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RESEARCH ARTICLE

Urban Growth, Green Space Dynamics, and Household Energy Consumption: Implications for Sustainable Regional Planning in Nigeria

Abubakar Zakariyya Al-Hasan[1*], Abubakar Ibrahim Suleiman[2], & Al-Hasan Fatimetu Olohigbe[3]

[*1]Department of Urban & Regional Planning, Auchi Polytechnic, Auchi, Nigeria
[2]Department of Agricultural & Bioenvironmental Engineering Technology, Auchi Polytechnic, Auchi, Nigeria
[3]Department of Public Administration, Auchi Polytechnic, Auchi, Nigeria
*Corresponding Author's Email: alhasanaz@gmail.com

ABSTRACT

Urban growth in Nigeria proceeds through the conversion of vegetated and agricultural land into impervious built surfaces, and the environmental consequences of that conversion are increasingly well documented. What remains poorly articulated is the connection between the loss of green space and the structure of household energy consumption, and the implications of that connection for regional rather than purely municipal planning. This paper examines the relationship between urban growth, green space dynamics, and household energy demand in Nigeria through a structured synthesis of published land cover analyses, energy access assessments, and urban climate studies covering the period from 2016 to 2025. The paper uses documented multi-decadal land cover trajectories for Nigerian cities as its empirical anchor, and reads them against the evidence on urban heat, cooling demand, and household energy behaviour. Three findings emerge. First, the rate of vegetation loss in Nigerian urban systems is severe, sustained, and concentrated in the peri-urban belt, with one well-documented case recording a fall in vegetation cover from over fifty-five percent to under fourteen percent of municipal area across four decades. Second, this loss operates on household energy consumption through a thermal channel that raises cooling demand and through a substitution channel that removes fuelwood and shade resources from low-income households. Third, the spatial scale at which these processes operate is regional rather than municipal, because peri-urban conversion occurs across local government boundaries and because energy systems and labour markets are organised at regional scale. The paper argues that the appropriate planning response is a regional green-space and energy framework and sets out its components. Limitations arising from the synthesis design and from the uneven geographic coverage of the Nigerian evidence base are stated explicitly.

Keywords: *Urban growth; Green space; Household energy; Regional planning; Land cover; Heat Island*

1. INTRODUCTION

The relationship between urban growth and environmental quality in Nigeria has been examined extensively, and the direction of the relationship is not in dispute. Rapid population growth, rural-to-urban migration, and economic concentration have produced a sustained expansion of built-up area at the expense of vegetated and agricultural land in every major Nigerian urban system (Fox et al., 2018; Aliyu & Amadu, 2017; Essien, 2023). What has received considerably less attention is the connection between that land cover transformation and the way Nigerian households consume energy, and the implications of that connection for the scale at which planning should be conducted. The omission matters for three reasons. First, cooling is the fastest-growing component of residential electricity demand in tropical urban systems, and cooling demand is directly conditioned by the thermal environment that land cover produces. Second, a substantial proportion of Nigerian households remain dependent on biomass for cooking, and the availability of that biomass is affected by the same peri-urban vegetation loss that drives the thermal effect. Third, the two effects fall unevenly, with low-income households in poorly served settlements experiencing both the highest thermal exposure and the greatest dependence on the resources being lost.

This paper examines the relationship between urban growth, green space dynamics, and household energy consumption in Nigeria, and asks what follows for regional planning practice. Three research questions structure the analysis. What is the documented magnitude and spatial pattern of green space loss in Nigerian urban systems? Through what mechanisms does that loss affect household energy consumption? And at what spatial scale must planning operate if it is to address those mechanisms effectively? The argument advanced is that the appropriate scale is regional. Peri-urban land conversion crosses local government boundaries and is driven by regional labour and land markets; electricity distribution networks and their reliability profiles are organised regionally; and biomass supply chains extend well beyond municipal limits. Planning instruments confined to the municipal boundary address a fraction of a process that operates at a larger scale, which is one reason why municipal green space provisions in Nigerian cities have proved so difficult to enforce.

