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Urban Planning and Green Infrastructure Under a Changing Climate in Africa

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Abstract

This article uses the PRISMA systematic review method to identify the challenges and opportunities of urban planning in Africa, with a focus on climate change. The article emphasizes the importance of sustainable financing, transparent management, and effective governance. It also highlights financial difficulties, privatization, short political cycles, and institutional limitations as some of the key challenges that need to be addressed. Cultural, religious, and socio-economic influences on awareness of green infrastructure are examined, advocating for the promotion of environmental awareness and education. Climate risks threaten the sustainability of green infrastructure, necessitating resilient planning. Legal gaps hinder urban planning implementation, underscoring the need for appropriate legal

frameworks. Coordination between government levels and long-term vision is essential to addressing political and administrative challenges. Overall, the article suggests sustainable, human-centered approaches and effective resource management for balanced urban development in Africa. It also emphasizes a holistic approach and ongoing collaboration for sustainability.

Keywords: Urban Planning, Green Infrastructure, Africa

1. Introduction

Africa is the second most populous continent in the world and is experiencing an unprecedented surge in urban growth, as stated by Owojori and Okoro (2023). The continent is undergoing significant demographic and economic changes, with most of the growth happening in cities, as described by Piketh et al. (2014). Urbanism is a complex concept that includes city planning, design, and management that aligns with land use, transportation, housing, and more. Rapid urbanization is putting pressure on green infrastructures, which are essential components of compact and sustainable cities, as indicated by Brom et al. (2023). Green infrastructure uses natural and environmentally friendly elements to address environmental issues such as climate change adaptation. Parks, wetlands, green roofs, and stormwater management systems are some of the features of green infrastructure, as mentioned by Culwick et al. (2016).

Climate change is one of the most significant obstacles to the growth of cities. Urban green infrastructures are a way to achieve sustainable urban development by improving sustainability, resilience, and the quality of urban life, reducing the impact of climate change, protecting biodiversity, and enhancing the environmental health of cities. As global climate change impacts urban areas, the need for green infrastructure is increasing, as stated by Evans et al. (2022). Climate change in Africa may lead to significant consequences, such as droughts, floods, and other disturbances in the ecosystem, as described by Matamanda et al. (2017). Cities in Africa face climate change-related challenges, including water management, food security, catastrophe resilience, and adaptation to changing climatic conditions, as noted by Addaney and Cobbinah (2019). According to Sharifi (2021), rapid urbanization may exacerbate these problems.

Government entities, local authorities, urban strategists, and experts are actively seeking ways to incorporate urban planning methodologies and environmentally friendly infrastructure in African cities, as described by Herslund et al. (2018). Strategies for achieving this include developing environmentally sustainable structures, establishing green areas for temperature control and water conservation, promoting public transportation, and implementing effective waste management systems, as noted by Chukwu et al. (2023). In this context, the issue of "Urban planning and green infrastructure under a changing climate in Africa" is crucial, emphasizing the need for urban planning in Africa to address the challenges posed by climate change while creating more resilient, environmentally friendly, and livable urban environments. Whitten (2023) argues that green infrastructures provide a conceptual framework and practical planning instrument to tackle complex environmental

problems by integrating economic, ecological, and social elements into planning policies and practices.

This literature review aims to comprehensively summarize recent progress in urban planning and green infrastructure while assessing Africa's response to climate issues in rapidly expanding urban environments. We examined the consequences of these developments for environmental preservation, community resilience, and economic growth. The period from 1995 to 2023 covers the past three decades, allowing us to analyze the latest developments in urban planning, green infrastructure, and climate change in Africa. In recent years, there has been a significant increase in the awareness of environmental issues and the importance of urban planning in several African countries. Scientific understanding and literature on climate change and urban planning have made significant strides over the years. Furthermore, we chose this timeframe because the first Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) was held in 1995.

This literature review aims to improve understanding of how African cities are addressing climate change through planning and green infrastructure by examining current trends, innovative approaches, policies, and challenges. This resource is intended for policymakers, scholars, urban planning practitioners, and anyone interested in creating a more sustainable future for African cities, despite the mounting climate challenges.

2. Materials and Methods

The study utilized the PRISMA technique, which is an acronym for Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (Selçuk, 2019). PRISMA is a methodology for conducting systematic reviews of literature, developed by a group of medical writers to enhance the clarity, reliability, and accuracy of such reviews.

2.1 Literature Review Approach

We conducted a literature search on the topic using the following online search engines: Science Direct, and Google Scholar, which are international databases. During the search, publications spanning the period from 1995 to 2023 (during which many African countries began developing strategies and policies to address the impacts of climate change in urban areas) were considered. The choice of this timeframe also allows for examining planning and infrastructure initiatives implemented in response to these challenges. The downloaded articles were primarily in English, with some in French. In Science Direct and Google Scholar, articles were collected using the following terms: "urban planning," "green infrastructure," "climate change," "Africa," "adaptation," and "mitigation." We utilized the following search equation across various databases: (urban planning OR city planning OR urban development) AND ("green infrastructure" OR "sustainable infrastructure" OR "eco-friendly infrastructure") AND ("climate change" OR "changing climate") AND "Africa".

Key journals and reviews in the field were consulted to download studies on the topic, including Environmental Systems Research, iScience, Environment, Development and Sustainability, Science of The Total Environment, Agriculture, Ecosystems and Environment,

Environmental Science and Policy, International Journal of Environmental Impacts: Management, Mitigation and Recovery, Urban Forestry & Urban Greening, Journal of Urban Planning and Development, Technologies, Sustainable Cities and Society, International Journal of Climate Change Strategies and Management, International Journal of Environmental Sciences, Science of The Total Environment, Journal of Urban Management, International Journal of Built Environment and Sustainability. Documenting these aspects provided valuable insights into current trends, approaches, and more.

2.2 Criteria for Selecting Articles, Reports, and Studies

The publications gathered from the two electronic databases underwent critical examination. This involved reviewing their titles, abstracts, and keywords to assess their relevance to the present literature review. Publications identified as duplicates and case studies published outside Africa were excluded. For final inclusion in the review, all publications underwent four stages of scrutiny: (0) Removal of duplicates, (1) Assessment of publication relevance based on titles, (2) Review of article abstracts to determine their suitability for the review, (3) Downloading and reading the full article, (4) Retrieval of publications meeting the inclusion criteria. The following information was compiled for the publications retained for this review: (i) journal and publication title; (ii) publication keywords; (iii) publication year; (iv) country; (v) aspect(s) addressed in the study, which could be any of the following: (1) green infrastructures, (2) urban planning, (3) socio-economic impacts, (4) climate change impacts, (5) technological innovations, (6) obstacles and challenges, (7) approaches and strategies. The final selected publications were thoroughly read to summarize the available information and knowledge based on the various aspects mentioned above.

