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RESEARCH ARTICLE

Role of Green Infrastructure in Strategic Land Use Planning in Imo State

Sabina Chiaka Osuji

Department of Urban & Regional Planning, Imo State University, Owerri, Nigeria
Corresponding author: chiakanne@yahoo.com

ABSTRACT

Green infrastructure is the interconnected network of natural and engineered systems that provide ecological, social, and environmental benefits. It plays a crucial role in strategic land use planning in Imo State by providing a network of natural and semi-natural areas that deliver a wide range of environmental, social, and economic benefits. Land use planning is the ordering and regulating of land use efficiently and ethically, thus preventing land use conflicts. This study investigates the role of green infrastructure in strategic land use planning. The objectives are to examine how green infrastructure plays its role in strategic land use planning, identify the challenges of green infrastructure in land use planning, and recommend key strategies to improve green infrastructure in strategic land use planning. A questionnaire survey was the main instrument for data collection. Simple random sampling and purposive sampling techniques were used. The sample size was 420. The study revealed that green infrastructure is increasingly recognized as a crucial element in building resilient cities that can withstand the impacts of climate change, urbanization, and other environmental challenges. It provides habitats for wildlife, connecting fragmented ecosystems and supporting biodiversity conservation, improving air quality, as well as improving human health and well-being. The study recommends that green infrastructure be integrated into planning so that communities can create more sustainable and resilient urban environments. It should be strategically planned and integrated into land use plans to ensure connectivity and maximize its benefits; it should be integrated into long-term strategic planning to ensure its sustainability and effectiveness.

Keywords: *Resilience; Green Infrastructure; Planning; Sustainability*

1. INTRODUCTION

The contemporary world is becoming more and more urbanized. Cities face unprecedented and extraordinary challenges due to global trends like rapid urbanization, economic globalization, and climate change (Gill, 2007; Surma, 2020). At the moment, more than half of the population lives in cities, and this number is expected to rise in the coming decades. The

cities' growth has put pressure on the capacity of the urban, sewerage among others. Therefore, the United Nations has called for more integrated city policies, where cross-cutting solutions can ensure better quality of urban settings and a sustainable development pathway (United Nations, 2015). In this context, green infrastructure is the interconnected network of natural and engineered systems that provide ecological, social, and environmental benefits. It plays a crucial role in strategic land use planning in Imo State by providing a network of natural and semi-natural areas that deliver a wide range of environmental, social, and economic benefits (Surma, 2020).

Green infrastructure can provide a significant tool, helping to resolve interconnected urban challenges such as climate change adaptation and migration; uncontrolled urbanization; decreased environmental quality; public health and wellbeing; biodiversity loss, among others (Surma, 2020). A green city environment has financial benefits for real estate and planning (Pain, 2018). Contributing to resilient, healthy, and environmentally friendly cities as an integral part of power and economy (Young, 2014).

Land use planning is the systematic, participatory process of managing land resources to achieve sustainable development, balancing economic, social, and environmental needs (Osuji, 2025). It directs land use to minimize conflicts, protect natural resources, and guide development through zoning – residential, commercial, industrial, and agricultural – to create efficient communities (Tao, Tan and He, 2007). Land use planning is the ordering and regulating of land use in an efficient and ethical way, thus preventing land use conflicts (Bako, Raheem and Abdulyekeen, 2017).

Green infrastructure plays a central role in fighting climate change impacts by protecting us against floods and other environmental disasters. As noted by the European Environment Agency, the multifunctionality of green infrastructure enables it to be fully integrated into different policy domains. Hence, this approach can potentially serve a role of a cross-cutting solution for sustainable land use planning. To fully integrate this concept, it is necessary to implement a network of different spatial levels ranging from the site, district, and city level to larger peri-urban and regional scale (European Commission, 2013).

Green infrastructure was extended to include not only semi-natural elements such as green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, and vegetated median strips, but also other engineered components with a "green" function, for instance, porous and permeable pavements, to better fit with strategies aiming to adapt the built environment to unpredictable events as a result of climate change (Foster, Lowe and Winkelman, 2011). Green infrastructure aimed to provide a hydrological balance for large areas of impervious surfaces within urban districts (EPA, 2008). This extended approach for green infrastructure – closely tied to the built environment – significantly contributed to current understanding of the green urban environment, previously limited to green spaces like parks.