The paper proceeds as follows. Section 2 reviews the evidence on urban growth, green space dynamics, and household energy in Nigeria and comparable contexts. Section 3 sets out the synthesis method and its limitations. Section 4 presents the evidence on land cover trajectories and the mechanisms linking them to energy consumption, discusses the regional scale argument, and also sets out planning implications. Section 5 concludes.

2. LITERATURE REVIEW

Urban growth and land cover transition in Nigeria

The theoretical literature on land use transition provides the frame within which Nigerian land cover change is best understood. Long (2022) sets out a human geography account of land use transition in which changes in land cover are the spatial expression of shifts in economic structure, demographic composition, and institutional arrangement, rather than autonomous physical processes. Applied to Nigeria, this account directs attention to the drivers rather than the symptoms, and the empirical literature has identified those drivers with some consistency: population growth, rural to urban migration, the availability of unregulated land at the urban fringe, the establishment of institutions such as universities and government offices, and the growth of small enterprise activity (Ogunbode et al., 2025; Farrell, 2018; Adedeji, 2023).

Empirical land cover studies for Nigerian cities are numerous and methodologically consistent, typically applying supervised classification to multi-temporal Landsat imagery. The documented trajectories are severe. In Iwo, Osun State, built-up area rose from 9.30 square kilometres in 1982 to 30.68 square kilometres in 2023, while vegetation cover fell from 167.16 to 41.76 square kilometres over the same period (Ogunbode et al., 2025). Comparable directions of change have been reported for Lagos State (Onilude & Vaz, 2020) and Osogbo (Oladehinde et al., 2019). Regional analyses of West Africa have shown that land cover change across the subregion accelerated over four decades in step with population pressure (Herrmann et al., 2020), and studies of drivers in southwestern Nigeria have linked deforestation to a combination of agricultural expansion, fuelwood extraction, and settlement growth (Fasona et al., 2018).

The international comparative literature confirms that these dynamics are not peculiar to Nigeria. Analyses of urban land expansion across three hundred cities have shown that population and economic growth jointly drive expansion but that the elasticity varies substantially with governance quality (Mahtta et al., 2022). Studies in Harare and in Indonesian metropolitan regions report similar patterns of peri-urban conversion driven by weak development control (Marondedze & Schütt, 2019; Surya et al., 2020). Work on fiscal drivers has shown that where subnational governments depend on land conversion for revenue, expansion accelerates independently of demographic need (Tong et al., 2022), a mechanism with clear relevance to Nigerian state and local government finance.

Green space and the urban thermal environment

The evidence connecting green space to the urban thermal environment is well established. Vegetated surfaces reduce both air and surface temperature relative to adjacent built surfaces through shading and evapotranspiration, and the magnitude of the effect depends on patch size, connectivity, and species composition (Aram et al., 2019; Murtinová et al., 2022). Research in tropical megacities has shown that the cooling effect of green space varies considerably with local climatic background, which means that cooling benefits observed in temperate cities cannot be transferred directly to Nigerian conditions without adjustment (Li et al., 2022). Threshold-based analysis has further shown that cooling benefit is non-linear in green area, with implications for how green space standards should be specified (Zhou et al., 2023).

Urban form independently conditions the thermal and air quality outcomes. Studies in developing country megacities have demonstrated that compactness, street geometry, and building height distribution affect pollutant dispersion and thermal accumulation (Zhou et al., 2018; Liang & Gong, 2020). This matters for Nigerian regional planning because the peri-urban belt where growth is concentrated is precisely where urban form is still being determined and where intervention is therefore still possible.

Household energy consumption in Nigeria

Household energy consumption in Nigeria is characterised by unreliable grid supply, extensive reliance on privately owned small generators, and continued dependence on solid biomass for cooking in a large share of households. Policy assessments have documented the scale of the access deficit and the systemic constraints preventing its closure, including underinvestment, infrastructural decay, and weak cost recovery in the distribution segment (Adeshina et al., 2024). National transition planning has set out a long-horizon pathway toward universal access and eventual net zero, with explicit acknowledgement that decentralised systems must carry a substantial part of the burden (Federal Government of Nigeria, 2022; Sustainable Energy for All, 2024).

