

Urban morphology, Infrastructure deficit, Climate resilience and Household vulnerability Ibadan, Nigeria

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ABSTRACT

Rapid, unguided urbanization and accelerating climate risks across Sub-Saharan Africa present severe governance challenges, particularly within high-density, low-income urban cores. This study examined the relationships between spatial morphology, municipal infrastructure deficits, social capital, and household climate resilience in Ibadan Metropolis, Nigeria. Utilizing an integrated theoretical framework synthesizing Urban Political Ecology, the Asset Vulnerability Framework, and Protection Motivation Theory, a multi-stage stratified random sampling technique was deployed to administer 800 structured household questionnaires across five inner-core Local Government Areas (Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East, and Ibadan South-West) stratified by low-, medium-, and high-density residential zones. Empirical analyses utilizing Pearson's chi-square tests (χ^2), Levene's test, and independent-samples t-tests revealed significant socio-demographic and economic stratification along density gradients ($p < 0.001$), with severe human capital, financial, and housing security deficits concentrated within high-density inner-core zones. A severe municipal failure was identified, as 49.4% of households rated drainage infrastructure as poor, 63.3% reported rare public maintenance, and 86.3% evaluated major macro-engineering initiatives such as the Ibadan Urban Flood Management Project (IUFMP) as ineffective or marginally effective due to the neglect and breakdown of localized tertiary drainage

channels. Furthermore, social capital proved insufficient to offset physical infrastructure failure: no statistically significant association was found between community association membership and self-help environmental project participation ($\chi^2 = 0.124$, $p = .725$), and mean Climate Resilience Index (CRI) scores did not differ significantly between association members ($\mu = 0.412$) and non-members ($\mu = 0.405$; $t(798) = 0.694$, $p = 0.488$). High building material costs (100%) and lack of municipal support (65.8%) represented universal adaptation constraints across spatial locations. The study concludes that community self-reliance cannot compensate for structural institutional neglect, emphasizing the urgent need for localized tertiary drainage engineering, routine municipal maintenance, and targeted asset-building interventions in high-density urban residential zones.

Keywords: Urban Morphology, Infrastructure Deficits, Household Climate Resilience, Asset Vulnerability, Urban Political Ecology, Ibadan Metropolis.

1. Introduction

Sub-Saharan Africa is experiencing a large-scale urban transition, characterized by rapid geographic expansion, spatial sprawl, and the progressive concentration of socio-economic activities within urban centers (UN-Habitat, 2024). However, this urbanization process is largely unguided and decoupled from corresponding investments in basic infrastructure, social services, and physical planning controls

(Bettencourt & Marchio, 2025; Allarane *et al.*, 2023). Consequently, cities across the sub-continent are defined by expanding informal settlements, high built environment densities, severe municipal service deficits, and heightened exposure to climate-induced environmental hazards (UN-Habitat, 2024; Bettencourt & Marchio, 2025; Allarane *et al.*, 2023). Climate change acts as a risk multiplier in these urban contexts, intensifying the frequency and severity of extreme weather events such as intense precipitation, flash flooding, heat waves, and prolonged dry spells (U.S. Environmental Protection Agency, 2020). Urban populations in developing regions are particularly vulnerable to these climate stressors due to low economic buffers, fragile housing structures, and widespread infrastructural decay (Moser, 1998). The intersection of rapid urban growth and accelerating climate risks presents a critical challenge for urban governance, requiring empirical investigation into how spatial structures and socio-economic inequalities shape household-level vulnerability and adaptive capacity. Ibadan Metropolis, located in southwestern Nigeria, exemplifies the structural and spatial complexities of rapidly expanding Sub-Saharan cities (Taiwo, 2022). As one of the largest indigenous urban centers in Black Africa, Ibadan features a distinct spatial morphology marked by strong historical and density gradients. The metropolis comprises a traditional, highly congested inner-core zone surrounded by intermediate transition belts and sprawling peripheral expansions. The inner-core areas encompassing historical local government areas such as Ibadan North-East, Ibadan South-East, Ibadan South-West, Ibadan North-West, and Ibadan North are characterized by extremely high building density, substandard housing quality, high rates of poverty, and deteriorating physical infrastructure (Adewale *et al.*, 2019). Economic activities in these central zones are overwhelmingly informal, with residents relying heavily on daily-wage labor, small-scale artisan enterprise, and petty trading (Ogunrinola & Ogunrinola, 2017). This socio-spatial arrangement creates sharp vulnerability differentials, where the highest concentrations of urban poverty coincide with areas most exposed to seasonal flood risks, poor drainage, and municipal maintenance neglect (Salami *et al.*, 2017).

2. Statement of Problem

Despite major public sector investments in metropolitan flood mitigation most notably the World Bank-assisted Ibadan Urban Flood Management Project

(IUFMP) localized flooding and urban environmental hazards persist across the city's inner-core neighbourhoods (Egbinola *et al.*, 2017). A fundamental driver of this persistent vulnerability is the systemic breakdown and spatial unevenness of municipal physical infrastructure. Secondary gutters and tertiary drainage channels in high-density residential areas are frequently dilapidated, under-sized, or entirely absent (Egbinola *et al.*, 2017). Furthermore, where drainage infrastructure exists, routine municipal maintenance and municipal solid waste management services are virtually non-existent (Mustapha & Ogunbode, 2025). As a result, drainage networks become clogged with solid waste and sediment, causing seasonal storm runoff to overflow directly into residential structures (Mustapha & Ogunbode, 2025). Because financial and human resources are unequally distributed across urban space, low-income households in high-density zones lack the private capital required to construct flood barriers, raise building thresholds, or recover from recurring property damage (Moser, 1998). This creates a self-reinforcing cycle of socio-spatial vulnerability. Faced with municipal service failures, policy interventions and scholarly literature frequently emphasize the role of community self-reliance, civic organizations, and social capital as alternative mechanisms for building urban climate resilience (Ekoh & Teron, 2023; Opoku-Boateng *et al.*, 2024). Landlord and Resident Associations dominate Nigerian cities and are often assumed to mobilize local resources for collective environmental action, such as drain clearing and infrastructure repair (Ekoh & Teron, 2023). However, a significant empirical gap exists regarding whether community social capital can meaningfully compensate for structural physical deficits and institutional neglect. It remains unclear whether active participation in neighbourhood associations translates into tangible household-level climate resilience or whether severe financial, technical, and institutional constraints render social networks ineffective in the face of macro-environmental hazards (Rogers, 1975). Investigating this disconnect is essential to prevent over-reliance on community self-help policies that may inadvertently misplace the burden of public infrastructure delivery onto marginalized populations.

