Review Article

Sustainable Smart Urban Form: Integration of Green Spaces and Ecosystem Services in Developing Cities of Nigeria

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ABSTRACT

Rapid urbanization in developing cities of Nigeria has led to significant environmental challenges, including the loss of green spaces and the degradation of ecosystem services. This review article explores the concept of sustainable smart urban form as a framework for integrating green spaces and ecosystem services into urban planning and development. The article highlights the importance of green spaces in urban planning, improving public health, and promoting environmental sustainability. The studies show that the integration of green spaces, such as parks, urban forests, and wetlands, can mitigate urban heat island effects, reduce air pollution, and support biodiversity. Additionally, ecosystem services, including water regulation, carbon sequestration, and recreational opportunities, contribute to the overall well-being of urban residents. However, challenges such as competing land-use priorities hinder the implementation of sustainable smart urban forms in Nigerian cities. Rapid urbanization in Nigeria has led to a significant increase in the number of people living in cities resulting in a growing focus on environmental protection and the integration of ecosystem services into urban planning frameworks.

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1. Introduction

Sustainable cities are gaining more attention due to their significant environmental problems as a result of climate change's prominence on the political agenda. There are debates over the relationship between a city's urban form, layout, and environmental performance. Urbanization is a defining feature of the 21st century, with cities worldwide battling with the issues of population growth, infrastructural demands, and environmental sustainability. In Nigeria, the fast development of metropolitan centres like Lagos and Abuja has gained interest in smart city initiatives as a strategy to foster sustainable growth, improve quality of life, and attract global investment [1]. Smart cities optimize infrastructure, government, and urban services by utilizing digital technologies and data-driven methodologies. Intelligent energy grids, effective waste management, smart transportation systems, and strong digital connectivity are essential elements of a smart city. These programs seek to improve the general experience of inhabitants, decrease resource consumption, and increase urban efficiency [2]. With a population of more than 20 million, Lagos, the economic centre of Nigeria, is the most populated city in Africa. Public safety, housing, refuse management, and traffic control are affected by this enormous population. The goal of the city's smart city initiative is to use technology to solve problems. Lagos is known for its heavy traffic. To facilitate mobility, the state government is investigating intelligent traffic management technology, such as digital ride-sharing platforms, Global Positioning System (GPS) enabled public transportation tracking, and adaptive traffic lights [3]. To promote a digitally linked society, projects like the Lagos smart city project seek to expand digital literacy and install broadband infrastructure. The solution to increasing efficiency and accountability is to improve service delivery through digital platforms for business registration, tax payment, and other public services.Abuja, Nigeria's capital can support smart city efforts because of its planned urban design. There are chances to more successfully apply technology-driven solutions because of the comparatively smaller population when compared to Lagos. To meet the city's expanding energy needs and lessen its dependency on fossil fuels, smart grids and renewable energy sources are being explored [4,5].

The urban planning framework in Abuja is being updated to include digital solutions for managing utilities like waste disposal and water delivery. To protect public safety, the government is prioritizing installing surveillance systems and AI-driven crime prevention technology as urbanization increases [6,7].

For Nigeria to establish sustainable cities, especially in fast-urbanizing places like Lagos and Abuja, green spaces and ecosystem services must be incorporated into urban design. This strategy tackles urgent environmental issues while simultaneously improving cities' living standards. Green infrastructure is a system of natural and semi-natural elements that enhances urban resilience and offers ecological advantages. Green infrastructure, such as permeable pavements and green roofs, lowers the danger of flooding by efficiently managing runoff. In packed regions, vegetation serves as a

natural filter, releasing oxygen and absorbing pollutants, a vital function for public health [7].

In modern urbanism, sustainable urban planning concepts and developments, as shown in Figure 1 seek to create urban settings. To encourage social contact, cultural events, and general well-being in public spaces, urban planners give priority to locations such as parks, plazas, and recreational zones. These spaces frequently act as meeting places that improve links within the community. Urban planners consider regional integration rather than a city's isolation. This includes managing infrastructure, protecting common resources (such as farms or waterways), and making sure that growth benefits the whole area. To develop resilient, long-lasting urban settings, urban planning is placing more emphasis on green building practices, energy-efficient infrastructure, and environmental protection as a result of growing awareness of climate change and resource depletion. For a complete neighbourhood, residents can easily access basic amenities such as public transportation, schools, food stores, and medical facilities.