The connection between this energy profile and green space dynamics has two components. The thermal component operates through cooling: households in hotter microclimates run fans and, where affordable, air conditioning for longer, raising both grid consumption and generator fuel expenditure. The substitution component operates through biomass: peri-urban vegetation is a fuelwood resource for lower-income households, and its conversion to built use raises the cost or the collection time of that fuel. Both components are plausible on the available evidence, but neither has been quantified directly for Nigerian urban households, and this paper is explicit that it identifies rather than measures them.

3. MATERIALS AND METHODS

Design and rationale

The study uses a structured evidence synthesis design. This choice reflects the nature of the research questions, which concern relationships across a national urban system over multi-decadal timescales, and the state of the data, in which land cover trajectories are well documented in the published literature while household energy consumption is documented separately and at a different spatial resolution. A synthesis permits the two bodies of evidence to be read against one another; it does not permit the estimation of coefficients linking them, and no such coefficients are reported.

Evidence base

Peer-reviewed studies were identified through indexed database searches combining terms for land cover change, urban expansion, green space, urban heat, household energy, and Nigeria, with a publication window from 2016 to 2025 and selective inclusion of earlier foundational work where it establishes a mechanism still in use. National policy instruments and energy transition datasets were obtained from the responsible federal agencies and their international partners. Studies were retained where they reported quantified land cover trajectories for Nigerian or West African cities, where they established thermal or hydrological mechanisms in tropical conditions, or where they characterised Nigerian household energy consumption. Table 1 summarises the composition of the retained evidence base.

Table 1. Composition of the retained evidence base

Evidence category	Principal contribution to the analysis	Geographic coverage
Land cover and urban expansion studies	Quantified multi-decadal trajectories of vegetation loss and built-up expansion.	Nigeria and West Africa, with international comparators
Urban climate and green space studies	Magnitude and configuration dependence of cooling effects	Tropical and temperate, mechanism level
Household and national energy assessments	Access deficit, supply reliability, fuel mix, transition pathway	Nigeria, national and sub-national
Land use transition theory	Framework for interpreting drivers rather than symptoms	General
Governance and fiscal driver studies	Explanation for the persistence of peri-urban conversion	International, with Nigerian relevance

Analytical procedure

Retained land cover studies were tabulated to establish the direction, magnitude, and spatial concentration of green space change. Mechanism-level studies were then coded against two candidate channels connecting land cover to household energy consumption, namely the thermal channel and the biomass substitution channel. For each channel, the analysis records the strength of the underlying mechanism evidence, the availability of Nigerian-specific quantification, and the spatial scale at which the channel operates. The scale finding is then used to derive the planning implications set out in Section 6.

Limitations

Four limitations bound the findings. The Nigerian land cover evidence base is geographically uneven, with southwestern cities markedly better represented than northern and eastern ones, and northern Nigerian cities differ materially in climate, building typology, and cooling demand profile. Household energy consumption in Nigeria is documented at national and state level rather than at the intra-urban resolution at which the thermal channel operates, so the two datasets cannot be joined directly. The mechanisms linking land cover to household energy are established in principle, but unquantified for

Nigeria, and the paper reports them as such. Finally, a synthesis reflects the state of the published literature and will therefore understate unpublished or informally documented practice.

4. RESULTS AND DISCUSSION

The magnitude and pattern of green space loss

The documented land cover trajectories establish three consistent features. The first is magnitude. The best-documented Nigerian case records vegetation falling from 55.79 percent of municipal area in 1982 to 13.94 percent in 2023, alongside a rise in built-up area from 3.10 percent to 10.24 percent and a substantial expansion of farmland (Ogunbode et al., 2025). Table 2 reproduces the reported trajectory.

