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Urban Sprawl and Environmental Degradation: A Bibliometric Analysis of Interlinked Challenges

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Abstract

This bibliometric analysis aims to explore the nexus between these phenomena, examining trends, research gaps, and emerging themes. Urban sprawl is characterized by unplanned and unchecked urban expansion, often linked to significant environmental challenges, including habitat loss, increased carbon emissions, and reduced biodiversity.

Keywords: Bibliometric Analysis, Urban Sprawl, Environmental Degradation, Geospatial Technology, Sustainable Urban Planning

Introduction

Bibliometric analysis has emerged as a powerful tool in academic research, offering a systematic and quantitative approach to evaluate the scientific literature within specific domains. By assessing trends, patterns, and networks in scholarly publications. Bibliometric methods provide insights into the evolution of research areas, identifying key contributors, collaborations, organizations, sources, citations and emerging topics. Similar studies using bibliometric analysis was carried out by Abdullahi et al., (2024) and Junhai et al., (2024) in Social media Addiction and Academic performance and Bibliometric Analysis of Chatbot and E-commerce Research: Growth, Collaboration, and Key Trends (2017–2024) respectively. In the context of urban sprawl and environmental degradation, bibliometric analysis becomes particularly relevant, as these interconnected challenges are increasingly shaping global urbanization trends. Understanding the drivers, impacts, and mitigation strategies for these phenomena requires a multidisciplinary approach, integrating geospatial technologies,

machine learning, and environmental sciences. Despite the growing body of global research, significant geographical gaps remain, especially in regions like Nigeria, where rapid urban expansion poses severe ecological and socio-economic threats. This study employs bibliometric analysis to explore the state of research on urban sprawl and environmental degradation, with the aim of highlighting global trends, identifying gaps, and providing a roadmap for future research, particularly in underrepresented regions.

Literature Review

The dynamics of urban sprawl and environmental degradation have become increasingly significant in the face of rapid urbanization and climate change. This bibliometric review highlights the growing body of research employing advanced geospatial and machine learning techniques to analyze these interlinked challenges effectively. However, a noticeable geographical gap exists in addressing these issues in the Nigerian context, where urbanization is occurring at an unprecedented pace without adequate research focus.

Urban green space depletion has emerged as a pressing concern, particularly in rapidly growing regions. Batasuma et al. (2025) explored the drivers behind urban green space depletion in Wa Municipality, Ghana, underlining socio-economic and policy-related factors. Their case study provides valuable insights into the conservation of urban ecosystems in developing countries yet highlights the absence of similar studies focusing on Nigeria, where comparable urban challenges exist.

Urban sprawl dynamics have also been a focal point of recent studies. Kumar and Sehgal (2025) analyzed the expansion patterns of Yamunanagar City, India, using geospatial modeling. Similarly, Sakti et al. (2024) integrated machine learning techniques to assess urban sprawl and its multi-hazard environmental and economic impacts. While these studies underscore the complex interplay between urbanization and environmental sustainability, there is a significant dearth of similar research addressing Nigerian urban centers such as Lagos or Abuja, which are experiencing rapid and often unplanned growth.

The implications of urban landscape changes for sustainable land use and environmental conservation are evident in diverse contexts. Seydou et al. (2024) examined Zinder's urban landscape in Niger, while Singh et al. (2024) studied urbanization's impact on environmental parameters in Indian cities. Both studies utilized remote sensing techniques, revealing critical insights into urban expansion's ecological footprints. However, despite Nigeria's high rate of urbanization and environmental degradation, studies utilizing these methodologies in this geographical region remain sparse.

Spatiotemporal analysis has further enriched our understanding of urbanization patterns. Singh et al. (2023) analyzed land use/land cover changes in the National Capital Territory (NCT) of Delhi, India, using geospatial technology. Their study revealed critical trends in urban expansion and resource allocation, providing a framework for sustainable urban planning. Unfortunately, comparable studies focusing on Nigerian cities are lacking, creating a significant knowledge gap in this critical area.

Coastal spatial planning has been revolutionized by the use of object-based image analysis (OBIA) and image classification techniques. C. S., Alabdulkreem, E., Alruwais, N., and M. K.