The concept of green infrastructure emerged as a holistic planning approach to ensure sustainability of land use in urban and rural regions. Green infrastructure is defined as a "strategically planned network" of natural and semi-natural areas, green spaces and other environmental features which together enhance ecosystem health and resilience, biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services (Naumann, Raymont, Nolan, Forest, Gill, Infrastructure and Forest, 2011, and European Commission, 2012). This "Strategically planned network" deals with two core elements. First, the ecological, socio-economic multi-functionality of green spaces (the individual elements) and second, the connectivity among them.

When referring to multi-functionality, each landscape feature, physical and natural, plays a role in satisfying different needs. In the case of urban landscapes, the needs of their population range from contact with nature and recreational needs to social interaction, citizen participation, building a sense of belonging, and reinforcing cultural values (Matsuoka and Kaplan,

2008). Connectivity considers different landscape features, individual elements with local effects, and the linkages among them until they form a network, which enables movement of species and matter, forming a green infrastructure with a higher-level effect (Hansen and Pauleit, 2014).

Land use planning refers to the ordering and regulating of land in an efficient and ethical way, thus preventing land use conflicts. Land use planning is described as a key tool to guide the spatial layout and time sequence of land use and to minimize the negative externalities of land use (Bako et al., 2017; Huang, Tiang, Li, Yongfu, Yu, Gao, and Xia, 2023). Land use planning affects the performance of regional economies. Government interventions in land use can promote regional economic prosperity by: (a) eliminating negative externalities, protecting public goods and implementing amenity improvements; (b) encouraging compact development, associated with higher efficiency in the provision of public services, as well as benefits related to potential agglomerations (urban areas); (c) improving transportation outcomes; and (d) reducing the uncertainty and transaction costs involved in land development (Metternicht, 2017).

Land use planning can achieve conservation outcomes by: identifying and protecting natural areas with significant biodiversity values; directing development away from natural areas; and controlling the impacts of land uses on natural areas. For example, the Planning and Development Act of Western Australia has established biodiversity as a valid planning consideration; the Act states that preservation and conservation matters need to be dealt with by the planning scheme. Specifically, its Planning Framework contains provisions for: the protection of biodiversity, preventing or limiting vegetation clearing; the protection of habitat from destruction and fragmentation; and the preservation or enhancement of ecological corridors (Metternicht, 2017).

The challenges in Imo State are the institutional and regulatory weaknesses, environmental and physical constraints, socio-economic and technical challenges, and specific contextual factors. The study aims to investigate the role of green infrastructure in strategic land use planning in Imo State. The objectives are to:

i. examine how green infrastructure plays its role in strategic land use planning
ii. identify the challenges of green infrastructure in land use planning
iii. recommend key strategies to improve green infrastructure in strategic land use planning.

2. LITERATURE REVIEW

Infrastructure

The "infrastructure" part of the term is used to link green space to economic development theory. It gives a common ground between environmentalists and economic growth strategies, placing green infrastructure as an "enabler" of economic growth (Horwood, 2011). It can be used strategically as a policy "fix" where development investment issues overlap with environmental constraints (Horwood, 2011); growth is facilitated together with satisfying environmental considerations, instead of putting them in conflict with one another (Davies, Macfarlane and McGloin and Roe, 2006; Karnbites and Owen, 2006; and Mell, 2008).

Green Infrastructure

Green infrastructure has been identified as a contributor to improving human health and air quality, lowering energy demand, reducing capital costs, increasing carbon storage, expanding wildlife habitat and recreational space, and even increasing land values by up to 30% (Foster, Lowe and Winkelman, 2011; Jabbar, Yusoff and Shafie, 2021; Hanna and Comin, 2021). Green infrastructure approaches help to achieve sustainability and resilience goals over a range of outcomes, in addition to climate

adaptation: land value, quality of life, public health, hazard mitigation, and regulatory compliance (Foster et al., 2011; Muluneh and Worku, 2022., and Wang'ombe, 2024; Jiang and Menz, 2025; Wang, Xu, An and Guo, 2024).