Table 2. Reported land use trajectory for Iwo, Osun State, 1982 to 2023 (percentage of total area)

Land use category	1982	2002	2012	2023
Built up	3.10	3.52	5.86	10.24
Vegetation	55.79	48.24	25.71	13.94
Farmland	35.25	45.30	66.69	74.91
Bare land	5.80	2.75	1.54	0.74
Water body	0.05	0.18	0.21	0.17

Source: Reported in Ogunbode et al. (2025). Reproduced here for analytical purposes

The second feature is the composition of the change. Vegetation is not being converted primarily into built-up surface. It is being converted into farmland, which then converts to built-up surface at the urban edge in a second phase. This two-stage process explains why municipal development control, which typically engages only at the point of building, intervenes too late to protect the vegetated resource. The intervention point is the first conversion, which occurs outside the municipal boundary and outside the scope of building regulation.

The third feature is spatial concentration. Studies of Nigerian and West African urban systems consistently locate the sharpest vegetation loss in the peri-urban belt rather than in the established urban core, where little vegetation remains to be lost (Oladehinde et al., 2019; Onilude & Vaz, 2020; Herrmann et al., 2020). The belt in question typically spans multiple local government areas, which is the first component of the regional scale argument developed in Section 5.

The thermal channel

The thermal channel operates as follows. Vegetation loss raises land surface and near-surface air temperature through reduced shading and reduced evapotranspiration; the magnitude is well established across contexts and is sensitive to patch configuration as well as aggregate area (Aram et al., 2019; Zhou et al., 2023; Li et al., 2022). Elevated ambient temperature raises the cooling load on residential buildings. In Nigerian conditions, this load is met through fans, through air conditioning in higher-income households, and through the extended operation of small generators when grid supply is unavailable. The consequence is a rise in both electricity consumption and liquid fuel expenditure at household level.

Each link in this chain is supported by evidence. The chain as a whole has not been measured end to end for Nigerian cities, and the absence of measured cooling energy elasticities for Nigerian building stock is the principal gap identified by this analysis. The chain is nevertheless sufficiently well supported at each link to justify planning action, particularly because the intervention required, which is the retention of existing vegetation, is substantially cheaper than the retrofit alternatives that would otherwise be needed.

The biomass substitution channel

The second channel is less discussed but has larger distributional consequences. Peri-urban vegetation is a fuelwood and charcoal resource for lower-income urban and peri-urban households, and drivers of deforestation studies for southwestern

Nigeria identify fuelwood extraction alongside agricultural expansion and settlement growth as a principal cause of vegetation loss (Fasona et al., 2018). When peri-urban land converts to built use, the resource is removed and the households that depended on it must either travel further, pay more, or switch fuels. Where switching is unaffordable, the outcome is increased expenditure or reduced consumption, both of which fall on the households least able to absorb them.

This channel connects the green space agenda directly to the clean cooking agenda in national transition planning, in which the population without access to clean cooking substantially exceeds the population without access to electricity (Sustainable Energy for All, 2024). Table 3 summarises the assessment of both channels.

Table 3. Assessment of the two channels linking green space loss to household energy consumption

Channel	Mechanism evidence	Nigerian quantification	Operating scale	Distributional incidence
Thermal	Strong at each link, untested end-to-end	Absent for cooling energy elasticity	Intra-urban to regional	Broad, weighted toward poorly ventilated housing
Biomass substitution	Established for fuelwood as a deforestation driver	Absent for urban household fuel cost effects	Regional, extends beyond city limits	Concentrated in low-income households

Discussion of findings

The evidence assembled in Section 4 supports a specific and consequential conclusion about scale. Three features of the processes examined here operate above the municipal level, and a planning instrument confined to the municipal boundary will therefore address only a fraction of each.

First, the locus of vegetation loss is the peri-urban belt, and that belt spans multiple local government areas in every substantial Nigerian urban system. A city that protects green space within its own boundary while conversion proceeds unchecked immediately outside it has displaced the process rather than arrested it, and has done so in a way that also displaces the thermal benefit, since the urban heat island is a regional rather than a strictly municipal phenomenon.

