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Benefits of Integrating Green Architecture in Public Buildings within the Savannah Region of Nigeria: A Review

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Abstract

This study examines the benefits of integrating green architecture into public buildings in the savannah region of Nigeria. The study emphasizes the region's unique climatic conditions, characterized by high temperatures and significant diurnal variations, and explores how green architecture can mitigate environmental challenges and enhance building efficiency. Key benefits identified include reduced energy consumption through natural cooling and ventilation, improved indoor air quality, and enhanced occupant comfort. The implementation of sustainable building materials and practices is discussed, highlighting their potential to reduce the carbon footprint and operational costs of public buildings. Additionally, the review addresses socio-economic impacts, such as job creation in green construction and long-term cost savings for government facilities. By synthesizing existing research, the paper aims to provide an understanding of how green architecture can promote environmental sustainability, economic resilience, and improved public health in the savannah region of Nigeria.

Keywords: Green Architecture, Public Buildings, Savannah Region, Green Building Practices.

Introduction

The rapid urbanization and industrialization of the 20th and 21st centuries have led to significant environmental challenges, including resource depletion, climate change, and environmental degradation. In response to these issues, the concept of green architecture has emerged as a sustainable approach to building design and construction. Green architecture aims to minimize the environmental impact of buildings through energy efficiency, resource conservation, and the use of sustainable materials and practices (Kibert, 2016). Buildings are a major contributor to global energy consumption and energy-related carbon dioxide emissions (Capeluto, 2022). According to the United Nations Environment Programme, buildings and construction together account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO_2) emissions when upstream power generation is included (UNEP, 2019).

The Nigerian climate, particularly in the savannah regions, presents unique challenges such as high temperatures and seasonal variations in rainfall. These conditions necessitate the adoption of architectural strategies that can enhance thermal comfort, optimize natural ventilation, and utilize renewable energy sources effectively (Owoeye et al., 2019). According to Liu T. *et al.* (2022), the built environment of cities in the tropics seems to suggest micro planning of public spaces with consideration given to temperature variations as to where the city warms and cools more slowly; experience increased surface runoff

during heavy rainfall, less evaporation; public spaces more likely having a surge in usage at certain hours of the day.

Historically, traditional Nigerian architecture has incorporated elements of sustainability, utilized local materials and adapted to the climatic conditions. Examples include the use of mud bricks and thatched roofs in rural buildings, which provide natural insulation and ventilation (Olanipekun et al., 2018). Modern green architecture builds on these traditional practices, incorporating advanced technologies and design strategies to further enhance building performance and reduce environmental impact.

Internationally, green architecture has gained recognition through frameworks such as the Leadership in Energy and Environmental Design (LEED) certification, which sets standards for environmentally responsible building practices (USGBC, 2020).

Integrating green architecture principles in public buildings offers a pathway to mitigate these challenges while promoting environmental stewardship. This study aims to investigate the various benefits of integrating green architecture in public buildings within this savannah region of Nigeria.

Problem Statement

The savannah region of Nigeria faces significant environmental, economic, and social challenges that are exacerbated by rapid urbanization and climate change. The savannah regions, characterized by hot and dry climates, traditional building practices often result in structures that are thermally uncomfortable and energy-intensive. These regions face specific challenges such as high temperatures, water scarcity, and limited natural resources, making the adoption of sustainable building practices essential (Owoeye et al., 2019). Despite the potential benefits of green architecture, its implementation remains limited in these areas due to lack of awareness, insufficient policy support, and financial constraints (Olanipekun et al., 2018). Therefore, there is a critical need to explore the benefits of integrating green architecture principles in public buildings in the savannah regions of Nigeria, to promote environmental sustainability, energy efficiency, and improved living conditions.

Objective

The objective of this research is to investigate and highlight the benefits of integrating green architecture principles in public buildings within the savannah regions of Nigeria.

Methodology

This study employs a qualitative research design to investigate the benefits of integrating green architecture in public buildings in the savannah region of Nigeria. The research process involves several key phases: literature review and data analysis. Data were collected through detailed literature reviews which was the primary source used to establish a

theoretical foundation and context for the study by examining existing research on green architecture and its benefits.