The Principles of Green Infrastructure Planning

Green infrastructure, a planning approach, goes beyond the conservation of land and natural resources and tries to create a linkage between the conservation of these resources and the development of spaces for people. As described by Mell (2008) and Rosales (2016), green infrastructure brings together different elements from landscape, ecology, geography, and planning in the way it links the ecological capacity of any given area with its corresponding environmental, social, and economic opportunities. A Green Infrastructure approach must consider the needs of the environment together with local perceptions when developing green spaces and to ensure well-being (Mell, 2008., Hansen and Pauleit, 2014., Davies, 2015., and Rosales, 2016) identified four common planning principles for green infrastructure namely: (1) Integration, (2) Delivery of Ecosystem Services or Multi-functionality, (3) Network or Connectivity, and (4) Multiple Scale.

Integration: The "Grey and Green" Elements of Green Infrastructure

Green infrastructure elements are considered to be all open spaces, urban parks, gardens, woodlands, green corridors, street trees and open countryside, within the boundaries of urban areas set – or defined by each region's administrative authorities. We are including elements categorised as "blue infrastructure" in other planning approaches; waterways, rivers, streams, lakes and other water bodies are integral parts of the natural or semi-natural elements of the environment.

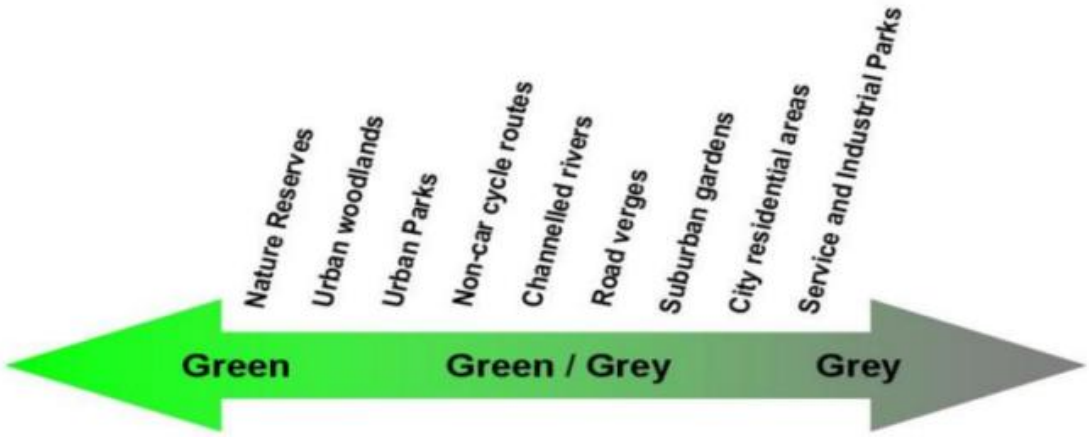

Figure 1. Green-grey continuum. Retrieved from Davies et al. (2006).

Ecosystem Services Delivery and Multi-functionality

Ecosystem Multifunctionality (EMF) refers to the ability of ecosystems to simultaneously provide multiple services – such as provisioning (food and water, regulating (carbon/climate change), cultural, and supporting services – rather than just one. Managing landscapes for multiple services, often through "bundles", enhances sustainability, biodiversity, and societal well-being by balancing ecological and socio-economic benefits.

Green Infrastructure Connectivity or Network

Connectivity refers to the relationship between landscape structure and function; the degree to which "landscape facilitates or impedes the flow of energy, materials, nutrients, species and people across a landscape" (Ahern, 2007). To assess the connectivity of any given landscape, we identify and characterize the aspects that create a connection between the different elements in the landscape as enhancers or reducers of connections (Roux, 2015). The end result is the identification of

physical linkages or existing connections. The "ecological network concept" suggested by Ahern (2007) addresses optimal spatial strategies; initially, its focus was the maintenance of biodiversity, and it is now used by the green infrastructure approach.

