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The Green Space Paradox: Adaptive Infrastructure and Its Displacement Effects on Low-Income Urban Residents

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ABSTRACT

As cities in the Global South invest in climate-resilient infrastructure, a paradox has emerged: while green infrastructure aims to reduce urban vulnerability, it may inadvertently intensify socio-spatial inequalities. This study investigates the relationship between green adaptation projects and patterns of social displacement in unplanned settlements in Asaba, Delta State, Nigeria. Using a mixed-methods design, we surveyed 420 households across four neighbourhoods impacted by recent urban greening and flood mitigation initiatives. Data were analysed using descriptive statistics, cross-tabulation, and logistic regression to assess correlations between environmental upgrades, rent changes, and tenure security. Results indicate that while 63% of residents recognize improvements in flood control and recreational space, 58% report rent increases of over 30% within two years of implementation. Additionally, 41% of informal tenants expressed concerns about eviction or future relocation, with the highest vulnerability observed among households earning below ₦50,000 monthly. Regression analysis ($R^2 = 0.67$, $p < 0.01$) confirms that rising rental pressure and lack of tenure documentation are significant predictors of perceived displacement risk. Qualitative interviews further reveal community distrust in planning authorities and the absence of compensatory or inclusive planning mechanisms. These findings highlight the unintended consequences of climate adaptation in informal urban contexts. The study recommends that resilience planning be integrated with pro-poor housing policies, participatory governance, and a tenure regularization framework to ensure that green infrastructure does not perpetuate urban exclusion. The paper contributes to debates on climate justice and inclusive adaptation in African secondary cities.

INTRODUCTION

Cities in the Global South are progressively implementing climate adaptation methods to meet the growing hazards of flooding, heatwaves, and environmental and environmental deterioration. Central to these strategies is the integration of green infrastructure such as rain gardens, green belts, bioswales, and urban retention parks which aim to improve resilience while enhancing the ecological and aesthetic value of urban spaces (Garcia-Garcia *et al.*, 2020; UN-Habitat, 2020). However, emerging literature suggests a paradox: while green infrastructure contributes to climate mitigation and improved urban functionality, it may also accelerate land value appreciation, catalyse gentrification, and displace vulnerable populations especially in informal and low-income neighbourhoods (Shokry *et al.*, 2020; Lewartowska *et al.*, 2024). This phenomenon, commonly referred to as climate gentrification, has been increasingly documented in cities such as Miami, New Orleans, and Accra, where environmental investments have created unintended social consequences (Keenan *et al.*, 2018; Alhassan & Hadwen, 2017). In many African cities, urban informality and poor land tenure systems create conditions where climate infrastructure interventions disproportionately affect low-income residents who lack legal protections or political voice (Adelekan *et al.*, 2022). These dynamics are often exacerbated by exclusionary planning processes and an absence of social safeguards.

In Nigeria, and particularly in secondary cities such as Asaba in Delta State, flood-prone zones have become focal points for green infrastructure deployment. Asaba's location along the River Niger and its rapid urban expansion have made it especially vulnerable to seasonal flooding, prompting state-led interventions such as floodwater retention parks and upgraded stormwater systems in areas like Umuagu, Cable Point, and Oko-Amakom (Delta State Urban Development Authority [DSUDA], 2023). While these projects offer environmental benefits, early reports and community concerns suggest rising rents, loss of tenure, and limited resettlement support for informal households adjacent to new green infrastructure developments. Despite the growing body of global scholarship on the social consequences of climate adaptation, empirical studies examining this phenomenon in African cities remain limited. Examining the relationship between green infrastructure planning and current urban disparities is necessary, especially in areas with unregulated housing markets and a significant number of unplanned settlements. Asaba offers a compelling case study for examining these issues, given its combination of ecological risk, rapid urban development, and socio-spatial fragmentation.

The socioeconomic effects of green adaptation initiatives in Asaba's low-income and informal areas are examined in this study. It specifically investigates how rent levels, housing security, and inhabitants' perceived danger of

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relocation are impacted by such developments. The study aims to determine the degree to which climate resilience infrastructure may paradoxically increase social vulnerability by examining survey data from 420 homes and gaining knowledge via key informant interviews with planners, residents, and non-governmental organisations. The report also outlines important policy levers to make sure that green urbanism in Nigerian cities supports fairness and inclusion rather than undercuts it. By doing this, this article adds to the current discussions on inclusive planning, urban displacement, and climate justice. It provides politicians and urban planners with evidence-based suggestions for balancing social justice and environmental sustainability.