3. Results

3.1 Selected Publications

During this study, a comprehensive set of publications was collected from two major online databases, namely Science Direct and Google Scholar. In total, a significant number of 518 publications were identified. Among these, Science Direct contributed 184 publications, while Google Scholar contributed 334. This exhaustive compilation of documents from various sources proved essential for our research, providing a solid foundation for our analysis and evaluation of existing knowledge in the field of study. Of these, 409 publications (e.g., studies unrelated to the topic, studies outside the geographical scope, as well as duplicates) were excluded during the selection and refinement stages. 123 eligible publications were thus considered for full abstract (and text) review, a process in which a total of 109 publications (46 in Science Direct, 63 in Google Scholar) were ultimately included in the review following the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) methodology (Selçuk, 2019) (Fig. 1). These 109 studies were published between 1995 and 2023.

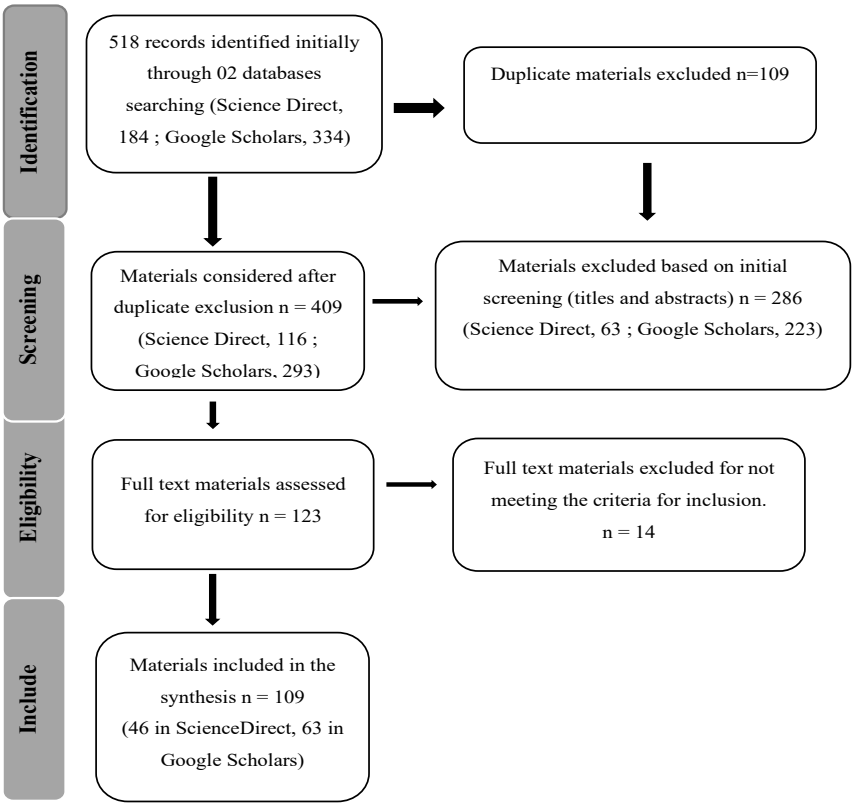

Figure 1. Diagram showing the selection of 109 studies included in the literature review

3.2 Spatio-Temporal Patterns

From 1995 to 2023, the number of articles on aspects such as urban planning, green infrastructure, obstacles and challenges, socio-economic and ecological impact of green infrastructure, approaches, and strategies has generally increased. The highest numbers of articles (n = 20 and 19) were recorded in 2018 and 2022 respectively, while the lowest (n = 0 and 1) were from 1995 to 2003 (Figure 2). All publications originated from the four regions of Africa. Most of these publications came from East Africa (n = 29), South Africa (n = 24), West Africa (n = 22), and Central Africa (n = 11) (Figure 3). Regarding study settings, studies leading to these publications were conducted in 18 countries, primarily South Africa (n = 24), Ethiopia (n = 12), and others. Most publications focused more on green infrastructure, urban planning, the impact of climate change on African cities, approaches and strategies to adopt, obstacles and challenges, and the socio-economic and ecological importance of green infrastructure (Figure 4). Technological innovation was sparsely studied.

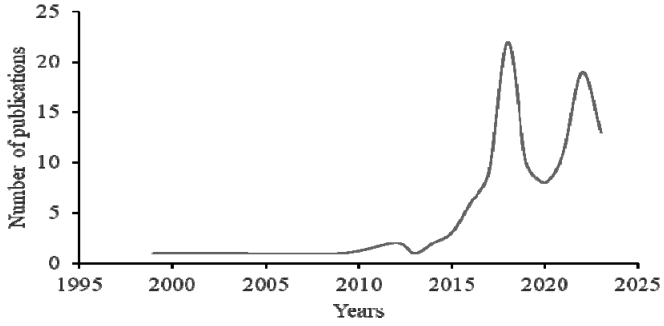

Figure 2. Number of publications per year

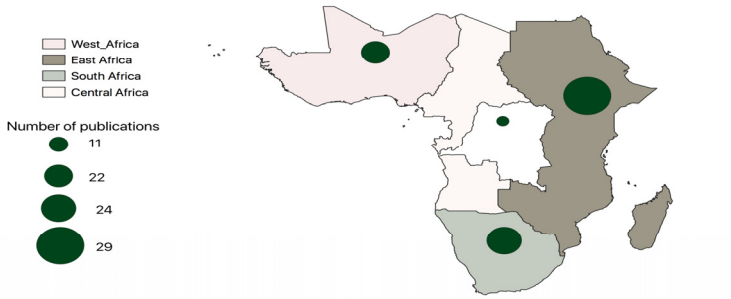

Figure 3. Number of publications per region in Africa

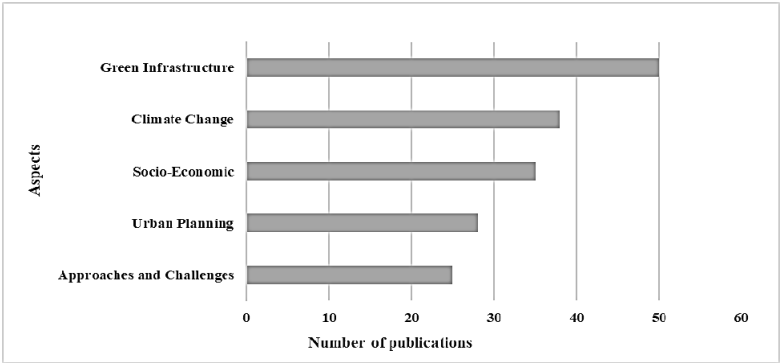

Figure 4. Various aspects addressed by publications

3.3 Climate Change in Africa

3.3.1 Trends in Climate Change in Africa

It is important to note that climate change trends in Africa vary considerably from one region to another, depending on geography and local conditions. Understanding these trends is essential for developing effective adaptation and mitigation strategies to address the challenges of climate change on the continent (Piketh et al., 2014). Climate change in Africa is marked by increasing temperatures, fluctuations in precipitation, rising sea levels, occurrences of severe weather events, loss of biodiversity, implications on food security, migration caused by climate change, and health consequences (Asmelash & Ababa, 2012).

