environments

Systematic Review

Urban Green Spaces in Africa: A Bibliometric Analysis

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Abstract: Africa has a lower proportion of urban areas compared to other continents, yet it is experiencing rapid urbanization, which is posing a significant threat to the urban ecosystem. This study presents the results of a bibliometric analysis from publications on urban green spaces (UGS) research in African cities. From the Web of Science, Science Direct, Google Scholar, and PubMed databases, 264 articles on UGS research in Africa were included in this study. This research topic experienced rapid growth, as more than 68% of all the articles were produced in the past five years, where about 63% of the studies included in this analysis were carried out in only four countries. Most of the studies were carried out at the intracity scale, with the main focus being on the ecosystem services provided by UGS. Change detection and overall UGS mapping studies show that high-income cities have a high percentage of UGS, while many African cities exhibited lower green coverage. We commend the work from researchers; however, there is still a gap to fill both in terms of high-quality datasets and state-of-the-art technology usage, and there is also a need for more comparative studies among cities and countries at the continental scale.

Keywords: urban green space; green area; green infrastructure; Africa

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1. Introduction

According to projections, approximately 70 percent of the global population is anticipated to reside in urban areas by 2050, assuming the continuation of current trends and practices. From the current standpoint, that is a 12% increase equivalent to approximately 2.2 billion new urban inhabitants. The majority of this growth is anticipated to occur on the continents of Asia and Africa [1]. The process of urban development involves the conversion of natural or semi-natural lands into human-dominated areas, such as buildings, roads, and public spaces, to meet the demands of a growing population [2,3]. Urbanization has resulted in increased pressure on natural resources and caused ecological and environmental issues in most cities, including increased risks of flood, heat stress, air pollution, and biodiversity decline [4–7].

Natural ecosystems, and their inherent capital, play a significant role in enabling the necessary reforms to tackle these challenges effectively [2,8]. As one of the most important components of the urban ecosystem, urban green spaces (UGS) refer to any completely or partly covered vegetated land in urban environments, including larger green spaces, such as parks, playgrounds, or greenways, and smaller green space features, such as street trees, roadside vegetation, and private gardens [9]; they have been broadly recognized as an effective nature-based solution to urban challenges through a wide range of ecosystem services [10–13]. They play a crucial role in maintaining fundamental life functions inside urban environments by upholding essential natural processes, including nutrient cycling, photosynthesis, the water cycle, and the formation of soils [14]. Urban green spaces play a significant role in sustaining biodiversity within urban areas through the provision of suitable habitats for a diverse array of plant and animal species, hence contributing to the overall equilibrium of the ecological system [15,16].

Including a wide range of plant and animal species inside urban green spaces contributes to the visual attractiveness of cities and fosters a positive state of mental and emotional health among inhabitants [17,18]. Vegetation plays a vital role in air purification by filtering, absorbing, and removing pollutants, such as particulate matter [19,20], as well as promoting carbon sequestration [21]. Some authors argue that UGS should be classified as sensitive areas in urban spaces, deserving protection from pollution sources to enhance their environmental and social functions [22]. UGS help to clean the air, regulate microclimates [23–26], reduce noise pollution, purify water, control erosion, and prevent floods. They also have the potential to significantly contribute to food security through urban agriculture [27–29]. In addition, they provide emotional, cognitive, and psychological advantages by mitigating stress and anxiety and enhancing individuals' memory and attention, because they offer both aesthetic pleasure and recreational prospects, thereby enhancing physical well-being and promoting better health outcomes [30,31]. Furthermore, they serve as catalysts for fostering stronger social bonds and empowering communities [32,33].

Both SDG 11.7 of the United Nations Sustainable Development Goals and the New Urban Agenda highlight the need to enhance urban residents' access to green spaces. These frameworks have the common objective of ensuring that public spaces are universally accessible, safe, inclusive, and of high quality. These spaces are intended to serve as multifunctional areas that foster social interaction, promote inclusion, and contribute to the overall health and well-being of individuals [34,35].