Result and Discussion

Savannah Region of Nigeria

The savannah region of Nigeria is a significant geographical and ecological zone, characterized by its distinctive climatic patterns, vegetation, and socio-economic activities. It encompasses a broad area stretching across the northern and central parts of the country, contributing to Nigeria's biodiversity, agriculture, and cultural heritage. Understanding the features and dynamics of the savannah region is crucial for sustainable development and environmental conservation. The savannah region covers a substantial portion of northern Nigeria, including states such as Kaduna, Kano, Katsina, Sokoto, and Borno. It also extends into parts of the central region, incorporating states like Niger and Kogi (Oladipo, 1995). The Nigerian savannah is typically divided into two main sub-regions:

a) **Guinea Savannah:** Also known as the Southern Savannah, this sub-region lies just below the Sahel and is characterized by its relatively higher rainfall and more diverse vegetation.

b) **Sudan Savannah:** Situated further north, this sub-region is drier and has a sparser distribution of vegetation, with longer dry seasons and shorter wet seasons.

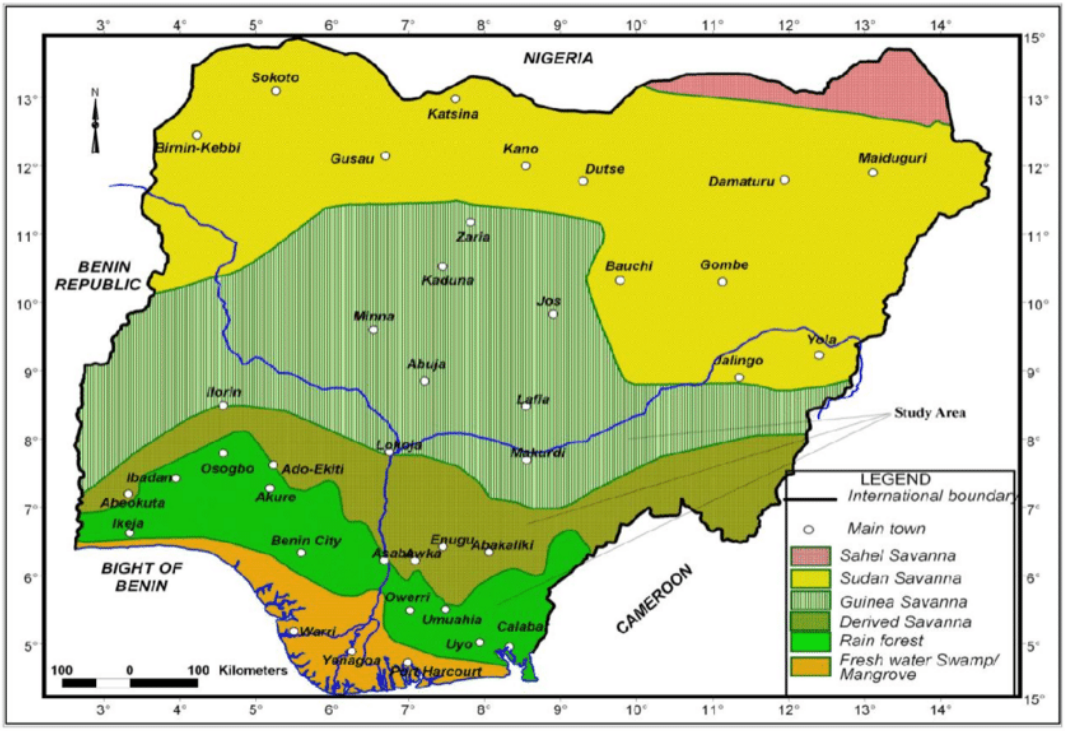

Fig. 1. Map of Nigeria showing the agro-ecological zones

Source: Odebode and Eniola (2019)

Features of the Savannah Region of Nigeria

Temperature

The savannah region experiences high temperatures throughout the year, with daytime temperatures often exceeding 30°C (86°F). The intensity of the sun is a defining feature, contributing to the warm climate typical of savannahs. There is a significant diurnal temperature variation, meaning that temperatures can drop considerably at night, sometimes falling below 20°C (68°F). While the temperature remains relatively high year-round, there can be slight seasonal variations. The dry season may see higher temperatures due to the lack of cloud cover, while the wet season might bring slightly cooler temperatures with increased cloudiness and rainfall (Ayoade, 2004).