3. Theoretical Foundation

Moser's (1998) Asset Vulnerability conceptualizes vulnerability as shaped not only by exposure to

hazards but also by household asset portfolios and capacity to manage risk. The theory identifies financial, human, physical, social, and natural capital, encompassing income and savings; education and skills; housing, land, and infrastructure; social networks and organizational participation; and access to environmental resources. Households with diversified assets are better positioned to invest in adaptation and recover from hazards, whereas asset-poor households face compounded vulnerability as losses in one asset can undermine others, such as income and health (Moser, 1998; Salami *et al.*, 2017; Sadiq *et al.*, 2024). This framework therefore supports analysis of how socio-demographic differences across residential density zones shape adaptive capacity in Ibadan. Urban Political Ecology (UPE)

further explains how urban environmental conditions are produced through political, economic, and institutional processes rather than occurring naturally. It shows how decisions concerning drainage, waste management, flood protection, and infrastructure allocation can reproduce spatial inequalities (Swyngedouw & Heynen, 2003; Akanle *et al.*, 2015). UPE is therefore useful for assessing why large-scale interventions such as the IUFMP may not adequately address inner-core neighbourhood vulnerabilities. Protection Motivation Theory (PMT) explains how perceived threat and coping appraisal influence protective behaviour. While threat appraisal reflects perceived severity and vulnerability, coping appraisal concerns response efficacy, self-efficacy, and response costs (Rogers, 1975; Tasantab

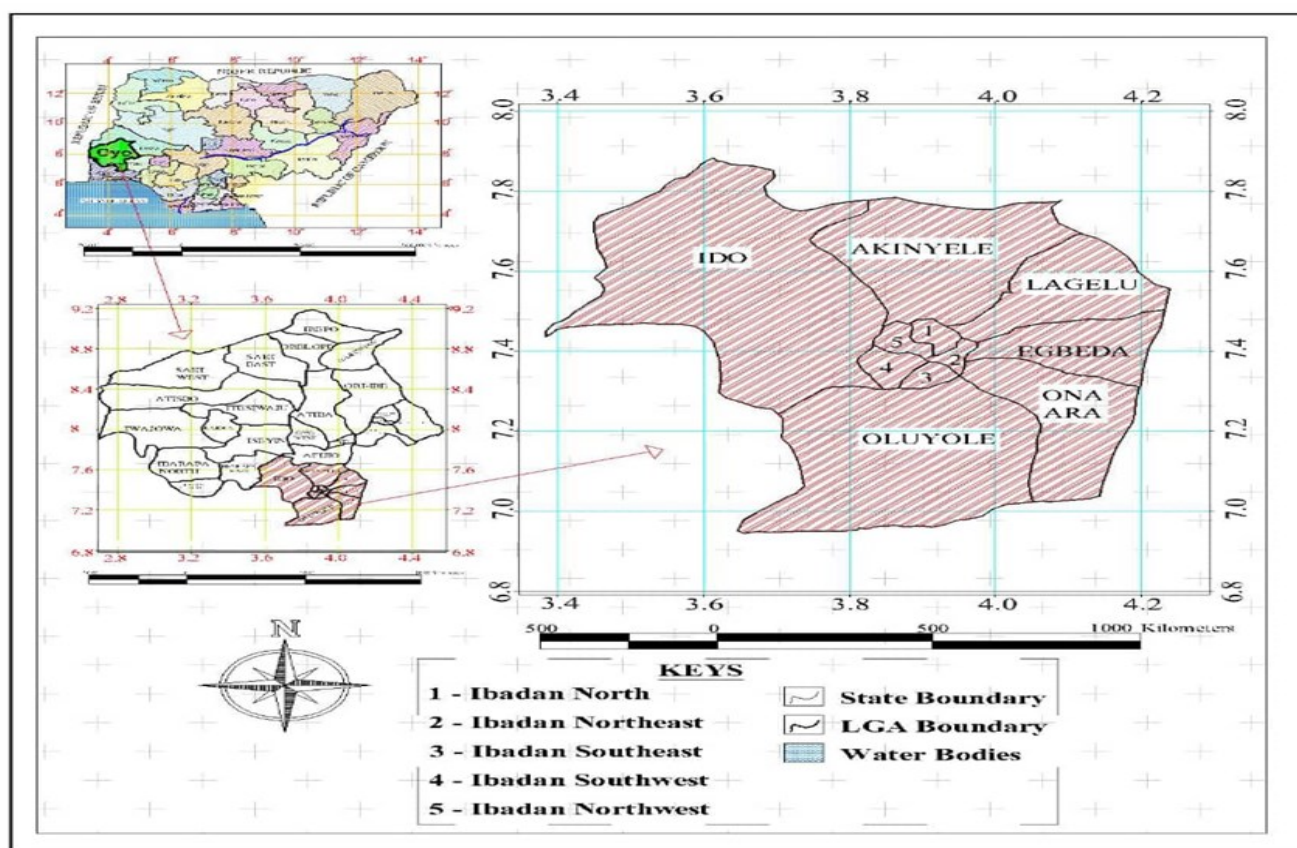


Figure 1: Location of the Study area and the Five Urban Local Government Areas of Ibadan Metropolis

Source: Oyo State Ministry of Land, Housing and Urban Development

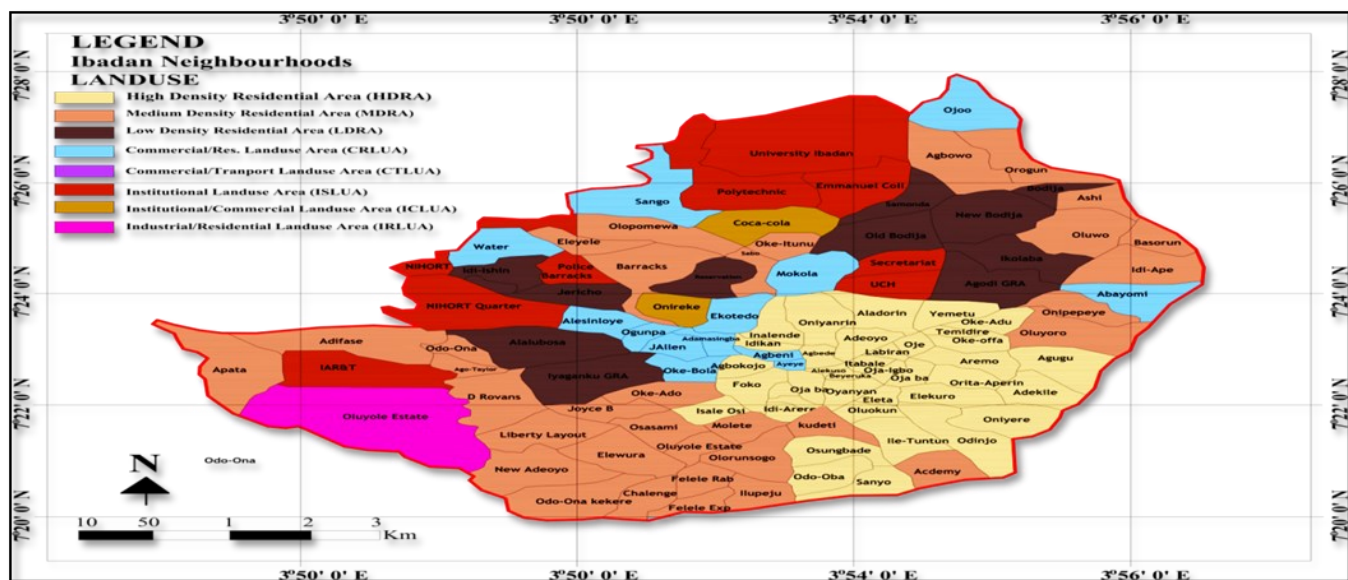


Figure 2: Neighbourhoods within the Five Urban Local Government Areas in Ibadan Metropolis
Source: Oyo State Ministry of Land, Housing and Urban Development

et al., 2022). PMT helps explain why high climate-risk awareness may not translate into adaptation when financial constraints, insecure tenure, or limited self-efficacy suppress coping capacity.