As more evidence emerges and recognition grows for the positive impact of green spaces on urban attractiveness and livability, and to align with the collective global objective of achieving a more sustainable and improved future, local governments around the world are investing in these spaces to provide well-being benefits to diverse communities and to meet diverse needs [36–40]. However, there exist disparities among countries or regions across the world, which have mainly been attributed to variations in their respective stages of development. In a review study by Sun et al. [41], they found that global studies have been mainly carried out in cities with over one million people, and large cities in low- and middle-income countries are highly affected by the inequity in access to UGS. Also, Gabriella et al. [42], in their review, consistently found a positive link between urban forest quality and socioeconomic status or race. This aligns with the existing urban green space literature, which also highlights the connection between access to environmental amenities and measures of socioeconomic status [43–47].

With the world's youngest and fastest-growing population, Africa is so far the least urbanized continent, but it is an important and fast urbanization cluster in the world. According to the United Nations, projections indicate that Africa's cities will grow by an additional 950 million urban dwellers between 2020 and 2050, accommodating two-thirds of Africa's population [48]. Urbanization in Africa is an undeniable reality, as cities across the continent experience rapid population growth, economic development, and infrastructure expansion. This urban transformation presents both opportunities and challenges, with one of the key challenges being the availability of green spaces within these burgeoning urban landscapes [49].

In the context of Africa, the provision and dynamics of urban UGS are influenced by diverse socio-economic, environmental, and cultural factors [50,51]. In this study, we conducted a systematic review of empirical studies to gain a comprehensive understanding of the evolution, trends, and patterns in UGS research in Africa. By analyzing peer-reviewed articles, we summarized the content of these studies, identified gaps in the existing research, and proposed future directions for further investigation. Our findings contribute to a better understanding of the progress and content of UGS research in Africa and offer guidance, references, and inspiration for future studies in this field.

2. Materials and Methods

In the pursuit of a comprehensive and methodical examination of the literature on UGS in the African context, we embarked on a bibliometric analysis in November 2023. Without the limitation of the publication year, this work involved a thorough exploration of prominent scholarly databases, including the Web of Science, Science Direct, Google Scholar, and PubMed. By meticulously scouring these repositories, we aimed to compile a thorough and up-to-date synthesis of the existing knowledge, thereby contributing to a nuanced understanding of the role and significance of UGS in the African landscape. We searched English language research articles in peer-reviewed journals that contained one of the following expressions in the title, abstract, or keywords: ("urban green space" OR "urban green area" OR "green urban area" OR "urban park" OR "public park" OR "urban forest" OR "green infrastructure" OR "urban garden" OR "urban vegetation" OR "green spaces in cities" OR "urban trees") AND (Africa). To minimize the risk of missing any studies, the search using the above expressions was repeated by replacing "Africa" with the name of each country in Africa. After doing the screening following PRISMA guidelines [52], as illustrated in Figure 1, a total of 264 articles were retrieved and included in this study.