(2025) demonstrated the utility of OBIA in identifying coastal land use patterns, highlighting its application in sustainable planning frameworks. While this work emphasizes the importance of integrating technological advancements into environmental management, the Nigerian coastal regions, facing threats from urbanization and climate change, remain under-researched.

Other niche explorations include the application of ecological and justice perspectives in understanding carceral sprawl (Russell, 2024) and the distribution of aquatic biodiversity in urban rivers using innovative modeling approaches (Temgoua Zemo et al., 2024). These studies broaden the scope of urban and environmental research by integrating diverse frameworks and methodologies. Despite their global relevance, the Nigerian context continues to lag behind in terms of similar interdisciplinary research.

In summary, the reviewed literature demonstrates the utility of interdisciplinary approaches combining geospatial technologies, machine learning, and ecological perspectives in addressing urbanization and environmental challenges. However, there is a noticeable geographical gap in research focusing on Nigeria. This gap underscores the urgent need for localized studies to inform policy and planning, particularly in understanding the socio-political drivers of urban sprawl and environmental degradation in Nigerian cities.

Research Methodology

The study employed a bibliometric analysis using Biblioshiny, R Studio, and VOSviewer to analyze 143 documents sourced from the Scopus database with the search string “Sprawl AND Environmental Degradation.” Initially, a broader search without quotation marks yielded 2,149 documents. However, refining the search with quotation marks reduced the results to 151. Through a rigorous inclusion and exclusion process, documents produced from 1998, marking the onset of research on the topic, to 2025 were considered. Exclusions were made for book chapters and non-English documents, ultimately narrowing the dataset to 143 documents. These documents were analyzed to uncover trends, collaborations, and thematic focuses within the field, providing insights into urban sprawl and environmental degradation. Figure 1 outlines the PRISMA diagram showing the inclusion and exclusion procedure.