In terms of the economy, sustainable urban planning aims to ensure economic viability and effective resource utilization, making sure those metropolitan regions can sustain robust economies without depleting their natural resources. This involves supporting green businesses and employment, lowering energy use through creative design, and fostering regional economic growth [8]. The article will provide an overview of green spaces and ecosystem services in urban sustainability, the role and importance of green spaces in urban planning, and discuss the role of ecosystem services in environmental protection. The study stands out by addressing the specific challenges faced by rapidly urbanizing Nigerian cities, which are often overlooked in broader global studies. While existing literature on sustainable urban planning predominantly focuses on developed nations, our work shifts the lens to developing regions, where urbanization is occurring at an unprecedented pace without adequate planning frameworks. Another key distinction of our study lies in its comprehensive exploration of how green spaces such as parks, urban forests, and wetlands can be systematically integrated into urban planning to enhance ecosystem services. The study introduces the concept of sustainable smart urban forms as an innovative framework for urban planning. This study not only advances academic understanding, but also provides a foundation for transformative urban planning practices that prioritize both human well-being and environmental sustainability.

Figure 1: Concepts of urban planning.

1.1. Overview of Green Spaces and Ecosystem Services in Urban Sustainability

Forests, meadows, residential yards, parks, grassy lawns, rain gardens, and engineered

green roofs are examples of urban green spaces (UGS), which offer a variety of ecosystem services to both the environment and people. The ecosystem services offered by these UGS are highlighted in studies focusing on Europe, North America, Australia, and more recently, China. These services include ecological services (such as supplying habitats for urban wildlife and biodiversity conservation), social and human health benefits, and environmental services (such as lowering elevated urban heat, pollution, flood mitigation, and offsetting greenhouse gas emissions) [9].

Often called "green lungs" or "urban oases," urban green spaces are sections of urban settings planted with vegetation. These can include large parks, community gardens, and street-side trees. Cities are growing denser as a result of the phenomena of urbanization, which has seen an unparalleled influx of people from rural to urban areas. Although this tendency fosters innovation and economic growth, it also presents several difficulties. Increased pollution, fewer green spaces, and the growth of concrete buildings are all signs of rapid urbanization, which hurts the environment and the health of city people. This urban transformation has many consequences. In addition to endangering biodiversity, diminished green spaces also fuel the urban heat island effect, a phenomenon in which cities' temperatures rise as a result of heat being absorbed and retained by constructed surfaces [10,11].

Further emphasizing the connection between environmental health and human well-being include the increase in pollution and sedentary lifestyles in metropolitan areas, which have increased public health concerns. For sustainable city living, urban green spaces offer a variety of ecosystem services. Absorbing carbon dioxide from the atmosphere, trees, and other vegetation assist in balancing out emissions from urban activity. Because they absorb rainwater, green spaces help manage storm-water more effectively, lowering the danger of flooding and runoff during periods of severe precipitation, reducing noise pollution from industry and traffic, and vegetation can provide a peaceful urban setting [12].

1.2. Development patterns of sustainable urban form

The United Nations World Commission on Environment and Development released the Brundtland Report, also known as Our Common Future, in 1987 as part of their quest for a sustainable development route [13]. It defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs and is regarded as the beginning of global sustainability. Different people have different ideas about the definition of sustainable development. "It can be defined within different political ideologies and programs underpinned by different kinds of knowledge, values and philosophy". Thus far, there has been no consensus on how such development should be defined or attained. The concept of sustainable urban development is thus ever-changing and evolving. A city's ability to reach new levels of socioeconomic, demographic, and technological output which in the long run reinforces the foundations of the urban system is how it is characterized in terms of its economic sustainability [14,15].

Others might place greater emphasis on social sustainability and social principles, such as equity, participation, and the future, particularly the public's involvement in the land development process. The idea of sustainable urban development is complex. It combines protecting the environment with land development. It also refers to the quality of life of its residents, the ability of nature to sustain its activities, and the vitality of a city as a complex system. Likewise, human development, environmental preservation, and resident well-being are some of the areas that are included in sustainable urban development. However, despite all the discussions, no single or agreed meaning has been produced. Taking account of all the concerns stated above, this study proposes to define sustainable urban development as the capacity of any significant human settlements to maintain environmental quality and carrying capacity, support socio-economic development and management, and provide sufficient services and livelihoods to all current and future inhabitants. In other words,

only in the overlap, or the dynamic, between the three basic capacities can sustainability be effectively and fully realized (Figure 2) [16-18].

In Figure 2, maintaining environmental quality and carrying capacity emphasizes preserving natural resources such as clean air, water, and green spaces and ensuring that urban growth does not exceed the environment's capacity to support it. Providing sufficient services and livelihoods for current and future inhabitants focuses on meeting people's needs from housing, transportation, and healthcare to education, employment, and recreation without undermining the well-being of future generations. Supporting socio-economic development and management involves creating jobs, encouraging innovation, and managing resources in a way that benefits local communities while remaining adaptable to changing social and economic conditions.