4. The Study Area

The study was conducted within the traditional inner-core and transitional metropolitan boundary of Ibadan, the capital city of Oyo State, Nigeria, located approximately between Latitudes 7°20'N and 7°28'N, and Longitudes 3°50'E and 4°00'E, (See Figure 1) with the focus placed on five primary Local Government Areas (LGAs) that constitute the historical core of the metropolis: Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East, and Ibadan South-West. These LGAs encompass the oldest, most densely built residential districts of the city (Ayeye, Agbeni, Mapo, Oje, Bere, Molete, and Beere), characterized by organic spatial layouts, high building site coverage, narrow unpaved access roads, and natural drainage basins vulnerable to severe flooding, such as the Kudeti and Ogunpa river catchments (Adewale *et al.*, 2019; Salami *et al.*, 2017). To evaluate spatial differentials in vulnerability, the study area was stratified into three distinct residential density zones (See Figure 2) based on urban planning parameters building spac-

ing, plot coverage, and structural layout: a high-density zone, characterized by traditional family compounds, informal infill development, plot coverage exceeding 80%, high occupancy rates, and minimal road/drainage reservation widths; a medium-density zone, characterized by planned and semi-planned residential layouts, moderate building coverage (50 –70%), mixed single- and multi-family structures, and partial municipal road networks; and a low-density zone, characterized by formal, planned residential estates (Bodija, Agodi GRA), low building coverage (< 50%), high greenery/canopy ratio, and paved roads with dedicated drainage channels.

5. Sampling Techniques and Data Collection

A multi-stage stratified random sampling procedure was utilized to select target households across the study area (Babbie, 2021), with a total sample size of $N = 800$ households determined to ensure statistical power and adequate representation across density zones, calculated using the standard sample size formula for large urban populations, $n = Z^2 \cdot p \cdot (1-p) / e^2$ (Babbie, 2021), where $Z = 1.96$ (95% confidence interval), $p = 0.5$ (maximum variability assumption), and $e = 0.035$ (3.5% margin of error), yielding a baseline that was stratified and adjusted to $N = 800$ across field sur-

vey sites; the sample allocation was proportionately distributed based on estimated population density and housing stock counts, with the High-Density Zone receiving $n = 475$ households (59.4% of total sample), the Medium-Density Zone $n = 260$ households (32.5%), and the Low-Density Zone $n = 65$ households (8.1%). Primary data were gathered through a structured, pre-tested household questionnaire administered structured into five thematic modules: household socio-demographic and economic characteristics; housing conditions, tenure status, and property characteristics; perceptions of drainage quality, municipal service frequency, and IUFMP performance; community association involvement and self-help participation; and perceived barriers to climate adaptation and coping strategies. Socio-economics and housing variables were measured using categorical and ordinal scales: educational attainment was categorized as No Formal Education, Primary, Secondary, Tertiary, and Postgraduate;

occupational status was classified into Artisans/Daily-Wage Workers, Urban Farmers, Unemployed, Self-Employed Professionals, Government Employees, and Private-Sector Workers; monthly income was measured in Nigerian Naira (NGN) across ordinal categories ($< \text{₦}70,000$; $\text{₦}70,000 - \text{₦}150,000$; $\text{₦}151,000 - \text{₦}300,000$; $> \text{₦}301,000$); and housing tenure was categorized as Owner-Occupied, Inherited Family Property, Rented, and Government/Corporate Housing. In addition, a composite Climate Resilience Index (CRI) was constructed to quantify household adaptive capacity on a normalized scale ranging from 0.00 (complete vulnerability) to 1.00 (maximum resilience), drawing on the asset framework established by Moser (1998), aggregating normalized scores across four equally weighted ($w = 0.25$) sub-dimensions Financial Security Score (income stability, savings capacity), Human Capital Score (educational level, flood preparedness knowledge), Housing and Structural Quality Score (wall materials,