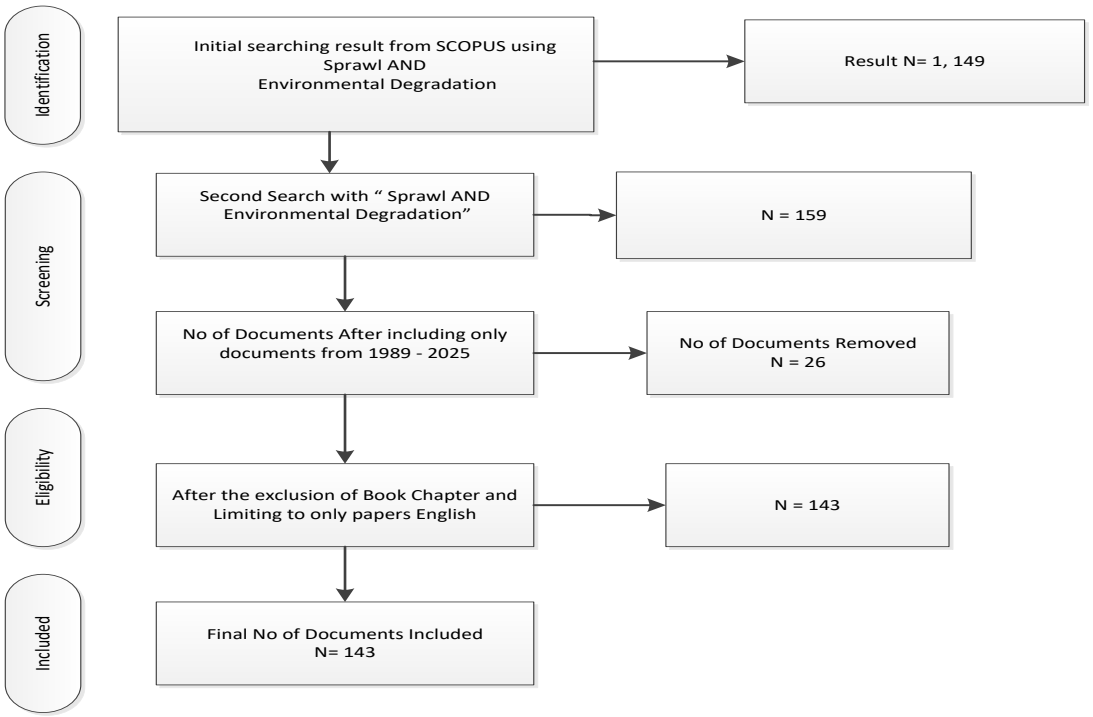
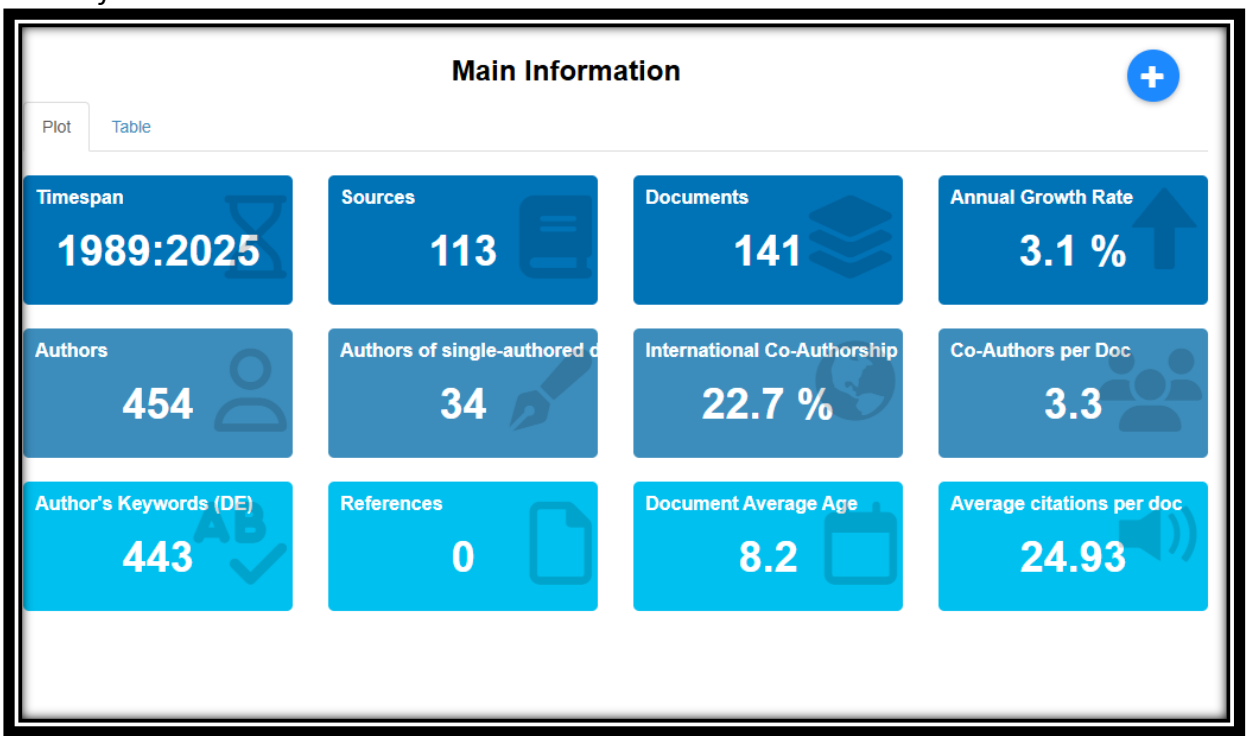


Figure 1: PRISMA Flow Diagram

Analysis

This bibliometric analysis explores the relationship between urban sprawl and environmental degradation, spanning 1989 to 2025. The dataset includes 141 documents from 113 sources, with an annual growth rate of 3.1% and an average of 24.93 citations per document, reflecting significant scholarly interest. A diverse range of 925 Keywords Plus and 443 Author's Keywords highlights thematic and interdisciplinary engagement. Authored by 454 researchers, the documents show a collaborative trend with an average of 3.3 co-authors per paper, though international co-authorship remains at 22.7%. Articles dominate the dataset, with fewer book chapters, conference papers, and reviews. The findings reveal steady research growth, with potential for enhanced global collaboration and focus on underrepresented regions. This study provides valuable insights for understanding and addressing the critical challenges posed by urban sprawl and environmental degradation.