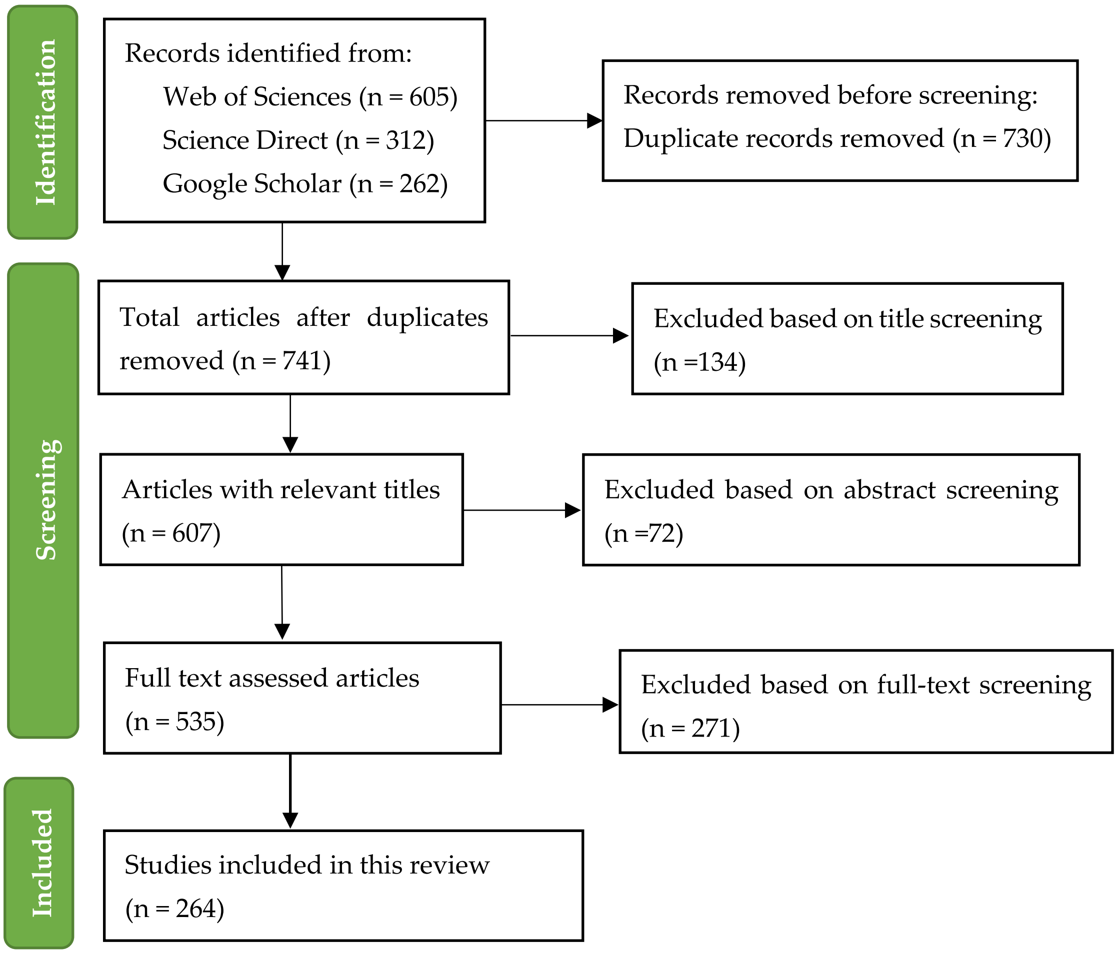

Figure 1. Flowchart delineating the research process based on the PRISMA flow diagram. Adapted from Matthew J. et al. [52].

Utilizing quantitative bibliometric analysis is instrumental in not only identifying prevailing research trends but also illuminating the present landscape of a given research domain. In the course of this investigation, the Bibliometrix package, an R-tool designed for comprehensive science mapping analysis, was employed. This facilitated the extraction of annual publication trends, the identification of the most influential countries, and the determination of the most frequently occurring keywords [53]. The visualization of keyword co-occurrence, essential for discerning research emphases, was accomplished using VOSviewer 1.6.20, a widely employed software for scientific knowledge analysis and mapping [54]. Following the full-text screening of all articles, an assessment of the distribution of studies at various scales was conducted.

3. Results

3.1. Trends and Patterns

In this study, we found a total of 264 research articles that met our inclusion criteria to examine urban green space research in Africa. Figure 2 illustrates the trend in the number of annual publications on the subject. It can be seen that, at the beginning of the last decade, the number of articles saw a gradual increase that culminated in a significant surge in 2016. The analysis reveals that a significant proportion of the articles examined, specifically 68%, were published during the past five years, indicating the current relevance and popularity of the subject.

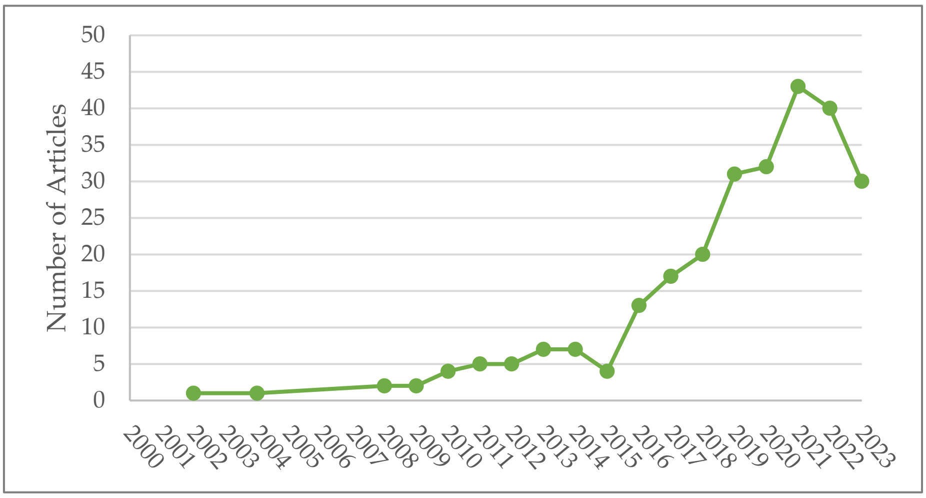

Figure 2. Annual publication trend.