The mountain glaciers in North and East Africa are experiencing a fast decline, posing a significant danger to the availability of freshwater supplies for communities that rely on these sources (Thorn et al., 2021). Desertification and land degradation are ongoing problems in Africa that are worsened by climate change. These difficulties may result in a decline in agricultural production and lead to migrations (Douglas, 2018). Climate change may lead to population movement as a result of environmental deterioration and the pursuit of improved living circumstances (Venkataramanan et al., 2020). Adaptation and mitigation initiatives are necessary to counteract the effects of these changes on the continent (Piketh et al., 2014). The climate change patterns in Africa exhibit a wide range of variations and have substantial effects on the continent.

3.3.2 Impacts of Climate Change in Urban Areas in Africa

Climate change has substantial effects on metropolitan areas in Africa. The repercussions are diverse and affect several facets of urban life (Addaney & Cobbinah, 2019). The phenomena include floods caused by heavy rainfall and scarcity of water resulting from prolonged dry spells (Li et al., 2022). In addition, heatwaves are leading to health issues and power disruptions, while coastal erosion poses a hazard to cities located along the shore (Di Leo et al., 2016). Additionally, there are difficulties with the assurance of sufficient food supply, public health concerns associated with the transmission of vector-borne illnesses, population relocation caused by climate change, infrastructure degradation, and the decline of urban biodiversity (Thorn et al., 2021). Climate change may result in the movement of people from rural areas to urban areas, which in turn puts more strain on urban resources and services (Addaney & Cobbinah, 2019). Adaptation strategies are necessary to enhance the resilience of cities to the effects of climate change (Mudzengi et al., 2021). Climate change has a substantial impact on agricultural productivity and food supply, especially in metropolitan areas (Evans et al., 2022). The intricate interplay between climatic changes and food insecurity sensitivity in these locations is shown in a recent research undertaken by Breed et al. (2023), which demonstrates a clear link. The effects of climate change on agriculture are evident in alterations to growing seasons, erratic precipitation patterns, and the occurrence of severe weather events, leading to disturbances in food production cycles (Evans et al., 2022). Moreover, the impacts of climate change are not limited to rural regions but can affect urban ecosystems. According to Douglas (2018), this disturbance leads to a decrease in the variety of living organisms in urban areas and directly affects the availability of natural areas in the city. The ecological modifications have significant ramifications for the quality of life of urban people. They negatively impact the health of local ecosystems, the availability of recreational places, and the natural management of urban temperature (Parikh & Bhavsar, 2023).

Consider, for instance, the more regular occurrence of heatwaves in metropolitan regions as a result of climate change (Parnell, 2015). Heatwaves have a dual effect on agricultural productivity and urban green spaces. They cause thermal stress on crops, leading to a decrease in agricultural output. Additionally, heatwaves contribute to the degradation of green spaces in cities, which in turn negatively affects local biodiversity (Galagoda et al., 2018). Trees, which are essential for regulating urban temperatures, might be especially

susceptible, potentially undermining natural defenses against extreme heat (Washbourne, 2022).

Moreover, the decline in biodiversity in urban environments has significant consequences for food security, since it impacts the pollination of crops and the genetic variability of farmed species (Feyisa et al., 2022). The aforementioned aspects highlight the intricate relationship between climate change, food security, and the well-being of urban ecosystems (Anguluri & Narayanan, 2017). It becomes obvious that the impacts of climate change go beyond the immediate repercussions on food production alone. Furthermore, they have significant ecological consequences that need a comprehensive strategy to alleviate detrimental effects on food security and the resilience of urban ecosystems (Lindley et al., 2018). A comprehensive comprehension of the interplay of climate change, agricultural, and urban settings is crucial for formulating efficacious and enduring adaptation solutions (Almaaitah et al., 2021).

African cities are making strategic efforts to adapt and mitigate the effects of climate change. Within these initiatives, we see the development of urban blueprints and the enhancement of systems for handling wastewater and stormwater (Almaaitah et al., 2021). In addition, we promote sustainable transportation, preserve urban biodiversity, and build catastrophe climate monitoring and early warning systems (Yirga Ayele et al., 2021). The prioritization of urban resilience has become more apparent among several towns throughout Africa.

3.4 Urban planning in Africa

3.4.1 Current Approaches to Urban Planning

Urban planning includes the strategic arrangement of land use, urban growth control, and infrastructure administration (Norman, 2022). Additionally, it contains sustainable transportation, the ability to withstand climate change impacts, and the encouragement of environmentally friendly infrastructure (Breuste et al., 2015). The objective is to simplify and organize policy choices and actions that might change the physical and social environment and impact the allocation of resources and activities (Anguluri & Narayanan, 2017). Additionally, it facilitates the progressive growth of a city in an environmentally conscious way and promotes equal participation of all individuals (Kozlowski & Yusof, 2016). Urban regions in several African cities are seeing significant expansion, prompting the development of particular strategies to include these communities in urban planning (Culwick et al., 2016).

The approaches differ throughout cities based on their local requirements and goals (Whitten, 2023). Tunisia exemplifies the significance of public engagement in urban and territorial planning and underscores the need to develop tailored strategies to enhance the efficacy and inclusivity of territorial government (Bochra, 2021). After the 2011 revolution and subsequent political transformations, Tunisia has seen an increase in citizen participation in the development of urban environments. The change has been characterized by an increasing need for active engagement of citizens, mainly via the implementation of participatory budgeting (PB), which has received backing from international development organizations and has been implemented by many municipalities in Tunisia (Bochra, 2021).