2. The role and importance of green spaces in urban planning

Green spaces are an essential part of urban planning, and their importance is recognized for maintaining the sustainability and natural quality of the urban environment. Urban Green Spaces (UGS) refers to a city's parks, gardens, recreational areas, bio-parks, waterfronts, historical sites, railroad and road corridors, and native vegetation. Overgrown gardens and abandoned industrial sites are examples of urban environments that exhibit UGS. To address the societal demands for green space, the system approach to UGI is more quantitative [19,20]. Greenbelts, green wedges, parks, and other city-centric artificially constructed scenic areas are examples of such places. Urban dwellers benefit from the UGS in several ways. They function like urban lungs, releasing oxygen and holding onto pollutants. Along with supplying clean air, they also aid in soil and water conservation and maintain the natural urban environment of the city [23]. Many studies show that UGS improves human behaviour and characteristics and aids in the recovery from stress and anxiety, both mental and physical. Cities' sustainable development is greatly impacted by urban green spaces. Interventions involving green areas enhance the city's natural character, enhance the environment, encourage outdoor enjoyment and active lifestyles, and preserve biodiversity by establishing habitats for wildlife. In addition, they lessen surface runoff and heat island impacts on a broader scale. Recently, there has been a focus on their contributions to lowering carbon emissions and enhancing public health.

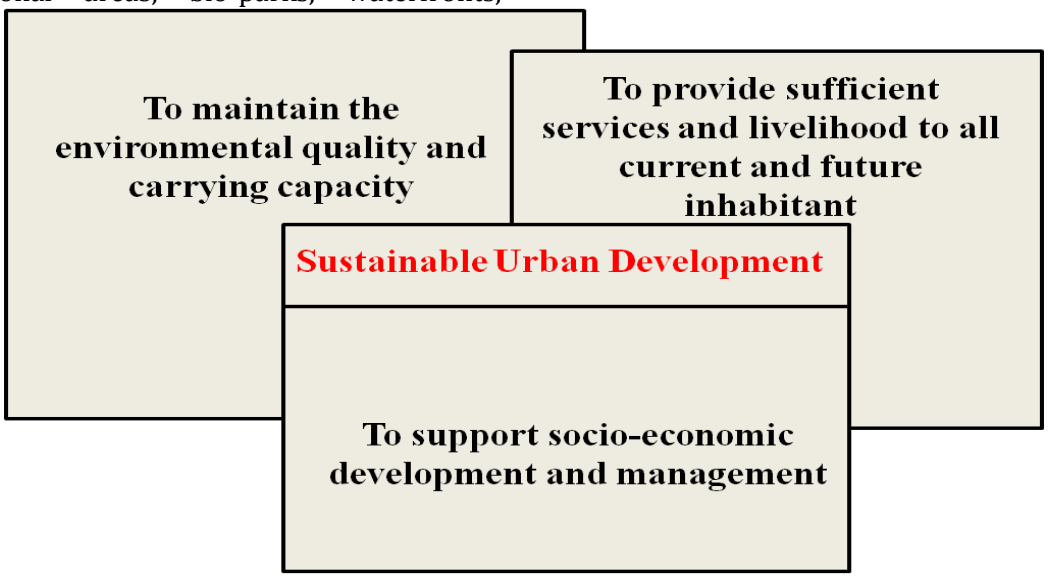

Figure 2: Three aspects of sustainable urban development.

Haq [21] suggested that there are numerous advantages to urban green spaces, which fall into three main categories: economic, aesthetic, social, psychological, and environmental

advantages. The reduction or prevention of urban noise is a significant ecological benefit that urban green spaces offer. Urban green spaces can lower urban noise levels by three to five decibels, according to a study by Perez Lopez and Lucas de Souza [22] in the city of São Carlos.

With their variety of plant species, urban green spaces promote biodiversity and aid in its growth. In addition, because of their soil, water supplies, and natural structures, urban green spaces can maintain their natural structures without being impacted by urban pollutants. These characteristics make up essential ecological areas for the preservation and growth of urban birds, insects, and other living creatures [24,25]. Besides their ecological and sociological advantages, urban green spaces also benefit the economy. A study in four Canadian cities demonstrated the economic advantages of these regions by revealing that homes near urban green spaces are 3% to 20% more valuable. Urban trees and plant communities in these regions lower the energy consumed in cooling systems and give energy savings, particularly during the summer months, as they control the urban environment [26].