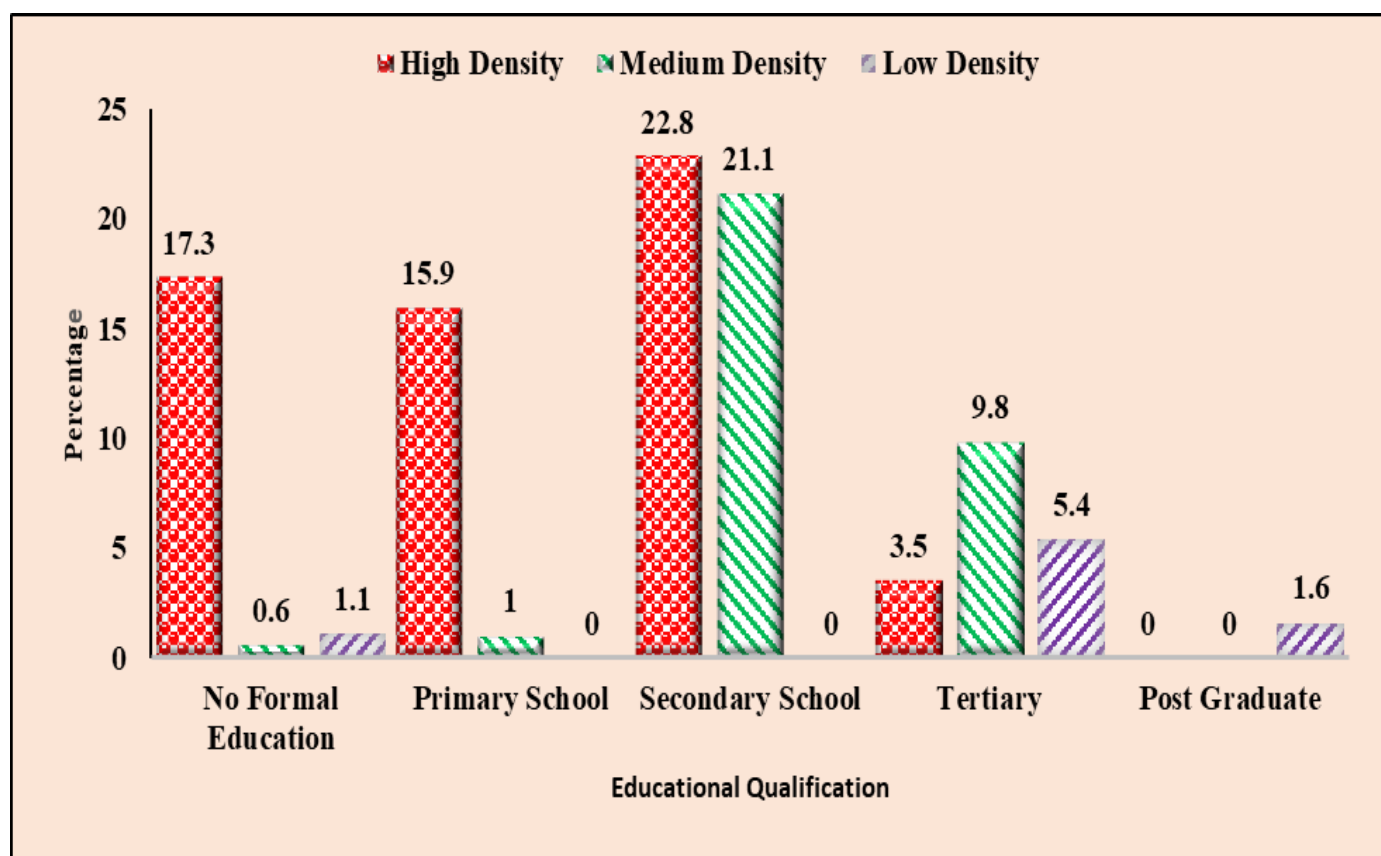


Figure 3: Educational Qualifications across Residential Density

foundation height, drainage connection), and Adaptation Strategy Score (installed flood barriers, active coping mechanisms) as $CRI = (wFS + wHC + wHCQ + 4AS)/4$.

6. Method of Data Analysis

Descriptive statistics including frequency distributions, percentages, arithmetic means (μ), and standard deviations (σ) were computed to summarize socio-economic profiles, housing characteristics, infrastructure evaluations, and adaptation barrier ratings, while inferential statistical tests were conducted using IBM SPSS (Version 23) to test the research hypotheses. Pearson's Chi-Square Test of Independence (χ^2)

was used to test for significant associations between categorical variables (residential density versus education/income/tenure; association membership versus self-help participation; LGA location vs. adaptation constraints), with Yates' Continuity Correction and Fisher's Exact Test applied to 2×2 cross-tabulations to ensure statistical validity where cell counts were small; in addition, an Independent Samples t-test was conducted to evaluate parametric mean differences in composite Climate Resilience Index (CRI) scores between independent groups (community association members vs. non-members), following Levene's Test for Equality of Variances (Babbie, 2021).