LITERATURE REVIEW

Climate adaptation has become a key driver of contemporary urban development strategies, particularly in flood-prone and ecologically sensitive regions. City planners are increasingly incorporating green infrastructure solutions as mitigation and adaptation strategies due to the increasing frequency and severity of climate-related events, such as heatwaves, flooding, and extreme weather (UN-Habitat, 2020; Garcia-Garcia, *et al.*, 2020; Asad *et al.*, 2024). Although there are structural and ecological advantages to such methods, a growing corpus of research has drawn attention to the unequal social effects of climate-resilient infrastructure, particularly in the Global South.

Green Infrastructure, Climate Adaptation and Displacement Risk

Green infrastructure refers to a network of natural and semi-natural systems designed to provide environmental services such as flood regulation, air purification, and temperature control (Lewartowska *et al.*, 2024; Grevisse & Jean-Pierre, 2025). It includes bioswales, retention parks, urban forests, permeable surfaces, and riverbanks restoration. In urban areas, these features are frequently used to mitigate storm water risks and adapt to future climate uncertainties (Koc *et al.*, 2017). However, despite their environmental merits, green infrastructure projects are increasingly associated with gentrification and exclusion when not implemented through inclusive and equity-centred planning processes (Checker, 2011). The concept of climate gentrification has gained prominence in recent years, describing the process through which environmental upgrades increase real estate values, thus displacing historically marginalized or low-income communities (Keenan *et al.*, 2018; Shokry *et al.*, 2020). This dynamic has been observed in cities like Miami, New York, and Accra, where green flood mitigation projects led to rising rents, speculative land use, and displacement in informal settlements (Alhassan & Hadwen, 2017; Garcia-Garcia *et al.*, 2020; Danladi *et al.*, (2024); Takal *et al.*, 2025). In African cities, this dynamic is particularly pronounced due to the widespread presence of informal housing, insecure tenure systems, and fragmented land governance. Adelekan *et al.* (2022) found that flood-prone areas in Nigerian cities are often populated by renters with low incomes, who lack legal recourse or state protections when infrastructural upgrades lead to eviction or land acquisition. Moreover, resilience projects frequently proceed without robust community engagement, further disempowering vulnerable groups (Ajibade, 2017).

Informality, Tenure, and Urban Inequality

The intersection of climate adaptation and urban informality is central to understanding the displacement risks posed by green infrastructure. In many Nigerian cities including Asaba informal settlements are simultaneously recognized as vulnerable and targeted for intervention, yet receive little protection in formal development plans (UN-Habitat, 2020). Land tenure insecurity, in particular, exacerbates the likelihood of displacement. A study by Wanjiru Kamunyori (2016) emphasized that adaptation effort lacking legal and procedural safeguards risk reinforcing patterns of marginalization under the guise of sustainability. Furthermore, informal tenants are more vulnerable to rent increases, as landlords take advantage of upgraded infrastructure to raise property values (Shokry *et al.*, 2020). These patterns are rarely offset by state policies for rent stabilization, relocation assistance, or tenure regularization, particularly in secondary cities with limited planning capacity. While climate gentrification has been extensively documented in Global North contexts, there remains a notable dearth of empirical research in Africa, especially outside of major metropolises. Alhassan & Hadwen, (2017) and Takal *et al.*, (2025) have called for expanded scholarship on climate adaptation outcomes in African secondary cities, where rapid urban growth intersects with weak governance, data gaps, and under-resourced planning institutions. Asaba, with its growing green infrastructure portfolio and significant informal housing stock, presents an important case for bridging this knowledge gap (figures 1 and 2). This study aims to build on this emerging discourse by providing empirical evidence from Asaba (figure 2), Nigeria. It contributes to the emerging subject of climate justice, namely understanding how infrastructure enhancements intended to minimise vulnerability might paradoxically raise relocation risks for low-income populations.