Table 1
Main Information Dashboard



Annual Scientific Production

The annual scientific production on urban sprawl and environmental degradation exhibits a steady increase over the years, reflecting growing academic interest in the subject. The initial years (1989–2000) saw limited production, with only sporadic publications such as one article in 1989, 1990, and 1997, and peaks of two articles in 1994 and 2001. A noticeable surge began in 2006, with seven articles published, marking the start of consistent growth. Between 2011 and 2017, the output stabilized at an average of 5–7 articles per year. The most significant growth occurred from 2018 onwards, with double-digit articles annually, peaking at 13 in 2019. Recent years, including 2020–2024, maintain this trend, averaging 10–12 articles yearly. Although 2025 has only three articles thus far, the upward trajectory highlights increasing attention and engagement from the academic community, demonstrating the evolving importance of addressing the complex interplay between urban sprawl and environmental degradation.

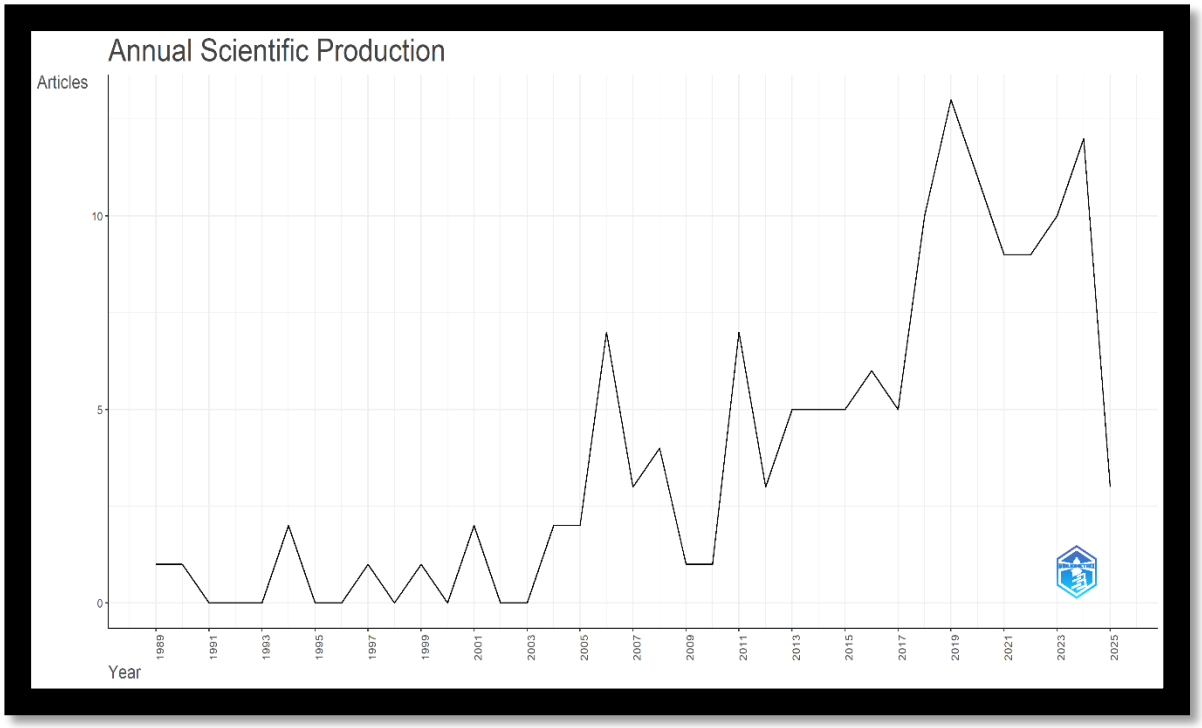


Figure 2: Annual Scientific Production

Average Citation Per Year

The dataset on average citations per year (Figure 3) provides a comprehensive view of scholarly impact across different time periods. Early years like 1989 and 1990 show minimal citation influence, with a MeanTCperYear of 0.06 and 0.00 respectively, despite a few publications. However, a significant increase in citation impact is observed in 2001, where the MeanTCperArt reaches 86.50, contributing to a MeanTCperYear of 3.60. Notably, 2016- and 2017-mark periods of substantial academic recognition, with MeanTCperArt values of 96.83 and 55.80, and corresponding MeanTCperYear figures of 10.76 and 6.97. The trend stabilizes in subsequent years, with sustained high citation averages in 2018 (MeanTCperArt of 40.80, MeanTCperYear of 5.83) and 2021 (MeanTCperArt of 24.56, MeanTCperYear of 6.14). Although the citable years decrease as publications become more recent, the upward trajectory in average citations per article and year underscores the increasing relevance and impact of research addressing urban sprawl and environmental degradation. This trend reflects heightened academic focus and growing societal concerns around these critical issues.