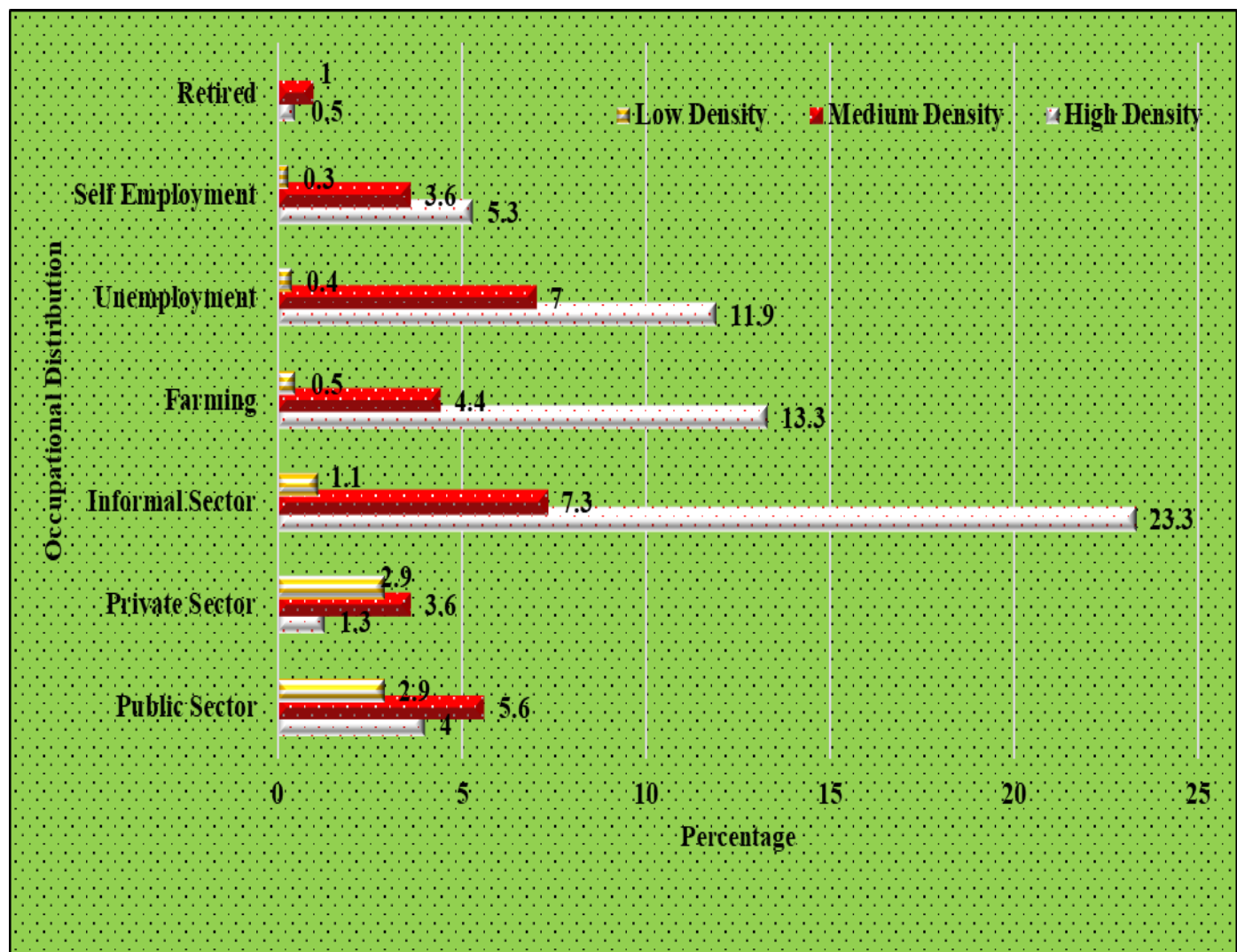


Figure 4: Residential Density and Occupational Distribution

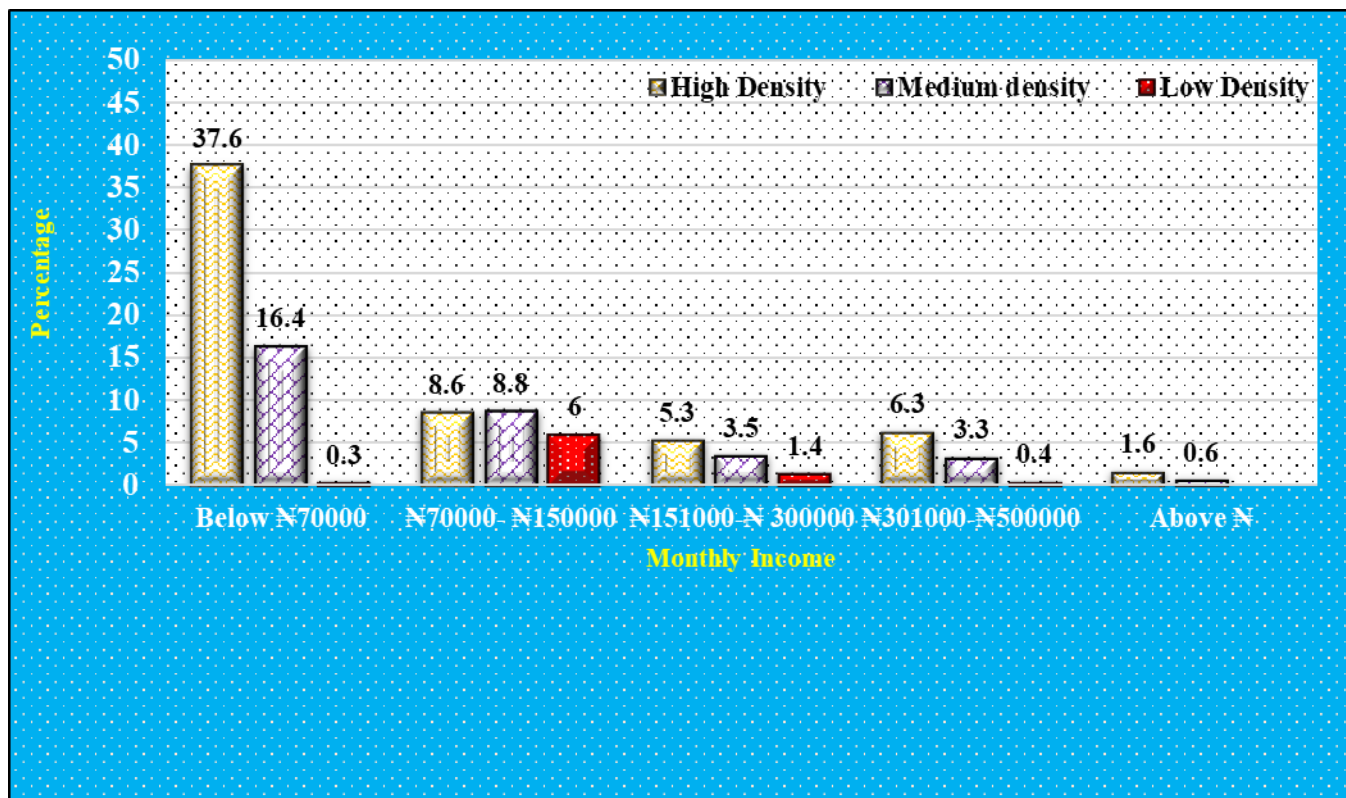


Figure 5: Monthly Income across Residential Density

7. Results and Discussion

Socio-Economic Characteristics

The empirical findings from the household survey (N = 800) reveal pronounced socio-spatial inequalities in climate vulnerability across the three residential density zones of Ibadan Metropolis. The sample comprised 475 households (59.4%) in the high-density zone, 260 (32.5%) in the medium-density zone, and 65 (8.1%) in the low-density zone. Pearson's Chi-Square tests demonstrated statistically significant associations between residential density and educational attainment, occupational structure, household income, and housing tenure, confirming that socio-economic characteristics are spatially differentiated across the metropolis, consistent with the historically stratified morphology of Ibadan (Taiwo, 2022). Educational attainment varied significantly across density zones, χ^2 (8, N = 800) = 184.32, $p < .001$, Cramer's V = 0.340. The high-density inner core recorded the greatest concentration of educational disadvantage, with 26.1% (n = 124) having no formal education and 34.5% (n = 164) possessing only primary education. Conversely, tertiary and

postgraduate qualifications were concentrated in low-density areas, where 64.6% and 18.5%, respectively, had attained these levels, compared with only 8.2% tertiary attainment in high-density neighbourhoods. This educational gradient suggests unequal human capital distribution and reinforces evidence of deprivation within Ibadan's traditional core.

Occupational patterns show spatial density gradients (χ^2 10, N = 800) = 212.65, $p < .001$, Cramer's V = 0.365). The high-density inner core is dominated by informal economic activities, with 39.2% (n = 186) working as artisans or daily-wage laborers and 31.8% (n = 151) engaged in informal petty trading. In contrast, formal sector employment comprising public service and corporate private sector roles is concentrated in low-density (69.2%) and medium-density (34.2%) zones. formal-sector employment was more prominent in low-density (69.2%) and medium-density (34.2%) areas.

Household income also differed significantly by residential density, χ^2 (6, N = 800) = 296.14, $p < .001$, Cramer's V = 0.430. About 63.4% (n = 301) of high-density households earned below ₦70,000

monthly, whereas 73.8% ($n = 48$) of low-density households earned above ₦300,000. These findings demonstrate that economic capacity for climate adaptation is strongly spatialized.

Housing tenure similarly varied significantly, $\chi^2(6, N = 800) = 158.41, p < .001$, Cramer's $V = .315$. High-density areas were dominated by inherited family compounds (42.3%) and owner-occupiers (36.6%), while formal rental arrangements predominated in medium-density areas (51.5%) and private ownership in low-density areas (66.2%). Collectively, these significant associations justify rejection of H_0 and demonstrate that socio-economic privilege and vulnerability are embedded within the spatial structure of Ibadan.

These findings strongly support Moser's (1998) Asset Vulnerability Framework, which explains vulnerability in terms of household access to and control over financial, human, physical, social, and natural assets. The concentration of low income, limited education, informal employment, and vulnerable housing conditions in high-density neighbourhoods indicates a cumulative asset deficit that restricts households' ability to anticipate, withstand, and recover from climate hazards. Financial capital deficits limit investment in protective infrastructure; human capital deficits may reduce access to technical knowledge and institutional information; while physical capital deficits increase exposure to flooding and other environmental hazards. The concentration of inherited family compounds in high-density areas further illustrates how tenure arrangements can constrain household autonomy to undertake structural improvements. Thus, vulnerability is not simply a consequence of hazard exposure but reflects unequal access to the resources required for adaptation.

8. Evaluation of Neighbourhood Drainage Infrastructure and Municipal Performance

The assessment of neighbourhood infrastructure further demonstrates that these socio-economic inequalities are reinforced by institutional and physical deficits. Nearly half of surveyed households (49.4%, $n = 395$) rated their immediate drainage infrastructure as poor, while 32.4% ($n = 259$) considered it fair and only 17.1% ($n = 137$) rated it good or excellent. Municipal drainage maintenance was particularly weak: 63.3% ($n = 506$) reported that desilting or clearance occurred rarely, while 36.8% ($n = 294$) stated that it had never occurred. Thus,

more than 99% of households experienced inadequate routine drainage maintenance. This institutional deficit was reflected in perception of the Ibadan Urban Flood Management Project (IUFMP), with 86.3% ($n = 690$) describing its effectiveness in eliminating localized flooding as ineffective or marginally effective. Respondents particularly associated continued flooding with blocked and deteriorated tertiary drainage channels.