2.1. Ecosystem services in urban planning

Regulation, provisioning, cultural, and supporting services are the four categories of ecosystem services. Buffer zones, trash management, disease control, and climate regulation are examples of regulating services. Resources such as food, water, raw materials, and medical supplies are produced as part of provisioning services. Tourism, recreation, science, education, and the arts and religion are all included in ecosystem services. Other services, like habitat, biodiversity, nutrient cycling, and more, are built upon supporting services [27].

Over 55% of the world's population lived in cities in 2019, and by 2050, that percentage is expected to rise to almost 68% (United Nations, 2018). This is an unparalleled increase in urbanization. Numerous sectors are impacted by the rise in environmental issues brought on by this massive urbanization. Among these problems are risks and water management [28].

Over the past ten years, with the advent of modelling tools and high-resolution spatial datasets, significant progress has been made in assessing and integrating ecosystem services into landscape planning. Ecosystem service models, which move away from single-goal-centred approaches, offer valuable tools to support national and regional decision-making by evaluating service trade-offs and synergies across different sectors under a variety of management scenarios. Recently, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has taken the lead in reviewing and summarizing current modelling tools to help policymakers use them effectively and to guide their usage in regional, global, and thematic assessments. Guidelines on how and when to manage ecosystems and their services to meet one or more human development targets, however, are still not well-defined and are challenging for policymakers to implement into national development plans [29].

There are several explanations for this recent shift to ES. Communicating the advantages of ecosystem conservation to various stakeholder groups has been made easier by the notion. Based on our reliance on the products and services that species and ecosystems offer, it is assumed that this is because it offers a fresh, human-centred rationale for their preservation. According to Daily and Ellison [30], researchers and practitioners also hope that the ES idea will make conservation more mainstream and economically appealing. The concept's ability to integrate biodiversity protection into the management of a larger landscape, including privately owned land, and to expand its reach beyond protected areas is another advantage. Payments for ecosystem services could be used to accomplish this [31].

Recent work has begun to argue that explicitly incorporating ecosystem services into urban planning could better prioritize environmental conservation during urban growth. Reflecting the trade-offs between various development scenarios, ecosystem services could aid in improving land use decisions by acknowledging the importance of healthy urban ecosystems to

social welfare and human well-being. Nonetheless, the incorporation of ecosystem services into urban land-use planning and decision-making is still relatively new [32].

2.2. Ecosystem services as human-centred services

Ecosystem services represent the diverse benefits that natural systems provide to humanity, encompassing provisioning, regulating, supporting, and cultural services. These services include essentials such as food, clean water, climate regulation, and recreational opportunities, all critical to human well-being [33].

In urban settings, the significance of ecosystem services grows as they mitigate the adverse effects of urbanization and enhance quality of life. Urban forests and parks, for example, act as carbon sinks, reduce the urban heat island effect, and improve air quality [34].

In Nigerian cities, where rapid urbanization puts immense pressure on natural resources and degrades environmental quality, the recognition of ecosystem services as central to human welfare becomes crucial. Beyond environmental benefits, ecosystem services also contribute to social and economic well-being by supporting livelihoods and fostering community engagement [35].

Developing cities must therefore prioritize the integration of ecosystem services into urban planning frameworks to ensure sustainable growth and enhanced urban resilience. Understanding ecosystem services as human-centered highlights the interconnectedness of supporting services, provision services, cultural services, regulating services, and urban life, as demonstrated in Figure 3. These services form the foundation for sustainable urban living by addressing essential human needs and promoting environmental stewardship [36].

For instance, wetlands in urban areas help in flood control, while green spaces offer residents access to recreation and stress relief. However, in many developing cities in Nigeria, ecosystem services remain undervalued and underutilized due to poor urban planning and limited public awareness. Incorporating ecosystem services into the design and management of cities, urban areas can achieve a balance between development and environmental sustainability, ensuring a higher quality of life for all residents.

2.3. Rapid urbanization and its environmental impacts

The exponential growth of Nigeria's urban population over recent decades has been fuelled by rural-to-urban migration and natural population increases [37]. This rapid urbanization has given rise to a host of environmental challenges, including deforestation, biodiversity loss, increased greenhouse gas emissions, and inadequate waste management [38]. Urban sprawl, often unregulated, exacerbates these problems by leading to informal settlements and overburdened infrastructure.