Upon examination of the scale of the research on UGS in Africa, as seen in Figure 3, it becomes evident that a significant proportion of the studies conducted focused on the individual city level, accounting for 48% percent of the total. A significant proportion of the studies were conducted at a sub-city scale, encompassing city blocks, parks, streets, neighborhoods, house gardens, and various other vegetated patches of varying sizes. At the regional level, several studies have conducted comparisons of cities across some African countries, while, at the international level, UGS in Africa have been examined in conjunction with countries from other continents. The scale that received the least amount of coverage pertained to both the national and continental levels, encompassing the inclusion of all cities within a country or all cities across Africa in a single study.

When the geographic distribution of research on UGS in Africa is analyzed, some differences become apparent, highlighting the notable concentration of academic studies in a small number of countries. It is noteworthy to observe that a resounding majority of about 63% of the studies included in this thorough analysis are from only four nations, as shown in Table 1. First and foremost, among these countries is South Africa, which makes up a sizeable portion of about 25% and hence takes the lead in the scholarly investigation of UGS. Following this are Ethiopia and Ghana, as they stand out as major contributors, with each making up 13% of the collected studies, demonstrating their growing interest in UGS research. Nigeria follows, demonstrating its presence with a notable 12% and adding to the corpus of knowledge accumulated on UGS.

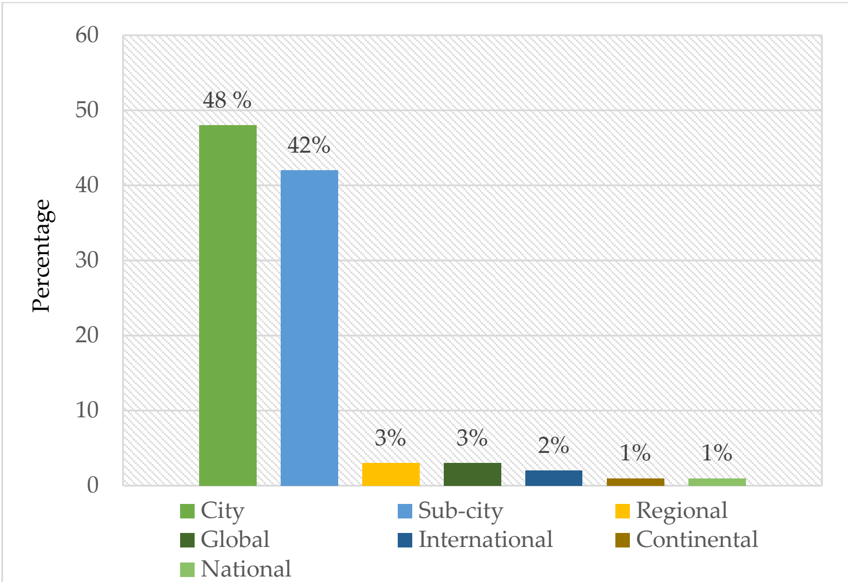

Figure 3. The percentage of geographical scope at which studies were conducted.

Table 1. Top 5 countries and their research shares by volume.

No	Country	Contribution (%)
1	South Africa	25
2	Ethiopia	13
3	Ghana	13
4	Nigeria	12
5	Egypt	6

3.2. Research Focus Mapping

The identification of study content and focus can be ascertained by the examination of the keywords of a research article. From Figure 4, we can see a bibliometric analysis of the findings regarding the prevalent utilization of keywords by researchers in the field of UGS within the African context. This analysis reveals that the most frequently occurring keywords in the dataset are as follows: ecosystem services, urbanization, biodiversity, vegetation, patterns, benefits, health, impacts, climate change, and conservation. The frequency of a keyword's appearance in numerous studies is directly proportional to the size of the letters used to represent it.