Participatory budgeting is a novel method that enables citizens to suggest and rank projects that are then included in the municipal budgets (Bochra, 2021). The adoption of participatory mechanisms, such as participatory budgeting, has progressively incorporated these practices into the conduct of municipal officials and employees (Bochra, 2021). The participatory model implemented in Tunisia encompasses both bottom-up and top-down approaches (Bochra, 2021). The bottom-up dynamic entails the active involvement of citizens, who directly engage with public authorities to exert influence. This is exemplified by the implementation of participatory budgets in various municipalities, including Gabès, Tozeur, La Marsa, Menzel Bourguiba, Gafsa, Sfax, Manouba, Raoued, Ben Arous, El Kef, and Sbeitla (Bochra, 2021). In contrast, the top-down dynamic is evident via government efforts that endorse and enable citizen engagement, shown by the backing of the German Development Agency (GIZ) and the European Endowment for Democracy (EED) for the "Eye on the Budget" project (Bochra, 2021).

Furthermore, in South Africa, a climate risk reduction approach has been incorporated into urban development planning following an examination of climate risks and the planning context in a constantly evolving municipal context in the country (Piketh et al., 2014).

3.4.2 Specific Challenges of Urban Planning in the African Context

Urban planning in Africa faces major challenges related to rapid population growth and changing political and economic dynamics (Brom et al., 2023). This growth necessitates rapid adaptation of planning strategies, but many municipalities in Africa face financial constraints, making it difficult to mobilize long-term funding (Thorn et al., 2021). Urban governance challenges, such as corruption, may worsen these limits and impede the successful execution of policies and planning initiatives (Chukwu et al., 2023). It is important to prioritize the integration of addressing socioeconomic disparities across various demographic groups and urban communities in urban planning (Whitten, 2023).

African cities are susceptible to the consequences of climate change, including occurrences such as floods and droughts (Mguni et al., 2016). To guarantee resilience, urban design must furthermore include targeted strategies to tackle these climatic issues (Chirisa et al., 2016). Nevertheless, a significant obstacle is the coordination across several tiers of government (central, regional, local) in the field of urban planning, necessitating enhanced synchronization of efforts (Azagew & Worku, 2020). The ongoing rural-urban migratory patterns provide persistent issues, exerting an impact on housing, jobs, and urban services (Wijesinghe & Thorn, 2021).

Moreover, the COVID-19 pandemic has underscored the vital significance of urban planning in tackling health issues and guaranteeing favorable living circumstances (Sharifi, 2022). The aforementioned highlights the need for resilient fundamental infrastructure, encompassing the provision of uncontaminated water, sanitation, power, and other vital amenities, which continues to pose a difficulty in several African urban areas (Almaaitah et al., 2021). African cities are addressing these difficulties by introducing policies and initiatives that focus on enhancing urban planning, bolstering local governance, and fostering urban sustainability (Parnell, 2015).

3.4.3 Socio-economic Benefits of Urban Planning in Africa

Urban planning pertains to the strategic planning, development, and management of cities to effectively tackle the difficulties posed by climate change (Addaney & Cobbinah, 2019). In addition, it oversees population growth by identifying suitable locations and methods for developing new commercial areas. It also incorporates strategies to adapt to climate change, such as implementing flood management systems, establishing green spaces for temperature control, and designing resilient buildings (Addaney & Cobbinah, 2019). The promotion of sustainable management of natural resources, reduction of waste, and preservation of green areas contribute to the conservation of the environment (Parnell, 2015). Urban design may enhance social fairness by guaranteeing universal access to vital services, affordable housing, and fundamental infrastructure across all demographic groups (Gelan & Girma, 2021). Urban planning improves citizens' quality of life by developing urban surroundings that are safer, cleaner, greener, and more functional (Parnell, 2015). As to the author's findings, infrastructure and urban development initiatives provide employment opportunities at the local level, including construction, infrastructure maintenance, and the service industry. Furthermore, urban planning may stimulate economic growth via the facilitation of company establishment, enhancement of investment appeal, and construction of a commerce-friendly atmosphere (Sharifi, 2021). Effective urban design may guarantee the availability of essential services such as potable water, sanitation, power, and healthcare, thus enhancing the overall well-being of residents (Mguni et al., 2016). Urban planning contributes to the reduction of transportation expenses and enhancement of accessibility by establishing efficient public transportation systems and building sustainable forms of transport infrastructure.

3.4.4 Urban Planning and Climate Change

Urban infrastructure has both advantageous prospects and formidable obstacles due to climate change (Li et al., 2022). This raises apprehensions since these infrastructures have a pivotal function in the urban framework, bolstering socio-economic progress and human welfare (Matamanda et al., 2017). Urban planning is intricately connected to climate change as it has a direct impact on the release of greenhouse gases, the ability of cities to withstand climate-related effects, and the overall livability of urban areas (Addaney & Cobbinah, 2019). Zimbabwe is now developing its second national communication (SNC), which may result in the creation of a national adaptation plan (PAN) (Matamanda et al., 2017). Harare prioritizes climate change issues in infrastructure construction and planning (Matamanda et al., 2017). The regulation and guidance of road and water infrastructure planning and development in Harare are governed by many laws and legislative documents. A representative from the Environmental Management Agency of Zimbabwe clarified that the constitution acknowledges the significant impact of climate change on infrastructure planning, emphasizing the need to safeguard the environment and uphold environmental rights (Matamanda et al., 2017). In the context of climate change, writers have highlighted the crucial importance of urban planning and management systems in restoring rivers to provide water security in urban places such as Durban, South Africa (Addaney & Cobbinah, 2019). Furthermore, the planning regulations in Tamale, Ghana, have impeded the effectiveness of local initiatives to address the consequences of climate change, particularly regarding food

security (Addaney & Cobbinah, 2019). Matenga and McLean separately discuss the issue of managing wetlands and protecting agricultural lands in Zimbabwe, as well as preserving heritage through green infrastructure on the Island of Saint-Louis, Senegal, in response to the increasing impact of climate change (McLean, 2017). Efficient planning may also diminish emissions, advocate for sustainable mobility, and include environmentally friendly infrastructure such as parks, wetlands, green roofs, and biodiversity corridors (Salomaa et al., 2017). These components enhance the ability of cities to withstand and recover from challenges, decrease the amount of carbon emissions, and enhance the overall well-being of residents (Piketh et al., 2014). Urban design plays a crucial role in mitigating the effects of heat islands by including strategies for sustainable waste and water resource management. This not only helps decrease environmental impact but also enhances climate resilience (Chirisa et al., 2016). Therefore, it has a crucial function in the development of cities that are more resistant, energy-efficient, habitable, and ecologically sustainable (Pratt, 2023).