This conceptual framework illustrates the paradoxical dynamics of green infrastructure implementation in Asaba, Delta State. On the one hand, adaptive interventions such as retention parks, flood channelization, and open green corridors strengthen the city's climate resilience by mitigating flood risks, reducing heat stress, and improving environmental quality. These benefits are particularly critical in flood-prone informal settlements such as Umuagu, Cable Point, Oko-Amakom, and Ogbe-Iyase, where households face disproportionate exposure to climate hazards. On the other hand, the upgrading of urban space through green amenities contributes to rising land values and speculative property development, processes that heighten housing costs and increase the

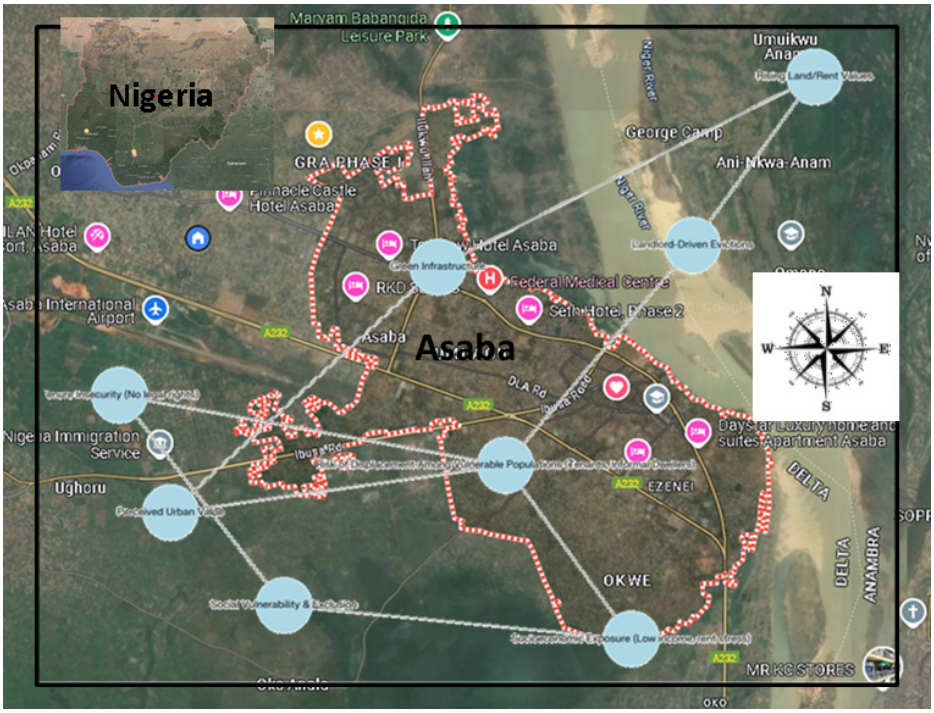

Figure 1: Climate Adaptation and Displacement Risk Pathway in Asaba, Delta State.

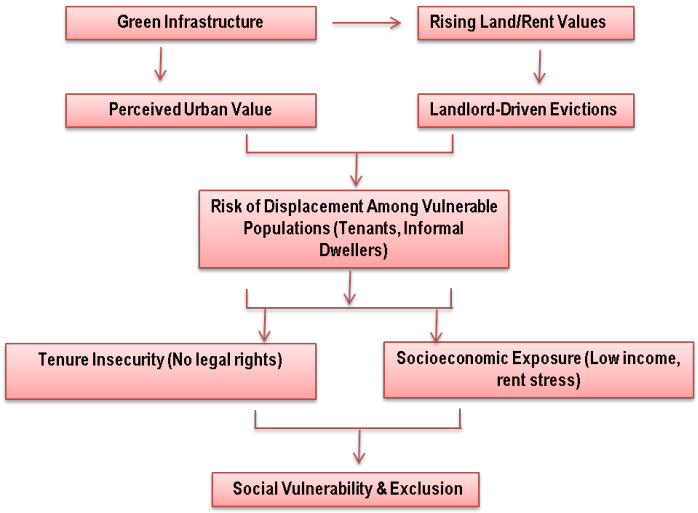

Figure 2: Green Infrastructure, Displacement Risk, and Urban Vulnerability in Asaba, Delta State.