A study was undertaken using cluster analysis to examine the connections between the keywords of different papers. This analysis aimed to provide insights into the links among these terms. A total of 69 pertinent keywords, each appearing at least five times, were retrieved from the sections mentioned above of the articles and categorized using VOSviewer into four primary groups centered on ecosystem services, urbanization, biodiversity, and vegetation. As shown in Figure 5, the clustering of keywords within these groups reflects their significant interconnectivity across various research studies. This systematic categorization not only highlights the prevalence of key concepts but also emphasizes the intricate relationships and interdependencies existing within the body of literature.

Figure 4. Word cloud of keywords for urban green space studies in Africa. Note: the keyword sizes in the diagram represent the frequencies of the keywords but the colors do not represent any special meaning.

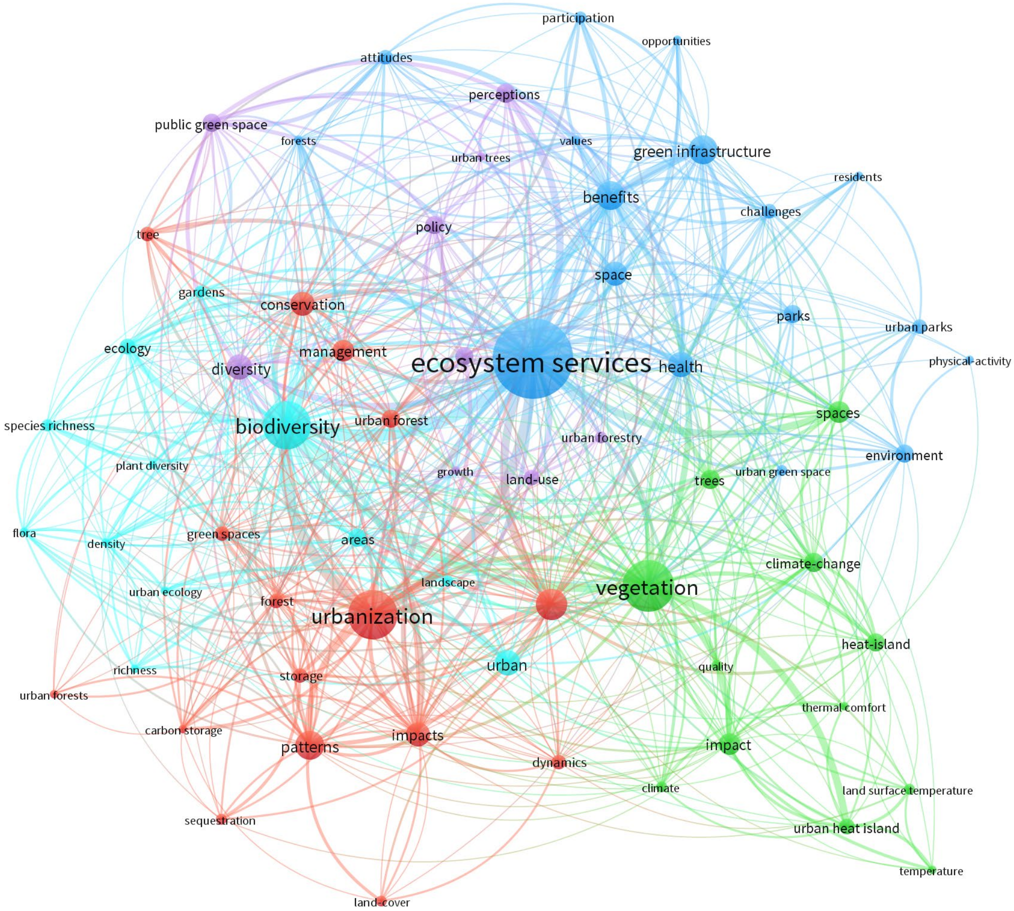

Figure 5. Keyword co-occurrence network map showing significant interconnectivity across various research studies.