3.5 Green Infrastructure in African Urban Environments

3.5.1 Types of Green Infrastructure

Green infrastructure (GI) refers to a network of linked natural and man-made ecological systems, such as green spaces and landscaped features. These components serve similar tasks and deliver services in a strategic manner, similar to conventional infrastructure (Culwick et al., 2016). Green infrastructure is becoming more often used in Africa to tackle the difficulties posed by climate change (Russo et al., 2017). Several African towns include parks, public gardens, and green spaces in their urban design to provide recreational places, enhance air quality, and encourage biodiversity (Breuste et al., 2015). Examples of building-scale green infrastructure components include green roofs, green walls (also known as vertical gardens), and rain gardens (Meerow, 2019). An urban park is a crucial component of urban green infrastructure and helps to alleviate the urban heat island effect (UHI) (Breuste et al., 2015). In addition, at the local level, there are district and neighborhood parks, roadways adorned with trees, surfaces that allow water to pass through, and channels for water flow (Tauhid & Zawani, 2018). Ponds, marshes, and water retention basins are established to effectively control stormwater, enhance water quality, and mitigate the hazards of flooding (Shackleton et al., 2018). African towns establish nature reserves and conservation zones to safeguard urban biodiversity and provide homes for indigenous species (Salomaa et al., 2017). Urban amenities such as playgrounds, sports fields, and bike lanes promote a physically active lifestyle inside the city. Community gardens and urban agricultural programs are gaining popularity as means to encourage local and sustainable food production (Evans et al., 2022). Regionally, there are green corridors, urban farms, and wetlands that exist (Herslund et al., 2018). Certain buildings are used to promote urban biodiversity by creating homes for birds, bees, and other insects (Cameron et al., 2012). Utilizing green infrastructure in Africa is crucial for enhancing urban sustainability, bolstering resistance to climate change, and enhancing the quality of life for inhabitants. Government entities, local authorities, NGOs, and communities work together to incorporate these environmentally friendly urban design methods into the growth and development of African cities.

3.5.2 Advantages, Limits, and Disadvantages of Green Infrastructures

The notion of green infrastructure is a crucial component of sustainable cities (Breuste et al., 2015). Natural habitats, green corridors, and open green spaces in the urban environment are interconnected components of the green infrastructure system. They play a crucial role in the evolution of urban ecology (Breuste et al., 2015). Green infrastructure is becoming more crucial in the development of resilient cities that can effectively manage the impacts of global warming and climate change in general (Ikeobilor, 2022).

Various scholars have extensively demonstrated the advantageous economic, social, and environmental outcomes of green infrastructure. According to Tauhid and Zawani (2018), green infrastructure has the potential to directly generate cash and provide food. Trees contribute to the purification of air by removing pollutants, as well as storing and isolating carbon dioxide. They also serve as a source of renewable biomass fuel, aid in minimizing noise pollution, and sustain biodiversity (Molla, 2015). In addition, they serve as de facto sanctuaries, mitigate urban heat islands, and exert a general cooling influence. They also contribute to the reduction of water pollution and help relieve floods (Venkataramanan et al., 2020). In addition, they provide psychological advantages, health advantages, and recreational advantages, and enhance community cohesion (Monteiro et al., 2020). According to Culwick et al. (2016), they therefore guarantee sustainability. Green infrastructure enhances the resilience of urban areas to climate change by providing a cooling impact (Galagoda et al., 2018). They enhance the interconnectedness of habitats and serve as unofficial sanctuaries, hence mitigating floods (Asmelash & Ababa, 2012). Nevertheless, there is a dearth of precise comparative data about the obstacles and drivers for incorporating green infrastructure into peri-urban regions (Thorn et al., 2021). Although a variety of services are offered, a prevailing issue is that these green infrastructures provide inadequate ecological services (Russo et al., 2017). Crime serves as a disincentive for the implementation of green infrastructure in some areas in Sub-Saharan Africa (Thorn et al., 2021). Certain offenders conceal themselves inside verdant areas adjacent to primary market locations (Thorn et al., 2021). Wild animals, particularly baboons, pose physical threats (Thorn et al., 2021). Individuals in some regions of Sub-Saharan Africa experienced physical discomfort when exposed to green or blue environments that emitted unpleasant odors, resulting in respiratory difficulties (Thorn et al., 2021). Failure to maintain or disregard of green infrastructure may intensify the transmission of hazards and issues related to green infrastructure and zoonotic illnesses, leading to worsened hygiene conditions (Azagew & Worku, 2020).

3.6 Integration of Urban Planning and Green Infrastructure

The incorporation of green infrastructure into urban design is crucial for the development of sustainable and resilient cities (Thorn et al., 2021). To achieve this goal, it is necessary for local governments to implement laws and regulations that support the incorporation of green infrastructure into urban development plans, construction codes, and urban development practices (Culwick et al., 2016).

To achieve successful integration, urban planning should prioritize the inclusion of green infrastructure as a basic component from the very beginning (Washbourne, 2022). The incorporation of green infrastructure into urban development depends on many methodologies. To adopt a proactive approach, urban project designs should include features such as green areas, biodiversity corridors, natural buffer zones, and water management systems (Herslund et al., 2018). Another unique technique is Edible Green Infrastructure (EGI), which, as described by Russo et al. (2017), enhances resilience and enhances the quality of life in urban settings. The EGI strategy has a substantial impact on social, economic, and ecological aspects, making a valuable contribution to urban sustainability and food security (Russo et al., 2017).

A spatial planning model has been created to evaluate the trade-offs and synergies of ecosystem services in three coastal megacities, to fully use the advantages of green infrastructure (Veiga, 2017; Meerow, 2019). This model exemplifies the intricacies of green infrastructure planning in different metropolitan settings and advocates for a versatile strategy to foster more inclusive, strategic, and multifaceted global green infrastructure development (Meerow, 2019).

Urban planning experts recommend the creation of a context-specific green index in all cities, regardless of their size, due to the enormous social and physical consequences that inhabitants face when there is a lack of urban greenery (Anguluri & Narayanan, 2017). Furthermore, a model that focuses on green cover inside urban areas emphasizes the need to conserve green spaces in urban design for the overall welfare (Anguluri & Narayanan, 2017). Research conducted in the Oromia Special Zone in Finfinne, Ethiopia, devised strategic methods to encourage sustainable development and the management of urban green infrastructure systems (UGI). This was achieved by identifying key obstacles (Gelan & Girma, 2021). Nevertheless, it is vital to comprehend the specific requirements of the local population, considering elements such as weather conditions, physical features, variety of species, and the preferences of the community (Bobbins & Culwick, 2015).