Multiple Scales of Green Infrastructure

The multi-scale approach from hierarchy theory (Ahern, 2007) studies how a system behaves simultaneously at different scales. In the case of landscape studies, our areas of study are always nested within larger areas that constrain or control the processes happening within the smaller part. To understand them, the multi-scaled approach assesses the spatial configuration of landscape patterns and ecological processes at different scales (Ahern, 2007). According to Dige (2014), their study, carried out in the review of the European Commission's guidelines for spatial analysis of green infrastructure in Europe, proposes a methodology that can be used by different entities at different scales. This helps in the assessment of landscape green infrastructures, and among its possible uses, it can help identify areas for improvement within green infrastructure. It focuses mostly on analysis at the national and regional level, and clearly states that its purpose is mostly aimed towards rural and natural landscapes (Dige et al., 2014).

Green Infrastructure Framework

To assess green infrastructure based on multi-functionality, Hansen and Pauleit (2014) linked the concepts of green infrastructure and ecosystem services and created a conceptual framework for the multi-functionality of green infrastructure, especially for urban areas. The authors mention how "approaches developed in ecosystem services can help to assess the integrity of green infrastructure networks" (Hansen and Pauleit, 2014). The framework makes a system analysis of green infrastructure from the ecological and social perspective, and then proceeds to do a valuation of multi-functionality.

Role/Benefits of Green Infrastructure

(1). In light of the challenges confronting urban areas due to increasing populations and spatial constraints, green infrastructure is vital for fostering environmental balance, enhancing community well-being, and promoting sustainable urban development.

(2). Green infrastructure improves the quality of the environment, the condition and connectivity of natural areas, as well as improving citizens' health and quality of life.

(3). Multifunctionality: Unlike traditional "grey" infrastructure, green infrastructure serves multiple purposes, such as biodiversity conservation, water management, and recreational space, within the same spatial footprint.

(4). Ecological Connectivity: By linking isolated ecological patches, green infrastructure enhances urban ecological integrity and prevents habitat fragmentation, supporting natural processes.

(5). Resilience to Climate Change: Green infrastructure helps cities manage severe weather events (e.g., heatwaves, flooding) by providing cooling, reducing runoff, and strengthening social-ecological resilience.

(6). Sustainable Development Goals (SDGs): Green infrastructure directly aligns with SDG 11 (Sustainable Cities) by enhancing quality of life and integrating nature into urban landscapes, making cities more inclusive, safe, and resilient.

(7). Smart Development and Management: This involves strategically integrating natural elements – such as parks, green roofs, and wetlands with technology to create efficient, sustainable, and resilient urban environments. Instead of relying solely on traditional "grey" infrastructure (concrete pipes and sewers), green infrastructure uses nature-based solutions to solve urban challenges, providing ecological, social, and economic benefits simultaneously.

Land Use Planning

Land use planning involves the allocation of land to different uses across a landscape in a way that balances economic, social, and environmental values. Its purpose is to identify in a given landscape the combination of land uses that is best able to meet the needs of stakeholders while safeguarding resources for the future (Bako et al., 2017; Huang et al., 2023). Land use planning is the systematic, participatory process of managing land resources to achieve sustainable development, balancing economic, social, and environmental needs (Osuji, 2025). It directs land use to minimize conflicts, protect natural resources, and guide development through zoning – residential, commercial, industrial, and agricultural – to create efficient communities (Tao et al., 2007). Land use planning is the systematic assessment of land and water potential, alternatives for land use, and economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future (Okeahialam and Osuji, 2019; Kent, Wood and Harmington, 2023).

3. MATERIALS AND METHODS

Imo State lies within latitude 4^0 45^1 N and 7^0 15^1 N and longitude 6^0 50^1E and 7^0 25^1 E. It is bounded in the North by Anambra State, in the East by Abia State, in the West by Delta State, and in the South by Rivers and Bayelsa States, with a total land area of 5,100km^2. It comprises 27 Local Government Areas and is divided into three senatorial zones, namely: Orlu, Owerri and Okigwe Zones.