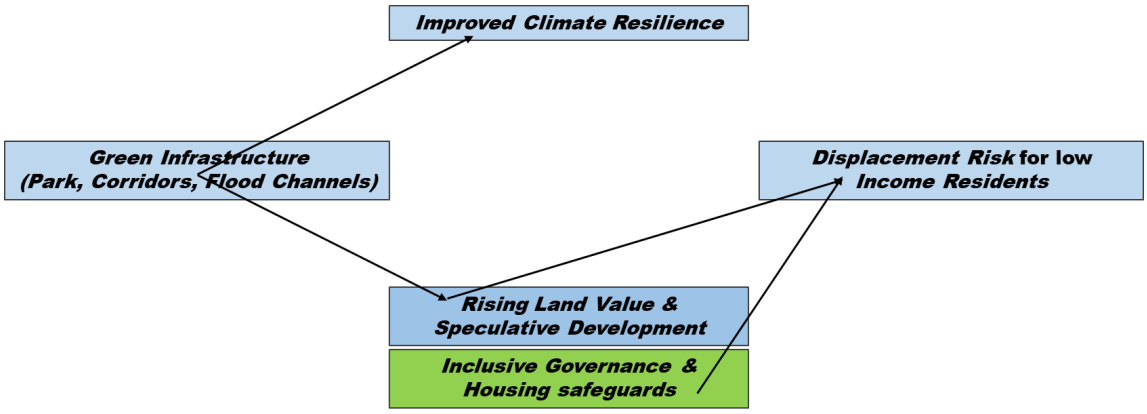

Figure 2: The Green Space Paradox in Asaba, Delta State. Source: Author's computation (2025).

risk of displacement for low-income residents (figures 3). The framework emphasizes the "green space paradox": while green infrastructure enhances ecological and infrastructural resilience, it may simultaneously generate new social vulnerabilities. In Asaba's context, the paradox manifests through the exclusion of poorer households from redeveloped urban corridors, perpetuating socio-spatial inequality. Inclusive urban governance anchored on participatory planning, affordable housing schemes, and socially equitable green infrastructure financing emerges as the critical mediator in balancing resilience gains with distributive justice. By explicitly linking ecological adaptation with social equity, the framework highlights the need for urban resilience policies that do not sacrifice vulnerable populations in the pursuit of climate-smart modernization.

Table 1: Explanation of Key Constructs

Variable	Definition / Influence
Green Infrastructure	Urban greening projects like parks, rain gardens, storm-water channels introduced for climate adaptation.
Rising Land/Rent Values	Economic uplift of neighbourhoods leads to increased demand and cost of housing.
Perceived Urban Value	Improved aesthetics and services make areas more attractive for real estate speculation.
Landlord-Driven Evictions	Informal renters are displaced as landlords seek higher-paying tenants or sell to developers.
Tenure Insecurity	Lack of legal recognition or formal titles among informal residents.
Socioeconomic Exposure	Households with low income are more affected by rent hikes and fewer relocation options.
Social Vulnerability & Exclusion	Outcome of spatial and economic displacement loss of housing, community, and access to services.

Source: Author's work (2025)

MATERIALS AND METHODS

This study adopts a mixed-method, explanatory sequential design to interrogate the paradoxical outcomes of adaptive green infrastructure on low-income urban residents in Asaba, Delta State. Specifically, it examines how interventions aimed at strengthening climate resilience such as flood retention parks, channelization schemes, and open green corridors intersect with processes of residential displacement and affordability challenges. The sequential design began with a quantitative phase, in which structured household surveys were administered across informal and flood-prone settlements including Umuagu, Cable Point, Oko-Amakom, and Ogbe-Iyase. The surveys captured indicators of rent dynamics, tenure security, and perceived risks of displacement following green infrastructure projects. These measurable outcomes were then expanded upon in a qualitative phase, which involved in-depth interviews with residents, urban planners, community leaders, and local government officials. The qualitative data contextualized statistical findings, offering nuanced insights into how resilience-oriented interventions simultaneously generate social vulnerabilities. This integration of numerical and narrative evidence aligns with Creswell and Plano Clark (2018) framework for explanatory mixed-methods inquiry.

The research was situated in Greater Asaba, an urbanizing riverine metropolis that epitomizes the challenges of climate vulnerability and rapid population growth in the Niger Delta. Located between 6°11'N and 6°23'N latitude and 6°43'E and 6°47'E longitude, Asaba is the capital of Delta State and administrative centre of Oshimili South Local Government Area (Figure 4). The city's expansion into low-lying, flood-prone areas has heightened exposure to climate risks while intensifying land and housing demand. The terrain is dominated by sandy sediments (90%) with minor clay and shale deposits, averaging 44 meters above sea level. The tropical equatorial climate, with annual rainfall ranging from 1,800 to 2,104 mm, compounds flood risks but also justifies recent ecological investments in urban greening. However, these same interventions while framed as resilience strategies have restructured local land markets, creating affordability pressures that disproportionately affect the urban poor.