Hence, a meticulous evaluation of these individual requirements will facilitate the development of solutions tailored to the given circumstances (Abbott, 2013). Ensuring the active participation of residents, stakeholders, and specialists in the planning process is crucial to guarantee that green infrastructure adequately addresses the requirements of the community and is positively welcomed (Pasquini & Enqvist, 2019). To serve various roles, green infrastructure must be developed to address significant areas of effect, such as stormwater management, public park construction, and urban heat reduction (Pincetl & Byrne, 2021) (Staddon et al., 2018). For instance, a park may further function as a pathway for maintaining a diverse range of species. By imitating natural processes, such as using indigenous plants, constructing man-made wetlands, implementing green roofs, and utilizing permeable roadways, these strategies help establish a more robust urban ecosystem (Molla, 2015). The incorporation of green infrastructure into transportation networks, the establishment of pathways for walkers and bicycles, and the advocacy for sustainable modes of transportation are fundamental components of this strategy (McLean, 2017). Financial

incentives may incentivize developers and property owners to include green infrastructure features in their projects (Wijesinghe & Thorn, 2021).

Nonetheless, the sustained efficacy of these environmentally friendly infrastructures needs ongoing surveillance and periodic assessment (Whitten, 2023). This essential measure guarantees that these facilities effectively meet their intended purpose in terms of durability, urban livability, and environmental responsibility. Through the incorporation of these strategies into urban design, cities may establish a healthier, more pleasurable, and more adaptable atmosphere for their inhabitants, while concurrently aiding in the reduction of the consequences of climate change (Sharifi, 2021). The implementation of institutional cultures that prioritize adaptive policy-making, equitable partnerships, co-designing futures, integrated landscape management, and experimental innovation can enhance the sustainable management of urban green infrastructure and foster transformative outcomes such as action, creativity, and strong relationships (Wijesinghe & Thorn, 2021).

3.7 Barriers to Urban Planning and Green Infrastructure

Urban planning and infrastructure development in Africa provide a formidable task, characterized by several intricate barriers. The current allocation of funds for the construction of green infrastructure is inadequate and restricted in the immediate future, while the potential benefits of public-private partnerships and asset monetization have not been fully used, therefore jeopardizing the long-term viability of sustainable management (Staddon et al., 2018). The problem is worsened by the privatization of land and water, which hinders access to green infrastructure, particularly in cases where water systems are privatized and discourage the use of water for activities that benefit ecosystems (Li et al., 2022).

Another problem arises from land use planning often influenced by private firms, resulting in higher expenses for accessing essential public services and putting at risk vital regions for biodiversity and ecosystem operation. The absence of transparency in the financial administration of public places is an additional hindrance (Girma et al., 2019). City planning efforts in some African areas have faced obstacles due to inadequate financial management and political intervention, despite the presence of comprehensive national laws and regulatory frameworks for urban development (Cilliers, 2019).

Commonly encountered challenges at a worldwide level include financial, legal, and institutional limitations, together with insufficient modifications in land use and ecological services (Parnell, 2015). The challenges faced in implementing renewable energy solutions differ depending on the level of implementation. At the household level, a significant obstacle is financing. At the community and municipal levels, the main issues revolve around design, performance, and maintenance. At the national level, persistent obstacles are related to legal and institutional matters (Wijesinghe & Thorn, 2021).

Values, traditions, and cultural perceptions are important factors in promoting awareness and acceptance of green infrastructure in Africa (Dipeolu et al., 2021). However, negative attitudes toward the advantages of such infrastructure, which are often influenced by cultural, religious, or unfavorable perceptions, can impede their adoption (Azagew & Worku, 2020).

The state's paternalistic views may impact how accountability is seen, perhaps strengthening reliance on relief services (Thorn et al., 2021).

Vegetation growth in urban and peri-urban regions is influenced by biophysical, ecological, and meteorological circumstances. According to Piketh et al. (2014), climate change heightens the likelihood of floods, droughts, and natural catastrophes in African towns. Furthermore, the depletion of forests, the expansion of deserts, and the diminishing availability of arable land pose significant challenges to the preservation of natural resources essential for urban development (Ikeobilor, 2022). Insufficient funding for urban planning and development continues to be a significant barrier, worsened by the fast increase in urban population and the presence of informal settlements that complicate the process of planning and regulation (Owojori & Okoro, 2023). The presence of these characteristics, together with the constrained capabilities of municipal administrations and intricate decision-making procedures, impede the efficient governance of African towns.

3.8 Political, Administrative Challenges, and Societal Issues

The presence of conflicts and political instability in some areas of Africa presents significant challenges to urban planning, often causing disruptions in the coordination among various levels of government and parties engaged in this process (Zakka et al., 2017). Insufficient legislation and rules complicate the successful execution of urban planning. The political and administrative obstacles concerning urban planning and green infrastructure in Africa are varied, encompassing issues such as inadequate institutional capacity (Alaci, 2017), insufficient legal frameworks (Shackleton et al., 2018), as well as corruption, and inconsistent policies (Venkataramanan et al., 2020).

To address these intricate obstacles, it is crucial to enhance the ability of institutions, enhance governance, and build appropriate legislative frameworks (Titz & Chiotha, 2019). It is important to take into account citizen engagement and efficient coordination of parties involved in urban planning and the execution of green infrastructure (Sharifi, 2021). Robust governance and a strategic long-term vision are needed to guarantee the success of urban development initiatives in Africa (Wijesinghe & Thorn, 2021). Moreover, social difficulties include socio-economic disparities, reluctance to adapt as stated by Sharify (2021), and cultural views and customs as mentioned by Thorn et al. (2021). To address these political and administrative issues, it is necessary to have synchronized actions at the local, national, and regional levels. Additionally, investments in infrastructure, education, governance, and awareness are crucial (Titz & Chiotha, 2019).

3.9 Guidelines and Recommendations for Urban Planners, Policymakers, and Stakeholders

Urban planners should embrace a comprehensive approach to planning, including environmental sustainability, social equality, and economic viability (Tauhid & Zawani, 2018). To take into account the wants, concerns, and ideas of citizens, it is important to include them in the planning process (Breed et al., 2023). Incorporating green infrastructure, such as parks, wetlands, and green spaces, into urban designs is crucial for improving environmental resilience and enhancing the overall quality of life (Shackleton et al., 2018). It

is important to encourage sustainable means of transportation, such as public transit and infrastructure for pedestrians and cyclists, as stated by Zakka et al. (2017). Moreover, it is important to take into account the use of technical instruments like Geographic Information Systems (GIS) to gather data, create models, and visualize urban areas (Ikeobilor, 2022).

