous knowledge and community support. Nevertheless, these actions are mostly reactive and insufficient considering intensifying climatic pressures and lack of institutional support or infrastructural investment. The research concludes that vulnerability reduction takes concerted efforts that entail improved infrastructure, funding, governmental participation, and adaptation at the community level. The identification of informal settlements in climate governance is crucial towards fair and sustainable resilience in the city. Future studies ought to consider hybrid adaptation models which combine local knowledge with formal planning.

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