Rainfall

The savannah climate is characterized by a clear division between the wet and dry seasons. The wet season usually lasts for a few months, during which the region receives the bulk of its annual rainfall. The dry season is much longer, with little to no rainfall. Annual rainfall in the savannah varies widely, typically ranging from 500 to 1,500 millimetres (20 to 60 inches). The exact amount depends on the specific location within the savannah belt. Northern parts of the savannah might receive less rain compared to southern parts (Oladipo, 1995).

Rainfall is often delivered in intense, short bursts during thunderstorms, rather than prolonged steady rains. This can lead to challenges with water management, as heavy rains can cause erosion and runoff (Ayoade, 2004).

Humidity

Humidity in the savannah region varies greatly between the wet and dry seasons. During the wet season, humidity levels are high due to the frequent rains and moisture in the air. Conversely, the dry season experiences very low humidity, often leading to arid conditions (Ayoade, 2004).

High humidity during the wet season can create a muggy and uncomfortable atmosphere, while the low humidity in the dry season can make the air feel more bearable but contributes to dehydration and water scarcity issues. These variations in humidity influence agricultural practices and the types of crops that can be successfully cultivated (Oladipo, 1995).

Vegetation

The dominant vegetation in the savannah is grassland, consisting primarily of drought-resistant grasses that can withstand the long dry season. Common grass species include bluestem, Bermuda grass, and Rhodes grass. These grasses are well-adapted to the fluctuating climate and play a crucial role in the ecosystem by providing food for herbivores (Oladipo, 1995).

The savannah is dotted with trees and shrubs, which are typically spaced apart to reduce competition for water and nutrients. Prominent tree species include acacias, baobabs, and various types of thorn trees. These trees have adaptations such as deep roots and the ability to store water to survive the dry season (Ayoade, 2004).

Vegetation in the savannah undergoes significant changes between seasons. During the wet season, the landscape turns lush and green, with grasses growing tall and trees flourishing. In contrast, the dry season sees many plants going dormant, grasses turning brown, and leaves shedding from trees to conserve water (Oladipo, 1995).

Environmental Benefits

The benefits of green architecture implementation reduced carbon footprint, energy savings, and efficient resource use. According to Merenkov, Akchurina and Matveeva (2019) green architecture reduce the impact on the ecosystems and all kinds resource saving as well as the conditions for efficient cooperation between the natural forms and man-made environment. Cuc *et al*. (2023) outlined that one of the benefits of green architecture that has been scientifically proven is its ability to incorporate techniques from all phases of a building's life cycle, including siting, design, construction, operation, maintenance, renovation, and deconstruction, to lessen its negative effects on energy, water, materials, and other natural resources. In addition, it can lessen environmental pollution caused by noise, heat islands, stormwater runoff, trash, air and water pollution, interior pollution, and more. Green architecture offers several environmental advantages that are particularly relevant to the savannah region:

1. **Energy Efficiency:** Green architecture utilizes energy-efficient designs and technologies such as solar panels, natural ventilation systems, and high-performance insulation. These measures significantly reduce energy consumption from non-renewable sources (Ragheb, El-Shimy, & Ragheb, 2016). Green architecture emphasizes passive design strategies such as natural ventilation, daylighting, and thermal insulation, which reduce reliance on mechanical heating and cooling systems (Ayodele, et al., 2021). In the Savannah region, where temperatures can soar during the day and plummet at night, incorporating these strategies can significantly lower energy consumption and enhance occupant comfort (Sani & Ahmed, 2019).
2. **Reduction of Carbon Emissions:** By incorporating renewable energy sources and energy-efficient systems, green buildings lower greenhouse gas emissions, mitigating the effects of climate change in the savannah region (Capeluto, 2022). Implementation of green architecture can effectively reduce carbon dioxide emissions and energy consumption, and the recyclability and low carbon nature of the materials used in green buildings make them a practical solution to environmental problems. Obviously, green buildings are designed to reduce the

emission of toxic substances throughout their life cycle, save resources and energy, and recycle materials (Liu et al. 2022).