Policymakers must invest sufficient resources in the development of green infrastructure and urban planning (Shackleton et al., 2018). It is essential to enforce coherent policies that promote urban sustainability, mitigate the release of greenhouse gas emissions, and enhance climate resilience. Breed et al. (2023) argue that it is essential to promote openness, and accountability, and prevent corruption in urban project management. It is crucial to include the private sector in urban development while safeguarding public interests. Moreover, it is crucial to promote the investigation and advancement of inventive remedies to urban problems.

The players engaged in urban planning and green infrastructure in Africa include several entities, such as local and national governments, who have the responsibility of formulating policies, implementing regulations, and allocating resources for urban planning. In addition, civil society and non-governmental organizations (NGOs) have a vital role in promoting citizen engagement, openness, and the sustainability of metropolitan areas (Pauleit et al., 2015). Moreover, individuals from the private sector participate in the development, administration, and funding of urban infrastructure. Active involvement of citizens is crucial since they play a vital role as stakeholders in urban planning and development processes. International organizations can provide financial, technical, and institutional assistance for urban planning in Africa (Breed et al., 2023).

The trajectory of urban planning in Africa hinges upon adopting a sustainable, climate-resilient, and human-centric methodology (Pauleit et al., 2020). Effective resource management, transparent administration, integration of green infrastructure, and continual commitment to public engagement are necessary (Parnell, 2015). For African cities to prosper, it is crucial to implement policies and practices that encourage equitable and sustainable urban development, while simultaneously improving the well-being of the population (Amado et al., 2020).

All of these elements constitute guidelines that can provide a solid basis to guide the actions of urban planners, policy makers and stakeholders. However, for these recommendations to come to fruition and reach their full potential, a holistic and multidimensional approach is necessary. Indeed, based on these guidelines, this study initially proposes investing more in training and capacity building of institutions responsible for urban planning and green infrastructure management. This can be done through professional training programs, partnerships with academic institutions and the exchange of good practices with other cities that have succeeded in this area.

Added to this is the need to develop appropriate legislative frameworks by adopting laws and regulations that support the integration of green infrastructure into urban development plans. This may include measures such as developing urban policies that promote environmental sustainability, creating green building standards, and establishing financing mechanisms to

support green infrastructure projects. Next, it is necessary to actively involve citizens in the planning and decision-making process to ensure that urban policies meet the needs and aspirations of the population. This can be done through public consultations, community forums and citizen participation mechanisms such as local advisory councils. By encouraging citizen participation, decision-makers can benefit from the local knowledge and expertise of residents to inform urban planning.

Additionally, promoting public-private partnerships can be an effective strategy to mobilize additional resources and accelerate the implementation of green infrastructure projects. Thus, public-private partnerships can take different forms, such as the joint financing of projects, the concession of public services to private companies or the establishment of corporate social responsibility programs. By establishing strong partnerships with the private sector, governments can leverage the expertise and financial resources of the private sector to deliver green infrastructure projects more efficiently.

Finally, it is essential to promote transparent management of public funds and fight corruption in the area of urban planning and green infrastructure management. This can be achieved by strengthening control and surveillance mechanisms, promoting transparency in decision-making processes and strongly sanctioning acts of corruption. By ensuring transparent and accountable governance, policymakers can build public trust in institutions and ensure efficient allocation of resources for green infrastructure projects.

By adopting an integrated approach that combines these different strategies, African governments can overcome the challenges of implementing urban planning and green infrastructure policies. By investing in institutional capacity building, the development of appropriate legislative frameworks, the promotion of citizen participation, collaboration with the private sector and the fight against corruption, decision-makers can create an environment conducive to the realization of projects of sustainable and beneficial green infrastructure for local communities.

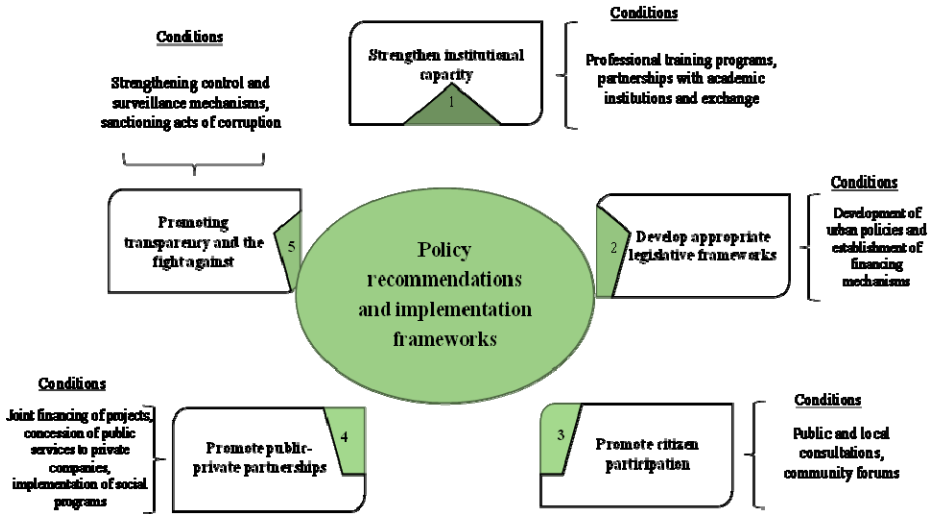

Figure 5. Strategies and Implementation Conditions for Sustainable Urban Development in Africa

4. Discussion

Climate change poses substantial challenges to the infrastructure and resources of metropolitan centers across Africa (Salomaa et al., 2017). The authors of the study (Mudzengi et al., 2021) discuss the existing methods used in urban planning, which entail addressing the fast expansion of informal settlements, engaging local people, and prioritizing urban sustainability and resilience. The article also addresses particular obstacles encountered in urban planning in Africa, such as the fast increase in urban population, the management of informal settlements, restricted financial resources, urban governance, and socio-economic disparities (Brom et al., 2023). Urban planning in Africa provides several socio-economic advantages, including enhanced quality of life, employment generation, encouragement of economic growth, greater access to essential services, and promotion of sustainability. Urban planning may serve as a deliberate and calculated approach to address the challenges posed by climate change (Tauhid & Zawani, 2018).