This finding provides strong empirical support for Urban Political Ecology (UPE), which conceptualizes urban environmental conditions as products of political, economic, and institutional processes rather than purely natural phenomena (Swyngedouw & Heynen, 2003). Although major engineering interventions have improved selected primary drainage corridors, inadequate maintenance and deterioration of secondary and tertiary drainage systems continue to expose inner-core communities to localized flooding. The resulting disconnect between large-scale infrastructure and neighbourhood-level service delivery demonstrates how institutional priorities can produce uneven environmental outcomes. In this context, environmental hazards are socially and spatially produced because communities with limited political and economic influence continue to experience inadequate infrastructure and municipal services (Akanle *et al.*, 2015).

An independent samples t-test was conducted to determine whether membership in civic/associational groups is significantly associated with differences in household Composite Climate Resilience Index (CRI) scores. This test is grounded in a growing body of literature that positions associational or social capital as a potential driver of household-level climate adaptation and resilience outcomes (Carmen *et al.*, 2022).

Levene's Test for Equality of Variances was not significant ($F = 0.118, p = 0.731$), indicating that the assumption of homogeneity of variance was not violated; the "Equal Variances Assumed" row was therefore used for interpretation. Active association members recorded a slightly higher mean CRI score ($M = 0.301, SD = 0.184$) than inactive non-members ($M = 0.292, SD = 0.179$), yielding a mean difference of 0.009. However, this difference was not statisti-

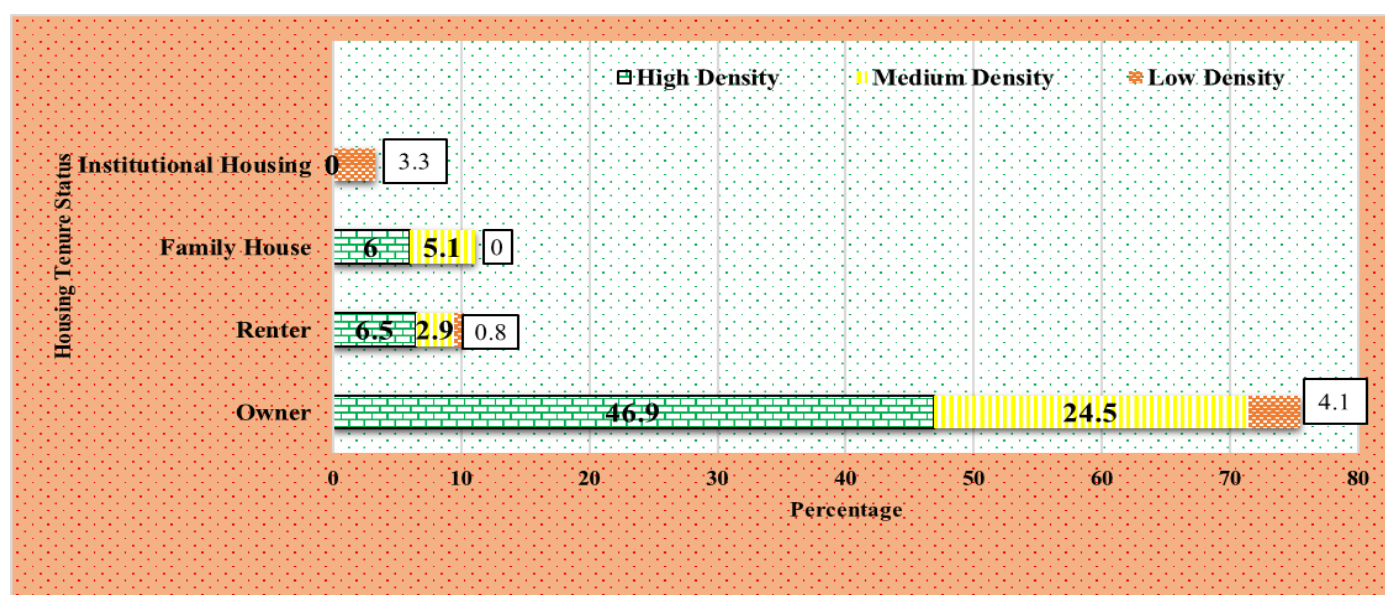


Figure 6: Residential Density and Housing Tenure Status

Table 1: Consolidated Profile of Civic Engagement, Infrastructure Status, and In-

Operational Variable Metrics & Attributes	Frequency (n)	Percent (%)	Mean (μ)	Std. Dev. (σ)
Active Landlord/ Resident Association Membership			1.44	0.497
Yes	449	56.1		
No	351	43.9		
Community Contribution to "Self-Help" Projects			1.79	0.410
Yes	171	21.4		
No	629	78.6		
Perceived Neighborhood Drainage Condition			3.38	0.808
Excellent	46	5.8		
Good	20	2.5		
Fair	330	41.3		
Poor	395	49.4		
Non-existent	55	6.8		
Frequency of Municipal Drainage/Waste Maintenance			1.63	0.482
Never	294	36.8		
Rarely	506	63.3		
IUFMP Infrastructure Reduced Water Overflow			4.01	1.073
Strongly Agree	45	5.6		
Agree	61	7.6		
Neutral	4	0.5		
Disagree	423	52.9		
Strongly Disagree	267	33.4		
Total Aggregate Sample Base	800	100.0	—	—

stitutional Performance

Table 2: Independent Samples t-Test for Association Membership and Composite Climate Resilience Index

Operational Civic Grouping	N	Mean CRI Score (μ)	Std. Deviation (σ)	Std. Error Mean		
Active Association Member (Yes)	449	0.301	0.184	0.009		
Inactive Non-Member (No)	351	0.292	0.179	0.010		
Assumption Variance Path	Levene's F	Levene's Sig. (p)	t-value	df	Two-Sided p-value	Mean Difference
Equal Variances Assumed	0.118	0.731	0.694	798	0.488	0.009
Equal Variances Not Assumed	—	—	0.696	749.2	0.488	0.009

Source: Authors' Field Analysis Modeling (2026).

cally significant, $t(798) = 0.694$, $p = 0.488$ (two-sided).

This finding contrasts with several recent studies that report a positive and significant relationship between associational or social-network participation and climate adaptation outcomes. In south-western Nigeria, farmers' participation in social capital networks was found to significantly influence both the decision to adopt climate change adaptation strategies and the specific strategies chosen (Ogunleye *et al.*, 2021). Related Nigerian evidence shows that economic association membership builds social capital that encourages uptake of climate risk-mitigation tools such as index insurance (Aina, *et al.* (2024). In urban informal settlements in Kumasi, Ghana, household decision-making capacity combined with membership in environment-related groups was linked to measurable differences in the adaptation measures households employed, partly because such groups delivered education and training that raised members' awareness of climate hazards (Opoku-Boateng *et al.*, 2024). Similarly, in

peri-urban Dar es Salaam, both bonding and bridging social capital were found to be strong among residents, pointing to their feasibility as pathways for building household resilience to climate change effects (Mngumi, 2020).