As illustrated in Figure 6, over the last half-decade, there has been a notable transformation in the focus of studies concerning UGS within African cities. Initially concentrated on ecological conservation concerns, the research priorities refs. [55–58] have since shifted towards examining the various ecosystem services offered by urban vegetation [59–63]. Presently, there is a significant emphasis on investigating how these green spaces contribute to enhancing the public health and well-being of urban residents, indicating a noteworthy evolution in research trends within this field [64–69].

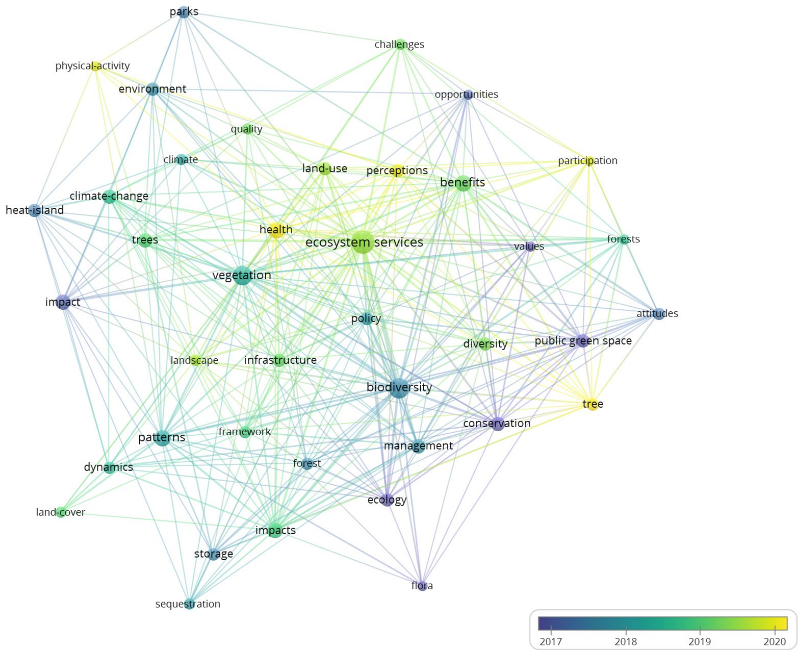

Figure 6. Mapping of keyword occurrence over time, illustrating the temporal change in the research focus.

4. Discussion

4.1. Geographical Scope and Trend of UGS Research

Africa has the lowest proportion (~45%) of urban population compared to other continents, yet it is experiencing rapid urbanization, leading to overcrowded informal settlements in cities and posing a significant threat to the urban ecosystem and environment [70–72]. In this literature review, we examined the trends and patterns, identified gaps, and suggested future research emphasis for research on urban green spaces in Africa. The annual production of peer-reviewed research papers serves as an indicator of the level of interest and significance attributed to a certain subject within the scientific community. Our results show that there has been an increasing focus on the topic since 2010, with a significant surge in attention since 2016 and a slight drop in the past two years. This surge can be attributed to the adoption of the Sustainable Development Goals (SDGs) in the preceding year, specifically, SDG 11, indicator 11.7, which emphasizes the necessity for cities to ensure universal access to safe, inclusive, accessible, green, and public spaces, while the decrease might be a consequence of the COVID-19 pandemic. Farkas et al., 2023 [73], conducted a comprehensive literature analysis on the subject of urban green spaces on a global basis and identified a similar pattern.

The geographical scale of a study has significant implications for interpreting and applying its findings in relevant contexts. For instance, local-scale research may offer insights directly applicable to a specific community or region, while regional or global-scale research can inform broader policies and strategies and the ability to make informed decisions at various governance levels [74]. Research on urban green spaces in Africa has primarily focused on the city and sub-city levels, with less attention given to the national, regional, and continental scales. The same trend was observed by Awoyemi et al. [75] in their literature review on the status of urban ecology in Africa. This can be linked to the fact that African cities often face unique and pressing challenges related to urbanization, environmental sustainability, and public health, making each of them a focal point for research. On top of that, the availability of data and resources at the city and sub-city scale may have made it more feasible for researchers to conduct detailed studies in these areas [76,77]. The focus on the city and sub-city scale likely reflects the importance of understanding and addressing UGS-related issues in the context where they have the most immediate relevance and impact. However, more research at larger scales is needed to gain a comprehensive understanding of the broader patterns across larger geographical areas, which can help inform policy-making, planning, and management strategies at higher levels of governance, leading to the more effective and sustainable development of cities in Africa.