Green infrastructure used in Africa encompasses several forms such as parks, public gardens, green roofs, green walls, rain gardens, ponds, marshes, and more. These provide a multitude of economic, social, and environmental advantages. Nevertheless, they also acknowledge constraints and disadvantages, including criminal activity and health hazards, along with concerns about cleanliness. It is important to acknowledge that these disadvantages may differ depending on the geographical area. Adopting favorable rules and regulations and engaging stakeholders is crucial for the careful design of urban projects that integrate green infrastructure.

The adoption of green infrastructure and urban design in Africa has several problems, including financial, legal, institutional, cultural, and environmental constraints (Feyisa et al., 2022). The allocation of immediate financial resources and the influence of political cycles have been recognized as key barriers that greatly affect the long-term viability of green infrastructure in Africa (Watson, 2009). The long-term usefulness of the system is compromised due to a lack of maintenance after its introduction. To guarantee effective long-term administration, political agendas need to place more emphasis on long-term urban development and the establishment of green infrastructure. This requires thorough financial preparation, continuous political dedication, and sustainable funding systems. Therefore, it becomes necessary to diversify funding sources, exploring public-private partnerships, international development funds, as well as innovative financing mechanisms such as payments for environmental services. Additionally, transparent and accountable financial management is essential to ensure that allocated funds are used efficiently and equitably, which builds stakeholder confidence and promotes the long-term sustainability of green infrastructure.

Furthermore, the effect of privatization on the availability of green infrastructure is a crucial concern, since it has the potential to impede access to such infrastructure, particularly access to vital natural resources. This deters the adoption of eco-friendly activities, as individuals may be reluctant to bear the cost associated with using these resources, and it may also pose a threat to nearby ecosystems. Possible measures include the implementation of regulatory

frameworks to safeguard natural resources, fostering active involvement of communities to mitigate excessive privatization, and advocating for the adoption of sustainable alternatives. Cultural and religious beliefs have a substantial impact on the level of understanding and acceptance of green infrastructure. To overcome these difficulties, focused awareness campaigns, community education on the advantages of green infrastructure, and promotion of pro-environmental principles are important. Religious and cultural leaders can significantly influence and promote ecologically sustainable habits.

Moreover, the natural resources essential for urban planning and the sustainability of green infrastructure are greatly impacted by climate change and deforestation (Washbourne, 2022). To address these risks, it is crucial to include climate resilience in planning, advocate for replanting and conservation, and enhance public understanding of environmental concerns. Precise gathering of climatic data and environmental modeling may aid in predicting and addressing evolving environmental effects. The increasing urban population expansion in Africa necessitates significant endeavors to address the infrastructural requirements (Alaci, 2017). African cities should prioritize investment in infrastructure that can accommodate the projected increase in population, including the development of efficient public transit systems, the provision of cheap housing, and the expansion of public services (Chirisa et al., 2016). Effective urban planning necessitates the regulation of informal communities (Thorn et al., 2021). Urban management in Africa is often hindered by limited capacity within municipal administrations. Therefore, it is crucial to prioritize institutional capacity creation to enhance urban management (Thorn et al., 2021). Municipal administrations should be provided with sufficient training and assistance, while intricate decision-making procedures should be streamlined. Furthermore, political, administrative, and sociological difficulties need political interventions (Lindley et al., 2018). Regulations that are suitable, open, endeavors to combat corruption, and collaboration across different levels of government are crucial (Chirisa et al., 2016). Addressing socioeconomic disparities and fostering fairness are significant objectives in Africa (Chirisa et al., 2016). Urban planning recommendations prioritize a comprehensive and enduring strategy, active involvement of citizens, incorporation of green infrastructure, sustainable transportation methods, and use of technical resources (Norman, 2022). Indeed, local communities are often the main beneficiaries of these projects, and their involvement from the planning and implementation phases can help ensure their acceptance and appropriation by the population. By encouraging residents' active participation in management, it is possible to create a sense of ownership and responsibility, which strengthens their long-term sustainability (Norman, 2022). Thus, creating inclusive and participatory governance mechanisms is essential to ensure that green infrastructure meets the real needs of communities and continues to thrive over time.

The trajectory of urban planning in Africa hinges on adopting a sustainable, climate-resilient, and human-centered methodology (Amado et al., 2020). The potential for progress exists in the implementation of efficient resource allocation, accountable administration, incorporation of environmentally friendly infrastructure, and ongoing engagement of the public (Bochra, 2021). It is important to support and promote emerging trends, such as the development of new solutions (Amado et al., 2020). To guarantee the long-term viability of green

infrastructure in Africa, it is crucial to confront the financial, institutional, cultural, environmental, and political obstacles, while also adjusting to the fast population expansion and enhancing institutional capabilities.

However, the issue of maintenance is essential to ensure the long-term viability of these infrastructures. Although the initial design and construction may be well planned, lack of regular maintenance can quickly compromise their effectiveness and durability. It is therefore essential to first and foremost establish solid mechanisms to ensure adequate maintenance, which could involve training local staff, establishing long-term maintenance contracts and raising community awareness of the importance of maintain these infrastructures in good condition.

5. Conclusion

This research elucidates the barriers and potential that characterize urban development in Africa in the presence of climate change. The text emphasizes the presence of financial limitations, short political terms, the act of transferring ownership to private entities, restricted institutional capabilities, and intricate methods for making decisions. Crucial for tackling these difficulties are sustainable finance, transparent management, and good governance. The knowledge and acceptance of green infrastructure are influenced by cultural, religious, and socio-economic attitudes, which highlights the need to promote awareness, provide environmental education, and foster community collaborations. The sustainability of green infrastructure is jeopardized by climate threats, deforestation, and the depletion of natural resources, necessitating the implementation of resilient planning. Insufficient legislation impedes the execution of urban planning, underscoring the need for suitable legal structures, transparency, and efforts to combat corruption. Coordination across government levels and a long-term vision are necessary to address political, administrative, and governance difficulties. The future of urban planning in Africa necessitates the implementation of sustainable, climate-resilient, and human-centered strategies. This entails efficient resource management, transparent governance, meaningful public engagement, and cohesive policies. The assessment emphasizes the need for urban development in Africa to effectively manage population growth, protect ecosystems, enhance climate resilience, and enhance the overall quality of life. The study determines that effective urban planning in Africa requires a comprehensive strategy, collaboration among all parties involved, and continuous dedication to environmental sustainability, social equity, and economic feasibility. This offers crucial direction for urban planners, politicians, and the general public.

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