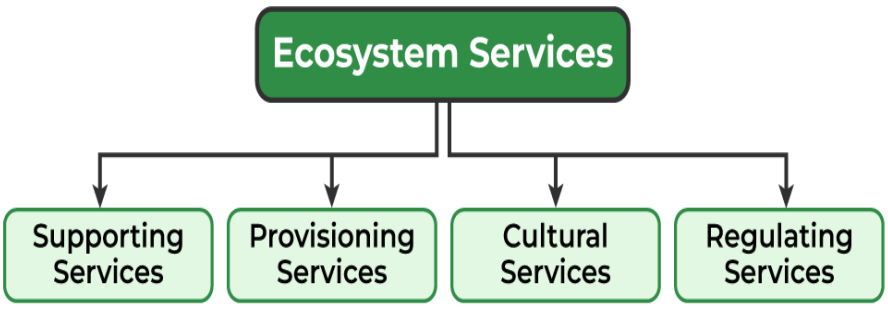

Figure 3: Types of ecosystem services.

Consequently, many Nigerian cities face water pollution, poor air quality, and a diminishing capacity to provide critical ecosystem services. These environmental impacts pose significant

risks to public health, economic productivity, and overall urban liveability, highlighting the urgent need for sustainable urban planning. As urbanization continues at an unprecedented pace, the environmental implications become more pronounced, particularly in developing countries like Nigeria. The unchecked expansion of cities often prioritizes economic growth over environmental protection, resulting in unsustainable practices that strain natural ecosystems [39].

For example, the conversion of green spaces into built environments not only reduces biodiversity but also limits the capacity of cities to adapt to climate change. Addressing the environmental impacts of rapid urbanization requires a paradigm shift in urban development policies to emphasize sustainability, resilience, and the integration of green infrastructure. Without such measures, the negative consequences of urbanization are likely to undermine the long-term viability of Nigerian cities.

2.4. Lack of green infrastructure in Nigerian cities

Green infrastructure, encompassing elements like parks, urban forests, green roofs, and wetlands, is conspicuously absent in many Nigerian cities. This deficiency is largely attributed to poor urban planning, lack of political will, and inadequate funding [40]. The absence of green infrastructure leads to increased vulnerability to flooding, reduced air quality, and limited urban resilience against climate change [41].

In addition, the preference for grey infrastructure, such as roads and buildings, over green alternatives further widens the gap between urban development and environmental sustainability. This imbalance not only exacerbates environmental challenges, but also diminishes the quality of life for urban residents [42].

The lack of green infrastructure in Nigerian cities highlights a critical need for more sustainable urban planning practices. Green infrastructure offers numerous benefits, including improved air and water quality, enhanced biodiversity, and better climate resilience [43].

However, the failure to prioritize such initiatives reflects broader governance and policy shortcomings. Many urban areas lack the institutional capacity and regulatory frameworks necessary to integrate green infrastructure into city planning. Addressing this issue requires a concerted effort to mobilize resources, build technical expertise, and foster collaboration among stakeholders. Through adopting green infrastructure, Nigerian cities can create more sustainable environments for their growing populations.

2.5. Governance and policy limitations to sustainable smart urban forms

Governance and policy frameworks in Nigeria are often inadequate in promoting sustainable smart urban forms. Weak institutional capacity, inconsistent urban policies, and limited enforcement of environmental regulations undermine efforts to integrate green spaces into urban development [44].

For instance, fragmented decision-making among government agencies frequently leads to poorly coordinated urban planning initiatives. Furthermore, policies that prioritize short-term economic gains over long-term sustainability further complicate efforts to create environmentally friendly urban forms. This lack of governance capacity not only hinders the development of green infrastructure but also reduces the overall resilience of Nigerian cities [45].

Addressing governance and policy limitations requires a comprehensive approach to reforming urban planning frameworks. This includes strengthening institutional capacity, improving inter-agency coordination, and enforcing environmental regulations more effectively. Furthermore, policymakers must adopt a long-term perspective that balances economic development with environmental sustainability [46]. Collaborative approaches that engage stakeholders from various sectors can also enhance policy effectiveness and ensure the successful implementation of sustainable urban initiatives. Addressing these governance challenges, Nigerian cities can pave

the way for smart urban forms that integrate green spaces and ecosystem services.

2.6. Socioeconomic and cultural barriers to sustainable urban planning

Socioeconomic and cultural factors significantly influence urban development patterns in Nigeria. High levels of poverty and inequality often limit investments in green infrastructure, as resources are directed toward addressing immediate economic challenges [47].