Population growth in Asaba underscores this tension. From 49,725 in 1991 to 149,603 in 2006, with projections of over 400,000 by 2025 (Onyemenam & Dibosa, 2025), demographic pressures have fuelled intense competition for space. The implementation of adaptive green infrastructure, often concentrated in marginalized wards and peri-urban communities, has paradoxically improved flood resilience while accelerating processes of gentrification and residential displacement. By selecting wards with high socio-spatial heterogeneity, the study captures the uneven distribution of both benefits and costs of green infrastructure. In doing so, it situates Asaba as a critical case for exploring the "green space paradox," where the pursuit of ecological resilience collides with urban equity, raising fundamental questions about the social justice dimensions of climate adaptation.

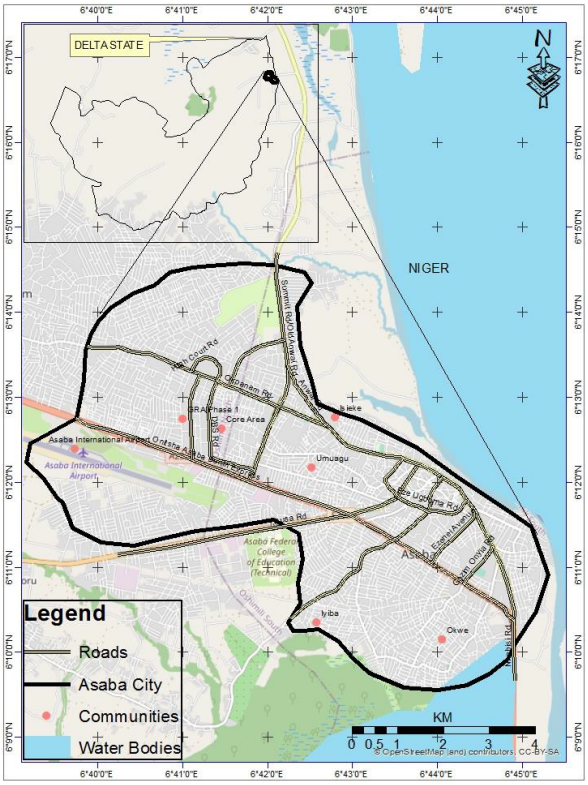

Figure 4: Map of Delta State showing Study Area.
Source: Modified after Onyemenam, (2025a).

Population, Sampling and Data Collection Instruments

The study population consists of residents living within 500 meters of green infrastructure projects in four informal settlements. Using Taro Yamane's formula for a known population with a 95% confidence level and a 5% margin of error, a sample size of 420 respondents was determined. A stratified random sampling technique was employed to ensure representation from various socio-economic backgrounds across the selected settlements. The strata included tenancy status (owners vs. tenants), income levels, and length of residence.

Quantitative Phase

A structured questionnaire was administered to 420 residents. The instrument comprised five sections: Demographics; Housing and rent dynamics; Access to infrastructure; Tenure security; Perceived risk of displacement. While some items gathered numerical or category responses, the majority employed a 5-point Likert scale. The instrument was pretested on 30 respondents, and internal consistency yielded a Cronbach's Alpha score of 0.83, indicating high reliability.

Qualitative Phase

Fifteen semi-structured interviews were conducted with key informants, including: 4 urban planners (state and local government); 3 NGO representatives working in informal housing; 4 community leaders; 4 landlords or property managers. Interview guides focused on the design, implementation, and socio-economic impacts of green infrastructure projects.

Data Analysis

Quantitative Analysis

Data were processed using SPSS Version 28. Descriptive statistics (means, frequencies, standard deviations) described housing and demographic patterns. Inferential analyses included: Independent t-tests: to compare rent increases between areas near vs. far from green infrastructure; Chi-square tests: to examine associations between tenure status and displacement concern; Binary logistic regression: to identify predictors of displacement perception using income, tenancy, and rent change as variables.

$$P(Y) = \frac{1}{1 + e - \left((\beta^0 + \beta^1 x^{1+} \beta^2 x^{2+\cdots+} \beta_n x_n\right)}$$

Regression model:
Where,
Y = perceived risk of displacement (binary outcome).