Imo State was created during the military regime of General Murtala Mohammed on the 3rd of February, 1976. Owerri became the capital of Imo State. Imo State has 306 autonomous communities. The projected population of Imo State in 2025 is 6.7 million, and the people are predominantly Igbo speaking people. Imo State is rich in natural resources, which include crude oil and natural gas. The annual rainfall is over 2250 mm (90 inches) with a mean temperature above 26.7^{o}C (Udo, 1978). The relative humidity is between 80 percent and 90 percent in the rainy season (April to October) and about 65 percent in the dry season (November to March). Imo State lies within the rainforest belt of Nigeria. The forest belt is characterized by trees that exist in different layers – low, middle, and upper layers. The assemblage of infrastructure makes Imo State a hub of economic, administrative, institutional, industrial, and commercial activities, which attracts investors to the state. Imo State has six major roads, namely: Orlu, Okigwe, Aba, Umuahia, Onitsha, and Port Harcourt Roads; also, Douglas and Wetheral Roads, access roads, and Sam Mbakwe International Cargo Airport along the Owerri – Aba Road.

Figure 2. Nigeria showing Imo State (Source: Ministry of Lands, Survey, and Physical Planning, 2023)

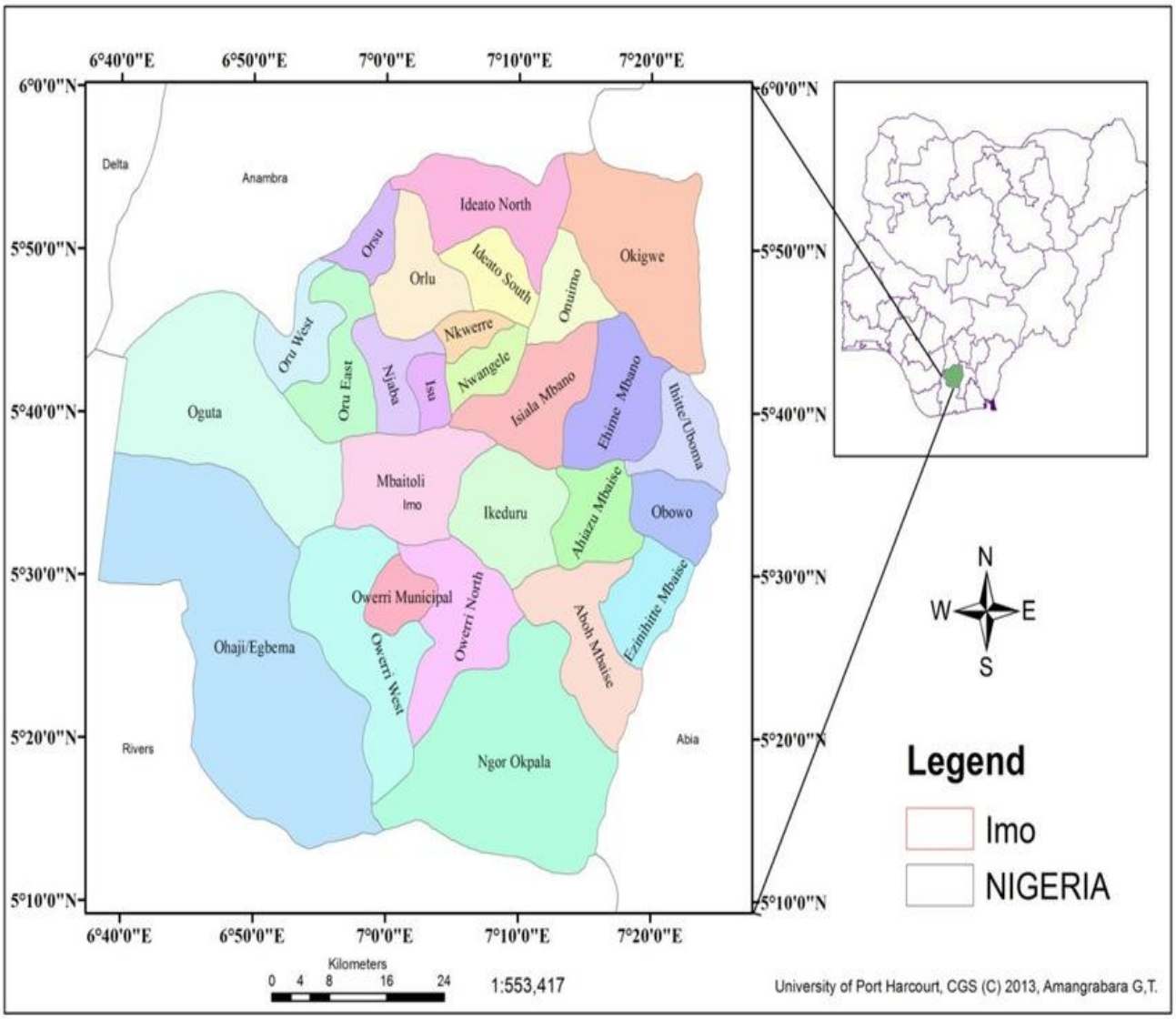

Figure 3. An insert map of Nigeria, showing Imo State [Source: Ministry of Lands, Survey and Physical Planning (2023)]

The research covers Imo State. It was divided into three zones: Orlu, Owerri, and Okigwe Zones. The study design is a survey research design. Data for the study were from primary and secondary sources. Survey methods using questionnaires, which were the main instrument for data collection, oral interviews, direct observation, records, private papers, journals, official records, and the internet were used. Simple random and purposive sampling techniques were used in selecting data collection. The total population of 960 forms the target population. A total of 468 copies of the questionnaire were distributed to the 40 communities selected from 27 Local Government Areas of the three Senatorial Zones of Imo State. Each zone had its share of questionnaire copies. The 40 communities are Okpala, Ngor Okpala, Egbu, Okwu, Umuoba, Umuorii, Orji, Umuororonjo, Amawom, Umuonyeche, Umuonyima, Umuodu, Ikenegbu, Akwakuma, Amakohia, New Owerri, Umuguma, Nekede, Avu, Obinze, Umudagu, Obeazu, Nworieubi, Ubomiri, Akabo, Ata, Abo Mbaise, Awo Omamma, Mgbirichi, Umuagwo, Oguta, Mgbidi, Awo Idemili, Anara, Okwele, Obowo, Ihite Uboma, Ubahu, Okigwe, and Ihube. The formula used was Taro Yamane's formula:

$$\frac{(n = N)}{1 + N\,(e)^2} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

10% attrition was included in the sample size of 468. 420 copies of the questionnaire were retrieved, which represents a response rate of 95%. In all, Town Planners were distributed 65% of the questionnaires, 25% to experienced professionals in the built environment, and 10% to the residents in the study area. Descriptive statistics were used in analyzing the data collected for the study.

4. RESULTS AND DISCUSSION

(1). Green infrastructure is increasingly recognized as a crucial element in building resilient cities that can withstand the impacts of climate change, urbanization, and other environmental challenges.

(2). It provides habitats for wildlife, connecting fragmented ecosystems and supporting biodiversity conservation, improving air quality, as well as improving human health and well-being.

(3). The study found that green infrastructure plays a good role in strategic land use planning in Imo State. It acts as a multifunctional, interconnected network of natural and semi-natural areas such as parks and waterways that delivers essential ecological, social, and economic benefits.

(4). Green Infrastructure is vital for fostering environmental balance, enhancing community well-being, and promoting sustainable urban development.

(5). Accessibility of public green spaces in Imo State: People living in urban areas have access to public green spaces, while those living in rural areas are disadvantaged due to distance. Most of them have limited leaf area and inadequate portions of accessible public green spaces. The majority of green areas within the urban environment are adorned with shrubs and trees. The presence of trees in public gardens, sports fields, and other open spaces provides a contribution of notably high leaf area values.

Challenges of Green Infrastructure in Strategic Land Use Planning in Imo State

It is necessary to study in more detail the "scope and methods" linking multi-functionality to ecosystem services, planning and design of green infrastructure to achieve sustainability. Another link that is missing is the lack of conceptual framing integrated into the practice of day-to-day landscape management. Kabisch, Qureshi and Haase (2015) suggest we need more information from different places to gain a better understanding of the benefits of green spaces and improve the practices of implementation of this planning approach in specific planning contexts.