Moreover, cultural perceptions that undervalue the importance of green spaces further impede efforts to prioritize sustainable urban planning. Many communities view urban greenery as non-essential, focusing instead on infrastructural development to meet basic needs. This mindset, coupled with limited public awareness about the benefits of green infrastructure, presents a major obstacle to achieving sustainable urban growth. Overcoming socioeconomic and cultural barriers requires targeted interventions that address both the economic and social dimensions of urban planning. Initiatives that promote community engagement and education can help shift public attitudes toward valuing green spaces. Furthermore, integrating green infrastructure into broader poverty alleviation and economic development strategies can ensure that sustainability becomes a shared priority [48].

Addressing these barriers, Nigerian cities can create urban environments that balance economic growth, cultural values, and environmental sustainability.

2.7. Relationship between sustainable urban form, green spaces, and ecosystem services

Sustainable urban form is inherently linked to the integration of green spaces and ecosystem services, as both are essential for creating liveable and resilient cities. Green spaces provide numerous benefits, including recreational opportunities, improved mental health, and enhanced social cohesion [49]. Simultaneously, ecosystem services contribute to urban resilience by mitigating climate change impacts, reducing flooding, and improving air and water quality. Together, they form a foundation for sustainable urban living, enabling cities to balance economic development with environmental protection [50].

The relationship between sustainable urban form, green spaces, and ecosystem services underscores the need for integrated urban planning approaches. In prioritizing green infrastructure, cities can enhance ecosystem service delivery while promoting social and economic well-being. For example, urban parks not only provide aesthetic and recreational value but also support biodiversity and climate adaptation [50].

In the context of Nigerian cities, aligning urban planning with these principles offers a pathway to addressing the challenges of rapid urbanization. Embracing sustainability, Nigerian cities can create urban environments that are not only functional, but also resilient and inclusive.

2.8. Integration of green spaces and ecosystem services into urban forms

Urbanization has led to the degradation of natural habitats and ecosystem services, compromising human well-being and environmental sustainability [52]. The world is experiencing rapid urbanization, with over 50% of the global population living in cities [66]. This trend is expected to continue, with the global urban population projected to reach 6.7 billion by 2050 [66].

As cities grow and expand, they face numerous challenges, including environmental degradation, social inequality, and economic instability. One strategy for addressing these challenges is the integration of green spaces into the urban planning, community engagement, and participation as well as collaborative governance and partnerships. Urban planning and design strategies are essential for creating green spaces that are accessible, visible, and connected to other urban areas. One approach is to incorporate green spaces into urban design, using techniques such as green infrastructure, urban

forestry, and landscape architecture [53]. Green infrastructure, including green roofs, rain gardens, and permeable pavements, can help manage storm-water runoff and reduce urban flooding [59]. Another approach is to create green corridors and networks, connecting fragmented green spaces and enhancing biodiversity and ecosystem services [64]. Green corridors can also provide habitat for urban wildlife, mitigate the urban heat island effect, and improve air quality [54].

Furthermore, one approach is to engage with local communities in the planning, design, and maintenance of green spaces, using techniques such as participatory budgeting, community-based planning, and volunteer programs [58]. Community-based planning can help ensure that green spaces are accessible, safe, and responsive to community needs [63].

Fostering community ownership and stewardship of green spaces, using techniques such as community gardening, urban agriculture, and environmental education is another approach [51]. Community ownership and stewardship can help promote a sense of responsibility and pride among community members, enhancing the long-term sustainability of green spaces. Collaborative governance and partnerships are also necessary for securing funding, expertise, and resources for green spaces. Another approach is to foster interagency collaboration among government agencies, private sector companies, and civil society organizations [55]. Interagency collaboration can help leverage resources, expertise, and funding for green spaces, enhancing their sustainability and effectiveness. This is in addition to establishing public-private partnerships, using techniques such as joint financing, co-management, and collaborative planning [61].

Public-private partnerships can help finance, design, and maintain green spaces, leveraging private sector expertise and resources. Green spaces, including parks, gardens, and green roofs, provide numerous benefits for urban residents, including improved air and water quality, reduced urban heat island effects, and enhanced biodiversity [54-65]. Green spaces also have social and economic benefits, including improved mental health, increased property values, and enhanced community engagement [63].

2.9. Public-private partnerships (PPPs) for green infrastructure development

Green infrastructure provides numerous environmental, social, and economic benefits [53]. These benefits include improved air and water quality, reduced urban heat island effects, and increased biodiversity. However, developing and maintaining green infrastructure requires significant funding and resources. PPPs offer a viable solution, enabling governments to partner with private sector companies to deliver green infrastructure projects [52].

Leveraging private sector financing, expertise, and innovation, PPPs can help bridge the funding gap and accelerate green infrastructure development. Public-private partnerships (PPPs) offer several benefits for green infrastructure development. This includes access to funding, allowing governments to leverage private sector financing for green infrastructure projects [56]. Private sector partners bring technical expertise, innovation, and efficiency to green infrastructure projects [60]. PPPs enable risk sharing between public and private partners, reducing the financial burden on governments [62].