Qualitative Analysis

Transcripts from interviews were coded using NVivo 14, applying thematic content analysis. Emerging themes included: Involuntary displacement; Rent speculation; Planning without participation; Trust in public agencies
Codes were developed inductively and refined iteratively to align with the conceptual framework.
Ethical Considerations and Methodological Limitations
Ethical approval was obtained from the Dennis Osadebay University Research Ethics Committee (Ref No: DOU/REC/CLIMATE/2025-015). Participants provided written informed consent, and all data were anonymized to ensure confidentiality. Interviewees were informed of their right to withdraw at any stage of the research without penalty. The cross-sectional nature of the study limits causality inference; Informal renters may under-report income or displacement fears due to fear of exposure; Access to highly displaced households was limited, possibly underrepresenting the most vulnerable. Despite these limitations, the triangulation of quantitative and qualitative data strengthens the credibility and relevance of the findings.

RESULTS AND DISCUSSION

Out of 420 respondents, 57% were tenants, 31% owner-occupiers, and 12% informal caretakers. The average monthly household income was ₦48,500 (approx. $60). About 64% of respondents resided within 300 meters of recent green infrastructure projects. Notably, 58% of tenants reported rent increases in the past 12 months, with 34% attributing it directly to neighbourhood upgrades like flood retention parks and drainage channels. Regarding tenure security, 45% of renters reported feeling insecure about their continued residence, citing landlord pressure, eviction threats, or unaffordable rent increases. Only 19% of owner-occupiers expressed such concerns.

Hypotheses and Statistical Testing

Hypothesis 1 (H_{01}): There is no significant relationship between green infrastructure implementation and rent increases in informal settlements.

Test: Independent t-test; Result: Mean rent increase near green infrastructure areas = ₦6,930; Mean rent increase elsewhere = ₦4,115; $t(418) = 3.74$, $p < 0.001$

Conclusion: Reject H_{01}. Green infrastructure is significantly associated with rent increases.

Hypothesis 2 (H_{02}): Perceived risk of displacement is not significantly predicted by income level or tenure type.

Test: Binary logistic regression; Dependent variable: Perceived displacement risk (1 = Yes, 0 = No); Predictors: Monthly income, tenure type, rent increase > 20%

Table 2: Income, tenure and rent increase.

Predictor	β	SE	Exp (β)	p-value
Income (< ₦50,000)	0.84	0.22	2.32	0.000
Tenant (vs. Owner)	1.12	0.19	3.06	0.000
Rent > 20%	1.39	0.25	4.01	0.000
Constant	-1.52	0.34	—	0.000

Source: Field Computation (2025)

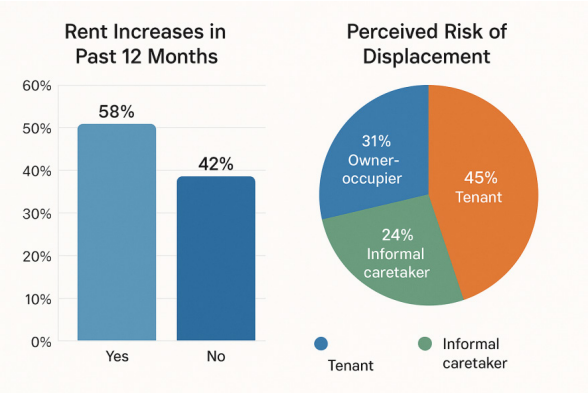

Figure 5: Rent increase and Perceived risk in Asaba, Delta state.
Source: Field computation (2025).

Model summary: Nagelkerke $R^2 = 0.68$, $Chi^2(3) = 102.3$, $p < 0.001$

Conclusion: Reject H_{02}. Income, tenure, and rent increase are strong predictors of displacement risk.

Thematic Insights from Qualitative Interviews. Three dominant themes emerged from NVivo - coded interviews:

i. Green Development without Representation: Residents consistently cited a lack of inclusion in the planning of climate infrastructure projects, a community leader stated: "They built these flood parks without asking us how it affects where we live. Now my rent has doubled;"

ii. Perceived Displacement as a Slow Violence: Interviewees described forced relocation through rising rents and landlord intimidation, not direct eviction orders. "It's not that they throw you out they make it impossible to stay."

iii. Planning Trust Deficit: Residents expressed skepticism toward government claims about sustainability and equity, often citing failed relocation promises from past projects.