The challenges for green infrastructure planning are found in addressing the development of adequate infrastructure and amenities required to sustain the population, which is affected by high levels of inequality and poverty. Reduce disaster risk and vulnerabilities to natural phenomena and climate change impacts. Promote development that does not degrade or destroy the environment; promote the preservation of the natural assets in the area.

Green infrastructure in strategic land use planning faces significant challenges in Imo State, driven by rapid urbanization, weak enforcement of planning regulations, and high vulnerability to environmental degradation. As of 2026, the state is actively developing climate change policies through partnerships with Spaces for Change to address these, but several bottlenecks remain:

Institutional and Regulatory Weaknesses

i. Weak Enforcement and Compliance: A fundamental challenge is the failure of developers to adhere to approved land use plans, with many constructing without approvals.

ii. Poor Coordination: There is a lack of inter-departmental coordination among ministries, departments, and agencies (MDAs), which leads to inconsistencies in strategic planning.

iii. Absence of Legal Framework: The lack of a comprehensive legal framework, especially for urban renewal and greening, limits the enforcement of nature-based solutions.

iv. Improper monitoring of development to ensure compliance, especially when a development permit/approval is granted.

Environmental and Physical Constraints

i. High Erosion Vulnerability: Imo State is highly susceptible to gully erosion, with over 50 active gully sites reported, which complicates the establishment of permanent green corridors.

ii. Rapid Loss of Natural Cover: Deforestation and the expansion of built-up areas (increasing from 30.23% in 2017 to 35.78% in 2022 in some studies) are reducing existing green areas and accelerating soil degradation.

iii. Impervious Surface Increase: Increased, unplanned development has created more surfaces that prevent water infiltration, worsening urban flooding.

Socio-Economic and Technical Challenges

i. Insufficient Funding: A major barrier is inadequate budgetary allocation for green projects, alongside a general lack of resources for implementation.

ii. Public Resistance: Development control measures, for instance, demolition of illegal structures, often face resistance from residents, affecting the ability to implement master plans.

iii. Technical Knowledge Gaps: There is a shortage of skilled professionals to plan and maintain green infrastructure projects, such as urban parks and specialized green roofs.

iv. Land Use Conflicts: High demand for land for housing and industry often overrides ecological considerations, leading to the conversion of green spaces.

Specific Contextual Factors (2025 – 2026)

i. Infrastructural Decay: Existing non-functional infrastructure often takes precedence over new green initiatives.

ii. Urgent Need for Climate Action: While the government is acting to address environmental issues through the Spaces for Change and Imo State Ministry of Environment and Sanitation partnership, the need to tackle rising climate vulnerabilities like increased temperature and erratic rainfall is a high-priority, urgent challenge.

iii. Speculative Landholding: The government has had to revoke unused plots at the Owerri Industrial Layout to combat speculative landholding, which prevents proactive, sustainable, and planned green use.

5. CONCLUSION

This study investigates the role of green infrastructure in strategic land use planning. The role of infrastructure and challenges in Imo State were identified. Green infrastructure can possibly help to resolve the issues of urban heat effect and stormwater flooding; interconnected city policies seem very relevant and up-to-date if we wish to ensure the future prosperity of city environments in the next decades. It is concluded that green infrastructure can act as a cross-cutting solution to various sustainability challenges in terms of land use planning.

The following recommendations are proffered based on the findings:

1) Green infrastructure should be integrated into planning, so that communities can create more sustainable and resilient urban environments.

2) It should be strategically planned and integrated into land use plans to ensure connectivity and maximize its benefits.
3) It should be integrated into long-term strategic planning to ensure its sustainability and effectiveness.
4) Planning laws should be adhered to. Developers should build according to the zoning regulations, as these will serve as a blueprint for long-term development and growth of the entire city or region. These provide a framework for guiding future development and decision-making processes and ensuring that growth occurs in a coordinated and sustainable manner (Osuji, 2025).
5) Law enforcement, monitoring, and development control should be put in place to guard against illegal land uses.

Permitting and approval processes granted to developers should be monitored before the commencement of building construction activities and during construction activities.

6. COMPETING INTERESTS

None to declare.

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