In addition, PPPs can expedite project delivery, as private sector partners often have more flexibility to mobilize resources quickly (London Green Infrastructure Fund). This can help accelerate the development of green infrastructure, enabling cities to respond more quickly to environmental challenges. While PPPs offer several benefits, they also present challenges and limitations. PPPs involve complex agreements and high transaction costs [52]. They require careful risk allocation and management to ensure successful project delivery [56]. PPPs may face public resistance or skepticism, highlighting the need for effective stakeholder engagement [60].

Furthermore, PPPs must address environmental and social concerns, ensuring that green infrastructure projects meet sustainability standards [62]. These challenges underscore the need for careful planning,

robust risk management, and effective stakeholder engagement in PPPs for green infrastructure development. To ensure successful PPPs for green infrastructure development, several best practices should be adopted. Clear project definition and scope are essential, defining project objectives and key performance indicators (KPIs) clearly [52].

Risks should be allocated fairly, and effective risk management mechanisms established [56]. Transparent and competitive procurement processes should be ensured to select private sector partners [60]. Effective stakeholder engagement is also crucial, deliberating with stakeholders, including local communities, to ensure public acceptance and support [62].

Finally, robust monitoring and evaluation frameworks should be established to track project performance and Key Performance Indicators (KPIs) (London Green Infrastructure Fund, n.d.). Adopting these best practices, PPPs can help deliver successful green infrastructure projects that meet environmental, social, and economic objectives. Several successful PPPs for green infrastructure development have been implemented worldwide. Examples include the Green Infrastructure Fund (GIF) in Australia, the Chicago Green Infrastructure Partnership, and the London Green Infrastructure Fund [57,62].

Moreover, Nigeria has also explored PPPs for infrastructure development, including green infrastructure, with the Infrastructure Concession Regulatory Commission (ICRC) Act of 2005 providing the legal framework. While specific examples of green infrastructure PPPs in Nigeria are limited, the country's experience with PPPs highlights the potential for innovative financing models to address infrastructure deficits.

2.10. The role of research and education in promoting green infrastructure

Green infrastructure plays a vital role in mitigating the impacts of climate change, improving environmental sustainability, and enhancing quality of life [53]. Research and education are essential components in promoting green infrastructure, as they facilitate the development of innovative solutions, inform decision-making, and foster a culture of sustainability [52]. Research plays a crucial role in advancing green infrastructure technologies, evaluating their effectiveness, identifying best practices, and addressing climate change [54].

Developing new technologies and materials, researchers can improve the environmental, social, and economic benefits of green infrastructure [59].

They also help identify successful green infrastructure projects and strategies, providing models for replication and scaling up [58].

Education is equally important in promoting green infrastructure. By raising awareness about the importance of green infrastructure, education can inspire community engagement and participation in green infrastructure planning and implementation [63].

Likewise, education builds the capacity of urban planners, policymakers, and practitioners to design, implement, and maintain green infrastructure [61]. Furthermore, education fosters interdisciplinary collaboration among architects, engineers, ecologists, and social scientists to develop holistic green infrastructure solutions. Collaborative research and education initiatives are essential for promoting green infrastructure. University-community partnerships, interdisciplinary research centres, professional training programs, and public outreach and education programs can all contribute to advancing research and education in green infrastructure [63].

Collaborating with researchers, educators, and practitioners can promote the development and implementation of effective green infrastructure solutions, ultimately contributing to more sustainable, resilient, and living cities.

2.11. Limitations and future direction of urban development in Nigeria

Most participating groups reported that civic leaders in particular gave some signs that organizations and persons who frequently feel left out of the traditional land acquisition process may prefer the informal land delivery

or acquisition procedure. This is because the official land delivery procedures have flaws, such as delays and exorbitant transaction costs. For example, one civic leader in Abuja said, "The community loses when the government buys land from the community". The government owns the land and distributes it however it sees fit. This lowers the amount of land that is available to that community. As a result, there is less land available for that community. The participant clarified that the amount of property that a community owns is diminished by the size of the land that the government purchases through forced purchase. Consequently, community members no longer have access to such land. When compensation for the acquisition is not given and the government distributes the land without taking into account community members in favour of meeting the demands of the wealthy and elite in society which is frequently the case the situation deteriorates [67].