Second, the drivers of conversion are regional. Land and labour markets, the fiscal incentives facing local governments, and the transport corridors along which peri-urban settlement concentrates are all organised at a scale larger than the individual municipality. The fiscal driver literature is particularly relevant here: where subnational governments derive revenue from land conversion, conversion accelerates independently of demand, and a single municipality acting alone is competitively disadvantaged if it restricts conversion while its neighbours do not (Tong et al., 2022).

Third, the energy systems through which the identified channels operate are regional. Electricity distribution networks and their reliability profiles are organised at a scale spanning many local government areas, and biomass supply chains extend into rural hinterlands well beyond any urban boundary. The devolution of electricity regulation to state level in Nigeria makes the state the natural unit at which the energy side of this coupling can be planned, and states already hold the physical planning function, so the two can in principle be aligned within a single tier.

Several qualifications apply. The evidence base is drawn disproportionately from southwestern Nigeria, and the thermal channel in particular is likely to operate with different magnitude in the drier and hotter northern cities, where the baseline vegetation stock is lower and cooling loads higher. The regional scale argument is derived from the spatial characteristics of the documented processes rather than tested against the performance of existing regional planning instruments, of which Nigeria has few in active operation. The analysis rests on published land cover studies whose classification accuracies vary and whose category definitions are not always directly comparable across studies.

Implications for Sustainable Regional Planning

Five implications follow for Nigerian regional planning practice.

- Establish regional green space frameworks at state level. Given that vegetation loss concentrates in a peri-urban belt spanning several local government areas, the protective instrument must operate at the same scale, with a designated corridor network binding on all constituent local governments.
- Intervene at the first conversion rather than the second. The evidence indicates that vegetation converts to farmland before it converts to built-up surface. Development control that engages only at the building stage arrives too late, and the regulatory instrument must therefore address agricultural conversion in designated corridors.
- Align physical planning and state electricity planning. With both functions now capable of sitting within the state tier, a single spatial plan should govern green corridor designation and the siting of distributed generation and distribution assets.
- Address the fiscal driver directly. Where local government revenue depends on land conversion, protection is fiscally self-defeating. Compensating transfers or alternative revenue instruments for local governments hosting designated corridors are a precondition for enforcement.
- Connect green space policy to the clean cooking agenda. The biomass substitution channel means that peri-urban vegetation protection and clean cooking transition are complementary rather than competing objectives, and should be appraised together.

These implications share a common structure. Each identifies a mismatch between the scale at which a process operates and the scale at which the current instrument acts, and each proposes the alignment of the two.

5. CONCLUSION

This paper has examined the relationship between urban growth, green space dynamics, and household energy consumption in Nigeria and has drawn out the implications for regional planning. The documented land cover trajectories establish that vegetation loss in Nigerian urban systems is severe, sustained, and concentrated in the peri-urban belt, and that it proceeds through a two-stage conversion in which vegetation becomes farmland before it becomes built surface.

Two channels connect this loss to household energy consumption. The thermal channel raises cooling demand and therefore both electricity consumption and generator fuel expenditure. The biomass substitution channel removes a fuelwood resource on which lower-income households depend, with distributional consequences that fall on the least able to absorb them. Each link in each channel is supported by evidence; neither channel has been measured end to end in Nigerian conditions, and this is stated as a limitation rather than resolved by assertion.

The central argument concerns scale. The locus of loss, the drivers of conversion, and the energy systems through which the channels operate are all regional, while the planning instruments currently deployed are municipal. The paper therefore argues for regional green space and energy frameworks established at the state level, intervening at the first rather than the second conversion, aligned with state electricity planning, and supported by fiscal arrangements that do not penalise the local governments asked to enforce them.

Two research priorities follow. Cooling energy elasticities for Nigerian residential building stock need direct measurement, disaggregated between the southern and northern climatic zones. The effect of peri-urban conversion on household fuel expenditure needs empirical estimation, since the distributional argument rests on a mechanism that is currently inferred rather than observed.

6. COMPETING INTERESTS

None to declare

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