The non-significant result obtained in the present study may therefore suggest that, within Ibadan's urban household context, the *mere fact* of association membership is insufficient on its own to drive measurable resilience gains. This pattern is consistent with the broader social capital literature, which finds that social capital is often necessary but insufficient for shaping resilience unless combined with other resources and capacities, meaning the *quality*, *type*, and *resource-mobilization capacity* of a network matter more than membership status alone (Carmen *et al.*, 2022). This points to associational *engagement quality* rather than membership status alone as a more decisive factor elsewhere in Nigeria that limited access to finance and technical know-how systematically constrains households' and smallholders' ability to adopt effective adaptation strategies, with such constraints falling unevenly across regions and income groups (Akinkuolie *et al.*, 2024). No-

warranting further disaggregated analysis in subsequent sections of this study (e.g., by association type, meeting frequency, or leadership role). On this basis, this finding mathematically proves that active membership in a Landlord/Resident Association has no statistically significant influence on whether a household contributes capital or labor to physical flood-mitigation self-help projects.

9. Spatial Distribution of Household Adaptation Barriers across Local Government Areas (LGAs)

The spatial distribution of adaptation barriers provides further evidence of structural constraints on household resilience, consistent with broader findings that climate vulnerability in Nigeria is shaped as much by governance quality and institutional reach as by direct hazard exposure (Agun, 2026). Lack of money/funds was the main reason cited for not taking further protective steps by 50.9% ($n = 407$) of households, followed by lack of technical knowledge (41.1%, $n = 329$) and the belief that adaptation is the government's responsibility (8.0%, $n = 64$). This distribution varied significantly and strongly across LGAs, $\chi^2(8, N = 800) = 468.837$, $p < .001$, Cramer's $V = .541$, indicating a strong spatial patterning of adaptation reasoning. Financial constraints were most dominant in Ibadan North (76.7%) and Ibadan North-East (65.7%), whereas Ibadan North-West (13.1%) and Ibadan South-West (25.8%) reported markedly lower reliance on financial explanations, instead citing lack of technical knowledge as the predominant barrier (86.1% and 74.2%, respectively). This pattern echoes findings

Table 3: Main reason for not taking further protective steps (Financial/Technical)

LGA	Lack of Money/ Funds	Lack of Technical Knowledge	Government's Re- sponsibility	Total
Ibadan North	148 (76.7%)	44 (22.8%)	1 (0.5%)	193 (100.0%)
Ibadan North-East	119 (65.7%)	0 (0.0%)	62 (34.3%)	181 (100.0%)
Ibadan North-West	16 (13.1%)	105 (86.1%)	1 (0.8%)	122 (100.0%)
Ibadan South-East	93 (50.5%)	91 (49.5%)	0 (0.0%)	184 (100.0%)
Ibadan South-West	31 (25.8%)	89 (74.2%)	0 (0.0%)	120 (100.0%)
Total	407 (50.9%)	329 (41.1%)	64 (8.0%)	800 (100.0%)
$\chi^2(8, N=800) = 468.837$, $p < .001$, Cramer's $V = .541$				

Table 4: Rising cost of building materials/labor as the biggest obstacle

LGA	Count	% within LGA	% of Total
Ibadan North	193	100.0%	24.1%
Ibadan North-East	181	100.0%	22.6%
Ibadan North-West	122	100.0%	15.3%
Ibadan South-East	184	100.0%	23.0%
Ibadan South-West	120	100.0%	15.0%
Total	800	100.0%	100.0%
Uniform response — chi-square not applicable			

Source: Authors' Field Analysis Modeling (2026)

tably, the perception that adaptation is "the government's responsibility" was concentrated almost exclusively in Ibadan North-East (34.3%), being negligible or absent elsewhere.

All respondents (100%, $n = 800$) identified the rising cost of building materials and labor as the biggest obstacle to structural adaptation, reflecting a uniform structural constraint with no meaningful spatial variation to test statistically.

Land tenure and rent-related insecurity (fear of eviction) was rated "a very significant obstacle" by 70.0% ($n = 560$) of households, with a further 18.6% ($n = 149$) rating it the single biggest obstacle. Perceived severity varied significantly across LGAs, $\chi^2(16, N = 800) = 37.824$, $p = .002$, Cramer's $V = 0.109$. Ibadan South-West recorded the highest proportion rating ten-

ure insecurity as the biggest obstacle (32.5%), while Ibadan North-West recorded the highest proportion rating it a very significant obstacle (81.1%) and the lowest proportion rating it the biggest obstacle (10.7%). This finding aligns with evidence from other Nigerian urban contexts, where the absence of formal land tenure or property rights compels lower-income households to remain in informal or high-risk structures, deepening their exposure to climate-related shocks (Ajibade & McBean, 2014).

Lack of municipal support was identified as the biggest obstacle to adaptation by 74.4% ($n = 595$) of households, with an additional 15.4% ($n = 123$) rating it a very significant obstacle. Perceived severity varied significantly across LGAs, $\chi^2(16, N = 800) = 33.994$, $p = 0.005$, Cramer's $V = 0.103$. Ibadan South-East

Table 5: Land tenure / rent issues (fear of eviction) perceived severity

LGA	Biggest Obstacle	Very Significant	Moderate	Minor	Smallest	Total
Ibadan North	31 (16.1%)	142 (73.6%)	10 (5.2%)	7 (3.6%)	3 (1.6%)	193 (100.0%)
Ibadan North-East	30 (16.6%)	117 (64.6%)	17 (9.4%)	10 (5.5%)	7 (3.9%)	181 (100.0%)
Ibadan North-West	13 (10.7%)	99 (81.1%)	5 (4.1%)	4 (3.3%)	1 (0.8%)	122 (100.0%)
Ibadan South-East	36 (19.6%)	132 (71.7%)	5 (2.7%)	7 (3.8%)	4 (2.2%)	184 (100.0%)
Ibadan South-West	39 (32.5%)	70 (58.3%)	5 (4.2%)	3 (2.5%)	3 (2.5%)	120 (100.0%)
Total	149 (18.6%)	560 (70.0%)	42 (5.3%)	31 (3.9%)	18 (2.3%)	800 (100.0%)
$\chi^2(16, N=800) = 37.824$, $p = .002$, Cramer's $V = .109$						

Source: Author's Field Analysis Modeling (2026)

Table 6: Severity of Perceived lack of municipal support

LGA	Biggest Obstacle	Very Significant	Moderate	Minor	Smallest	Total
Ibadan North	148 (76.7%)	28 (14.5%)	11 (5.7%)	3 (1.6%)	3 (1.6%)	193 (100.0%)
Ibadan North-East	133 (73.5%)	24 (13.3%)	11 (6.1%)	7 (3.9%)	6 (3.3%)	181 (100.0%)
Ibadan North-West	89 (73.0%)	14 (11.5%)	7 (5.7%)	7 (5.7%)	5 (4.1%)	122 (100.0%)
Ibadan South-East	146 (79.3%)	24 (13.0%)	3 (1.6%)	6 (3.3%)	5 (2.7%)	184 (100.0%)
Ibadan South-West	79 (65.8%)	33 (27.5%)	2 (1.7%)	6 (5.0%)	0 (0.0%)	120 (100.0%)
Total	595 (74.4%)	123 (15.4%)	34 (4.3%)	29 (3.6%)	19 (2.4%)	800 (100.0%)
$\chi^2(16, N=800) = 33.994, p = .005, \text{Cramer's } V = .103$						

Source: Author's Field Analysis Modeling (2026)

(79.3%) and Ibadan North (76.7%) recorded the highest proportions rating it the biggest obstacle, while Ibadan South-West recorded the lowest proportion rating it the biggest obstacle (65.8%) but the highest proportion rating it a very significant obstacle (27.5%). This is broadly consistent with governance-focused assessments of Nigerian climate adaptation, which identify limited institutional reach and weak public-service delivery as factors that systematically constrain the adaptive capacity of marginalized urban groups (Agun, 2026).