The results clearly demonstrate a statistically significant association between green infrastructure investments and socioeconomic displacement risk in Asaba's informal settlements. The results are consistent with worldwide climate gentrification trends, whereby infrastructure resilience initiatives ironically make the urban poor more vulnerable (Shokry *et al.*, 2020; Garcia-Garcia *et al.*, 2020). Rent increases averaging ₦6,930/month post-intervention represent a critical affordability threshold in a city where 69% of households earn below ₦50,000/month. Furthermore, tenants who comprise over half the sampled population—were three times more likely than owner-occupiers to perceive displacement threats, a finding consistent with studies in Accra and Lagos (Alhassan & Hadwen, 2017; Adelekan *et al.*, 2022). The regression model confirms that rent inflation, low income, and informal tenure are key drivers of perceived displacement, corroborating the literature on urban vulnerability under climate adaptation regimes (Lewartowska *et al.*, 2024). The absence of participatory planning mechanisms and tenure protections suggests that well-meaning environmental projects may inadvertently exacerbate urban inequality when applied without inclusive governance structures. These findings contribute new empirical insight to the underexplored nexus of green infrastructure and displacement in secondary African cities. They highlight the urgent need for urban planning frameworks in Nigeria to integrate social equity safeguards into environmental resilience initiatives.

This study contributes critical insights into the underexplored intersection of climate adaptation, green infrastructure, and urban social fairness in the setting of secondary cities in Africa that are gradually becoming more urbanised. While green infrastructure is increasingly promoted as a solution to environmental risks such as flooding, this research reveals its unintended socio-economic consequences particularly the risk of displacement and housing insecurity among low-

income residents in informal settlements. By focusing on Asaba, Delta State, Nigeria, the study addresses a major geographic and thematic gap in the literature. Much of the existing scholarship on climate gentrification has focused on cities in the Global North like Miami and New Yorkor large African capitals like Accra and Nairobi. This research extends the discourse to a mid-sized Nigerian city, illustrating how global adaptation paradigms manifest in localized contexts marked by weak tenure systems, informal housing markets, and minimal urban governance capacity.

Empirically, the study's use of mixed methods including survey data from 420 households and key informant interviews provides robust evidence of rent inflation and displacement perceptions linked to green infrastructure interventions. These findings contribute to a growing body of research arguing for socially inclusive urban design methods that include tenure security, rental safeguards, and participatory governance systems into resilience programs. Theoretically, the study reinforces and expands the framework of climate gentrification by introducing a "slow displacement" lens applicable to African informal settlements. It highlights how eviction is not always physical but may occur through economic pressure, rent hikes, and the erosion of community tenure. For urban policymakers, development agencies, and planners, this study underscores the need to integrate social equity safeguards into climate adaptation planning. These include the establishment of relocation compensation schemes, rent control in upgraded areas, and community involvement in project design and implementation. In doing so, the study supports the realization of Sustainable Development Goal 11 (Sustainable Cities and Communities) and Goal 13 (Climate Action) by promoting climate-resilient cities that are inclusive, equitable, and just.

CONCLUSION

This study examined the unintended social consequences of climate-adaptive green infrastructure in informal settlements in Asaba, Delta State. The infrastructure is designed to enhance urban resilience against climate-induced threats, but it has a negative socioeconomic impact, particularly on low-income renters in unregulated housing markets. Survey results from 420 households revealed significant associations between proximity to green infrastructure and increased rent burdens, with households with low income, insecure tenure, and exposure to quick rent increases more likely to perceive a danger of displacement. Qualitative insights supported these findings, pointing to indirect eviction pressures, a lack of participatory planning, and widespread distrust in public institutions.

The study highlights a critical policy gap in the integration of social equity measures within climate resilience strategies, particularly in African secondary cities like Asaba, where informal housing dominates and governance structures remain fragmented. It underscores the urgency of embedding inclusive planning, rent stabilisation, and tenure regularisation into adaptation policies to ensure social justice and affordable housing are not sacrificed for climate resilience. Policy recommendations include integrating social safeguards into resilience planning, implementing rent stabilisation and housing protection zones, formalising tenure and providing legal protections, adopting participatory and community-based planning, establishing climate equity funds for relocation and compensation, and improving inter-agency coordination and transparency.

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