3. **Water Conservation:** Water scarcity is a pressing issue in many parts of the Savannah region (Olalekan, et al., 2018). Green architecture promotes water-efficient fixtures, rainwater harvesting, and wastewater recycling systems, reducing dependence on dwindling freshwater resources and mitigating the impact of droughts (Eze & Ali, 2020). Rainwater harvesting, greywater recycling, and low-flow plumbing fixtures, which are crucial for water conservation in a region prone to water scarcity (Merenkov, Akchurina, & Matveeva, 2019).

Economic Benefits

Longer building lifespan, reduced maintenance costs, and resilience to changing needs serves as economic benefits of green building. Green architecture makes efficient use of resources resulting in significant operational savings and workplace productivity improvement (Norouzia and Soorib, 2020). The economic benefits of green architecture in public buildings are extensive:

1. **Long-term Cost Savings:** Although the initial investment in green architecture may be higher, the long-term savings are substantial due to reduced energy and water consumption, leading to lower utility bills (Liu et al., 2022).
2. **Job Creation:** The adoption of green building practices stimulates job creation in various sectors, including construction, renewable energy, and environmental consultancy, contributing to economic growth and reducing unemployment rates in the savannah region (Masood, Abd Al-Hady, & Ali, 2017).
3. **Increased Property Values:** Green public buildings often have higher property values and attract better investment opportunities, boosting local economies (Daud, 2012).

Social Benefits

Increased awareness of sustainability principles among students and stakeholders. Liu et al. (2022) points to the fact that the use of green buildings can enhance the social reputation of companies and promote the formation of a competitive market for green buildings. Hence, green buildings harmonize with traditions, climatic conditions, surrounding environment, and culture (Norouzia and Soorib, 2020). Green architecture also brings numerous social benefits to communities in the savannah region:

- **Improved Health and Well-being:** Green architecture provide better indoor air quality, natural lighting, and comfortable thermal conditions, enhancing the health and well-being of occupants (Craven, 2021). Indoor air pollution is a significant health concern in densely populated urban areas of the Savannah region (Ogunshakin & Adedeji, 2016). Green architecture employs low-emission materials, adequate ventilation, and pollutant filtration systems, creating healthier indoor

environments that enhance occupant well-being and productivity (Bello & Abdulrahman, 2018). Green sustains and improve the quality of human life while maintaining the capacity of the ecosystem at global and local levels (Norouzia and Soorib, 2020).

- **Enhanced Community Engagement:** Public buildings that incorporate green spaces and community areas foster social interaction and community cohesion, leading to stronger, more resilient communities (Pucar et al., 2018). Public buildings serve as powerful educational tools for raising awareness about sustainability and inspiring eco-friendly behavior change. Educational programs, workshops, and tours organized within green public buildings can effectively communicate the benefits of sustainable design to the community (Olugbenga et al., 2020).
- **Educational Opportunities:** Green public buildings can serve as educational tools, demonstrating the benefits of sustainability to the community and inspiring future generations to prioritize environmental stewardship (HMC, n.d.).

Despite the growing body of literature on green architecture, research often overlooks the cultural and socio-economic context of the savannah region. Studies need to explore how green architecture can be adapted to local traditions, materials, and economic conditions to ensure community acceptance and feasibility.

Conclusion

The integration of green architecture in public buildings in the savannah region of Nigeria offers extensive environmental, economic, and social benefits. By embracing sustainable building practices, policymakers and developers can contribute to a more sustainable and resilient future for the region. Continued research and investment in green architecture are essential to fully realize these benefits and ensure the long-term sustainability of public infrastructure.

Recommendations

The conclusion drawn from these findings are:

- If public buildings are designed with principles of green architecture applied, it will be a more human friendly environment and this will make the occupants more comfortable resulting to better overall output.
- Cost of running and maintaining the public buildings will be cheaper and the building will have a longer life span.
- The world will be less polluted and so reducing the effect of global warming.

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