Access to land was not thought to be significantly limited by gender. This is because financial capability is becoming a more significant factor in determining access to land. Nonetheless, some of the participants' especially civic leaders mentioned the potential for gender-based discrimination. They claimed that although some traditional groups in the nation still have restrictions on women's land ownership, these restrictions do not necessarily prevent women from owning land; rather, they place women in a subordinate position to men. It was also discovered that the reason these restrictions persist is because they are based on upholding family customs and benefit men, who are influential in various communities [67].

In Nigerian cities, housing is the least accessible, least affordable, and least equitable, even though these factors have been the main focus of numerous housing policies and programs. There is a terrible housing market where policies are at best only partially implemented and where informal housing production still predominates, according to Fatusin and Aribigbola's [68] study of the urban housing market in Ondo state. This confirms the need for more homes to accommodate a population of 170 million people expands by 2.5% annually. The state's informal sector dominates the housing market, and because developers are not subject to quality standards or lending programs, the result is a chaotic housing market. The increase of the housing stock, the production of housing materials, housing economics, and housing infrastructure have all improved somewhat as a result of the free market structure's functioning; the above-mentioned primary goals have not been met. In their study of housing quality in the urban centers of Ondo state, Akure, Ikare, and Okitipupa, Fatusin and Aribigbola [68] found that 35% of homes in these cities can be categorized as poor based on criteria like the presence or absence of structural defects, building materials, roofing, privacy, and the availability of courtyards or court gardens, among other things, while more than 11% are in dilapidated forms. However, of these 46% (poor and dilapidated), the majority (58%) were constructed after the National Housing Policy's launch. Nigeria's housing issues are widespread, according to the country's housing experts. The Nigerian National Bureau of Statistics had previously assessed the entire housing shortage in 2007 to be between 12 and 14 million, but a more recent United Nations assessment put it at 17 million. The Nigerian Federal Government created the National Housing Programme (NHP) in 1991, reviewed it in 2002, and created a new one in 2012 in an attempt to address this problem [69].

All participant groups acknowledged that one of the largest issues facing all of the nation's cities is the provision of infrastructure according to the previous literature. Everyone who took part in the survey agreed that informal settlements lacked infrastructure, and that uncontrolled informal development was threatening to encroach on the existing infrastructure. Participants from the public and private sectors also noted that, in certain formal settlements, infrastructure is either non-existent or of low quality, even despite master plan requirements and the good intentions of accountable parties. It was observed, meanwhile, that there have been occasions in which the government and informal settlements have collaborated to offer these

communities essential services and infrastructure [70].

For example, the Enugu participants were again cited by the Emene community. The participant groups also acknowledged that basic infrastructure for informal growth can occasionally be provided through community self-help and non-governmental organization support. In big towns where master plans already exist, it is also important to make sure they are implemented and monitored appropriately. In cases where master plans are out-dated or non-existent, new ones must be prepared and implemented. In addition, it is necessary to analyse existing master plans to make sure they are still relevant to the current situation. The problem of weak institutions, particularly those related to urban development, such as the ministries of urban development, needs to be addressed to withstand political interventions from powerful people who are determined to get around the system for their gain. For local governments to effectively carry out their responsibilities in urban development as outlined by the Urban and Regional Planning (URP), they should be strengthened [69].

3. Conclusion

Sustainable cities are increasingly important due to climate change's political agenda. Cities like Lagos and Abuja in Nigeria are focusing on smart city initiatives to foster sustainable growth, improve quality of life, and attract global investment. These initiatives optimize infrastructure, government, and urban services using digital technologies and data-driven methodologies. Urban green spaces (UGS) provide ecosystem services to both the environment and people. These services include ecological services, social and human health benefits, and environmental services such as lowering elevated urban heat, and pollution, flood mitigation, and offsetting greenhouse gas emissions. Rapid urbanization has led to increased pollution, fewer green spaces, and the growth of concrete buildings, which negatively affect the environment and the health of the citizens. The concept of sustainable urban development proposes that sustainable urban development is the capacity of any significant human settlements to maintain environmental quality and carrying capacity, support socio-economic development and management, and provide sufficient services and livelihoods to all current and future inhabitants. Incorporating ecosystem services into urban planning can achieve a balance between development and environmental sustainability, ensuring a higher quality of life for all residents. Rapid urbanization in Nigeria has led to a significant increase in the number of people living in cities, which has led to a growing focus on environmental protection and the integration of ecosystem services into urban planning frameworks. The study highlights collaboration between government and informal settlements to provide essential services and infrastructure for informal growth. Weak institutions, particularly urban development ministries, need to be addressed to withstand political interventions. Strengthening local governments is essential for effective urban development.

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Conflict of interest

The authors declare that there are no conflicts of interest in this study.

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