An analysis of the country distribution of research on UGS in Africa showed that about 63% of the studies included in this thorough analysis were carried out in only four countries. This could be attributed to both their urbanization level and economic status, whereby, according to 2023 GDP estimates based on purchasing power parity from the IMF, these countries are among not only the top 10 richest countries, but are also those with highest number of urban populations on the continent [78]. This is consistent with the current body of research on urban green spaces, which also emphasizes the positive link between the attention given to urban greening and socioeconomic status, where insufficient studies in different countries could be associated with limited resources and investment to support such studies [79–81]. The focus on research efforts in a small number of countries highlights the need for more inclusive research and understanding of UGS throughout the continent, which could have consequences for international comparisons, policy development, and urban planning in a variety of settings.

4.2. Research Focus Analysis

A network analysis of keyword co-occurrences, which can help to reveal research focuses from bibliometric data, was performed and revealed four main keyword clusters centered on ecosystem services, biodiversity, urbanization, and vegetation. The ecosystem services viewpoint shows that the health benefits provided by public green spaces and urban forests to residents, in terms of green infrastructures, were at the center of most of the studies [60,66,68,82]. The regulation of micro-climates by urban vegetation, with a particular emphasis on urban trees, is a significant focal point identified through keyword analysis. This implies that there is a growing recognition on the continent of the importance of urban vegetation, especially trees, in providing ecosystem services related to thermal comfort, controlling land surface temperatures, and mitigating the urban heat island effect. This highlights the potential for urban greenery to play a critical role in creating more comfortable and sustainable urban environments [83–86]. Urban greening is largely considered to improve the well-being of citizens; however, if not properly maintained, it can be the source of ecosystem disservices, which could be a major public health issue. For example, in one study, they found out that urban forests in poor hygienic conditions might be the source of vector-borne diseases [87].

The biodiversity components of UGS were another major prevalent keyword that has been explored on the continent in terms of the prevalence, composition, and distribution of different plant species [56,57,88,89]. Africa possesses diverse and abundant biodiversity assets that constitute the natural wealth of the continent, serving as the foundation for its social and economic structures. These resources hold global significance, influencing the world's climate and playing crucial roles in the advancement of agriculture, industry, pharmaceuticals, construction, and tourism, among other key sectors [90,91]. However, African biodiversity hotspots suffer both direct and indirect consequences of urban development. As a result, the need to integrate the conservation of biodiversity into city planning processes and decision making is increasingly being recognized by researchers. Ecosystem disservices of the biodiversity found in green spaces were also pointed out in some studies. For example, there is a need to consider the allergenic properties of plant species when choosing vegetation for urban green spaces throughout the design and planning process. Soil biodiversity has been found to support the delivery of multiple ecosystem functions in urban greenspaces [65,92–95]; however, some studies pointed out that urban greenspaces and nearby natural areas harbor soil contaminants that pose a significant threat to the sustainability of ecosystems and the well-being of humans [65,94,95].

The research on the social dimensions of EGS has garnered significant attention on the continent, mostly by means of approaches such as questionnaire surveys [64,96–102]. This could be linked to the fact that the use of affordable methods indicates a practical and efficient approach to gathering data about visitor patterns, preferences, satisfaction levels, and public opinions regarding UGS on the continent. By focusing on these social dimensions, researchers aimed to gain a comprehensive understanding of how people interact with and perceive green spaces. This emphasis on social aspects reflects a keen interest in the human experience of UGS and the potential impact of these spaces on communities and individuals in the African context and the results show no particular patterns.