Consequently, the null hypothesis of no significant spatial variation in adaptation barriers across LGAs is not supported by the data. Financial constraints, land tenure insecurity, and lack of municipal support all show statistically significant spatial patterning across the five LGAs, with financial/technical-knowledge reasoning showing an especially strong association (Cramer's $V = 0.541$), confirming pronounced geographic disparities in the structural and institutional barriers shaping household climate adaptation capacity in Ibadan metropolis.

10. Discussion of Findings

The findings in this study demonstrate that climate vulnerability in Ibadan Metropolis is strongly shaped by socio-spatial inequalities in household assets, infrastructure, institutional support, and adaptive capacity. Significant relationships between residential density and educational attainment, occupational structure, household income, and housing tenure indicate that vulnerability is unevenly distributed across the urban area. High-density inner-core neighbourhoods concentrate households with lower educational attainment, greater dependence on informal employment, lower incomes, and constrained housing conditions. This finding is consistent with Taiwo (2022), who links Ibadan's spatial structure to historically established socio-economic differentiation, and Adewale *et al.* (2019), who documented persistent deprivation and housing-quality challenges in the traditional core.

The findings strongly support Moser's (1998) Asset Vulnerability Framework. The concentration of low income, limited education, informal employment, and inherited family compounds suggests that house-

holds in high-density areas possess fewer assets with which to anticipate, withstand, and recover from climate hazards. Low and unstable incomes restrict investment in drainage improvements, raised foundations, wall reinforcement, and other adaptation measures. Dependence on informal and daily-wage employment further limits households' ability to absorb income losses following flooding and other climate-related disruptions, reinforcing the characterization of Ibadan's inner-core economy as predominantly informal (Ogunrinola & Ogunrinola, 2017). Lower educational attainment may also constrain access to technical information and institutional disaster-management resources, while inadequate housing and drainage increase physical exposure. Inherited family compounds may further restrict occupants' authority to undertake structural modifications, illustrating the asset-erosion process described by Moser (1998).

Infrastructure deficiencies further demonstrate the institutional dimensions of climate vulnerability. Poor neighbourhood drainage and inadequate municipal maintenance indicate that flood exposure is partly produced through inadequate service provision. The finding that 86.3% of respondents considered the IUFMP ineffective or marginally effective in addressing localized flooding suggests that large-scale engineering interventions may have limited impact where secondary and tertiary drainage systems remain blocked, deteriorated, or absent. This finding supports the Urban Political Ecology perspective of Swyngedouw and Heynen (2003), which views urban environmental conditions as products of political, economic, and institutional processes. Unequal drainage provision and maintenance reflect resource allocation and institutional priorities, reinforcing earlier observations of infrastructure and flood-management challenges in Ibadan (Akanle *et al.*, 2015; Egbinola *et al.*, 2017). The disconnect between major infrastructure projects and neighbourhood-level maintenance further illustrates the institutional and community dimensions of urban environmental management.

The findings on community participation challenge the assumption that social capital alone can generate climate resilience. Although many respondents belonged to community organizations, membership was not significantly associated with participation in environmental self-help activities or higher Climate Resilience Index scores. Community networks may support information sharing and emergency assistance but cannot substitute for formal infrastructure and financial resources. This

supports Opoku-Boateng *et al.* (2024), who argue that informal social networks cannot replace sustained institutional investment.

Finally, adaptation barriers reveal structural rather than merely behavioural constraints. Financial limitations, rising building-material costs, tenure insecurity, inheritance disputes, and inadequate municipal support restrict households' ability to implement adaptation measures. These findings align with Protection Motivation Theory (Rogers, 1975), which explains protective behaviour through threat and coping appraisal. Although households may perceive climate risks as severe, inadequate income, high adaptation costs, tenure insecurity, and limited institutional support suppress coping capacity. Consistent with Tasantab *et al.* (2022), high risk awareness therefore does not automatically produce adaptive action. Overall, the findings show that climate vulnerability in Ibadan is socio-spatially and structurally produced, requiring interventions that simultaneously strengthen household assets, improve neighbourhood infrastructure, address tenure constraints, reduce adaptation costs, and enhance municipal support.

11. Policy Recommendations

To shift Ibadan Metropolis from reactive emergency response to proactive climate resilience, policy should address institutional inequalities, household asset deficits, and adaptation constraints.

1. The Oyo State Government, in collaboration with Local Government Councils, should establish a Localized Tertiary Drainage Maintenance Fund (LTD MF) to finance the construction, desilting, and repair of secondary and tertiary drains in high-risk core areas.
2. Maintenance should be decentralized to LGA Works Departments, with Community Development Associations (CDAs) monitoring scheduled operations.
3. Given the role of waste accumulation in localized flooding, OYOWMA should introduce a Micro-Franchised Waste Collection Model, using local youth cooperatives with light collection vehicles suited to narrow inner-core streets.
4. To strengthen household financial capital, a Household Resilience Retrofitting Scheme (HRRS) should provide low-interest microloans and targeted subsidies for materials such as cement, reinforcement bars, and flood barriers, supporting raised foundations, retaining walls, and drainage connections (Moser, 1998; Rogers,

1975). For inherited family compounds, the Ministry of Lands, Housing and Urban Development should establish customary-property resilience guidelines and mediation mechanisms to facilitate collective approval for safety modifications.

5. CDAs should be formally integrated into municipal governance as civic monitoring bodies responsible for reporting infrastructure failures, supporting disaster preparedness, and monitoring local projects (Ekoh & Teron, 2023).

This study contributes to urban planning, climate adaptation, and spatial vulnerability literature in Sub-Saharan Africa in three ways.

1. It integrates Urban Political Ecology (Swyngedouw & Heynen, 2003), Moser's (1998) Asset Vulnerability Framework, and Protection Motivation Theory (Rogers, 1975).

2. It challenges social capital determinism by demonstrating that community association membership does not necessarily improve structural resilience amid infrastructural neglect and poverty (Carmen *et al.*, 2022).

3. It demonstrates the importance of spatially disaggregating vulnerability by residential density and *administrative LGAs*.

12. Areas for Further Research

Future research should pursue three priorities. First, longitudinal evaluation of IUFMP interventions should assess changes in flood incidence and household economic recovery across core LGAs. Second, gender-disaggregated studies should examine how gender, informal trading, care responsibilities, and resource control shape vulnerability within traditional family compounds. Third, research should evaluate the economic feasibility and spatial viability of ecosystem-based adaptation, including permeable surfaces and riparian buffer restoration, within densely developed areas of Ibadan.

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