The economic standing of nations is a significant element that influences the global distribution, pattern, and accessibility of UGS, in addition to the primary influence of climatic conditions on the UGS of cities throughout the world in various biomes [103]. One study showed that high-income cities have almost three times as much green space as low-income cities, which justified the scarcity of green spaces in African cities [41]. The results indicate that areas with high population densities and low development status, which are mostly concentrated in the global south, have less urban green space. The association between population density, the human development index, and urban green spaces may assist in explaining why there is less green land cover in the global south than in Europe and North America [104]. Research on continental and global scales, which compared cities from all continents, focused more on overall UGS mapping and change detection [105]. In reference [106], the authors estimated that in 2010 the UGS in Africa covered about 0.39×10^4 km^2 in a scattered pattern, with a proportion of less than 20% of the total urban area which was the lowest among other continents. In 2020 [107], the authors assessed the global number of trees and changes that happened over a 5-year period (2012–2017) within urban areas. Their results showed that, except for Europe, all other continents had a decrease in urban trees, with the highest decrease of −1.5% in Africa. This can be related to the research by Zhang et al., 2021 [108], who pointed out a negative vegetation trend in African cities where, among the top 10 countries around the world with the largest vegetation decrease, 9 of them are in Africa. However, a study carried out by Yin et al., 2021 [109], in which they studied the 20-year change in urban land and its fractional covers in Africa from 2000 to 2020, found a significant positive increase in urban vegetation space on the continent, with an around 5% increase in the average fraction of urban vegetation space.

Research is always evolving with time; the studies included in this review show that there has been a significant change in the research focus on UGS in Africa, especially in the past five years. Initially centered on ecological conservation, studies have now shifted towards exploring the ecosystem services provided by urban vegetation, with a current emphasis on understanding how these green spaces improve the health and well-being of city dwellers. This shift underscores the growing recognition of the multifaceted benefits provided by urban greenery, highlighting its pivotal role not only in ecological conservation but also in promoting the health and quality of life of those living in urban environments across the continent. A shift in research perspective can influence the methodologies and technologies employed in UGS studies. Contemporary UGS research initially relied heavily on geographic information systems (GIS), which have consistently served as foundational tools across various UGS disciplines. However, the advent of satellite-based sensor technologies has elevated remote sensing to a key method in UGS research, with the current application of artificial intelligence seeming to be the most recent milestone of the methodological evolution of UGS research [110]. This literature study unveiled a notable inadequacy in the integration and application of state-of-the-art technologies and detailed remote sensing data, particularly concerning social implications, comprehensive mapping efforts, and gaining deeper insights into the intricate patterns and dynamic behaviors of urban green spaces across the continent. This deficiency underscores the need for the further exploration and implementation of advanced methodologies to enhance our understanding and management of these vital ecosystems.

This research exclusively focused on works published in English due to its widespread use in academic publications globally. One notable limitation of this study is its exclusive examination of English literature, overlooking other officially recognized languages on the continent. Furthermore, the scope of this study was limited to peer-reviewed publications concerning green spaces. Additionally, there is a possibility that the search terms utilized may have inadvertently omitted pertinent literature.

5. Conclusions

Africa is an important urbanization cluster in the world, where cities are experiencing rapid and poorly managed urban growth while green areas continue to be threatened and essential ecosystems are being degraded, which reduces the quality of life for urban dwellers. Around the world, the provision of quality urban green spaces has recently been at the core of urban planning and policies, as they stand out as potential nature-based solutions to the complex challenges faced by cities through the multiple ecosystem services they provide. Researchers have been supporting city authorities by providing them with data related to urban green spaces in order to make scientifically informed decisions. Based on this literature review, it is evident that research on African cities' urban green spaces (UGS) has primarily been conducted on a smaller scale within the city and on the social dimension. The main emphasis of these studies has been on the ecosystem services provided by UGS, particularly their role in climate regulation. Authors have emphasized the necessity for using a more organized approach to developing green spaces in urban areas of Africa to maximize the advantages of the ecosystem services they provide. More of the observed patterns, like research focus trends and socioeconomic disparities regarding the quality and accessibility of UGS on the continent, are also similar to results from other parts of the world. Another area of attention was the change detection and mapping of UGS, which was addressed mainly at the global level and showed that Africa is lagging behind other continents in terms of the percentage of green cover and provision. There have been significant endeavors in the research on urban green spaces (UGS) on the continent. Nevertheless, we recommend conducting additional studies utilizing high-resolution satellite data and advanced technologies, along with comparative analyses among cities across the continent at various scales—national, regional, international, and continental. These efforts will facilitate a deeper exploration and enhanced comprehension of the spatial distribution of urban green spaces. Such insights can then inform more comprehensive policies and strategies, empowering decision-making processes at different governance levels.

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