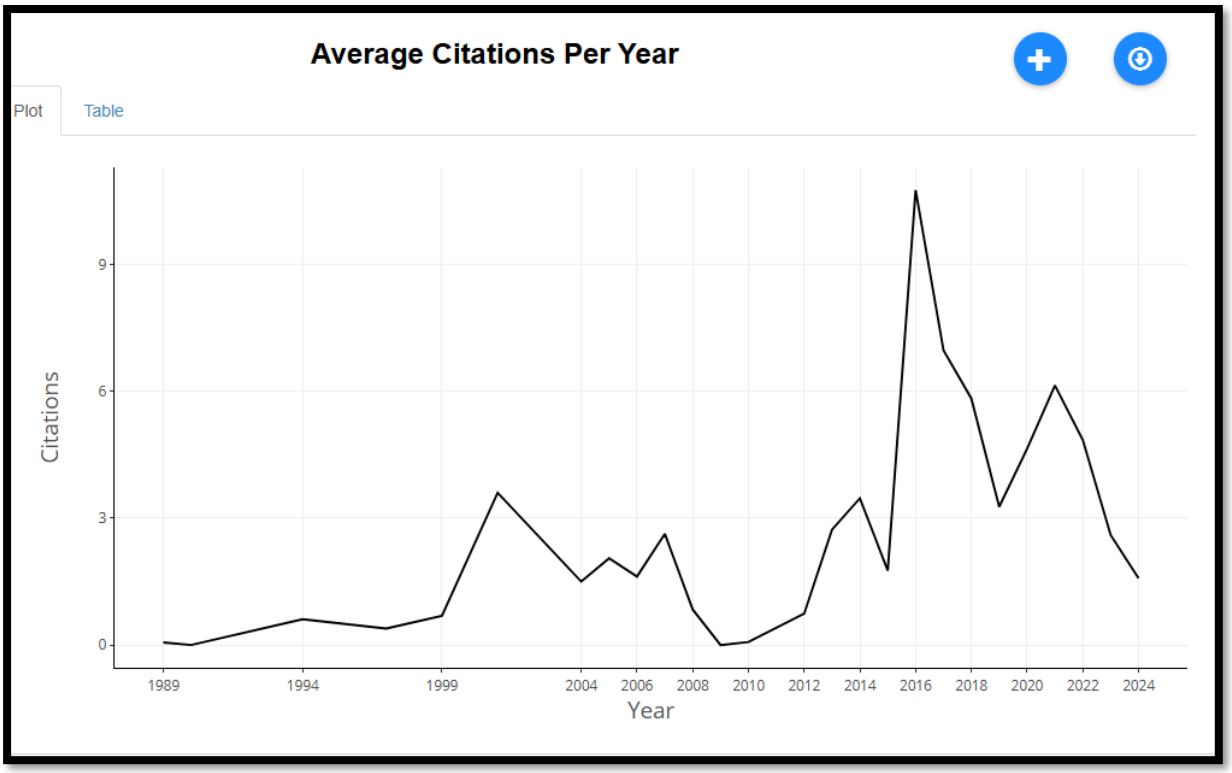


Figure 3: Average Citation Per year

A Network Visualization for Co-Authorship by Organization

The network visualization for co-authorship by organization provides insights into collaboration patterns among institutions. Items in the visualization are represented by labels and circles, whose sizes are determined by their weights—higher weights result in larger labels and circles. Labels for some items may be omitted to avoid overlap. The colour of each item corresponds to its cluster, while lines between items indicate links, with at most 1000 lines shown to represent the strongest connections. Figure 4 and Figure 5 depict the co-authorship network among higher education institutions and departments. Figure 5 reveals that most institutions with at least one document are not collaborating, highlighting a significant gap in collaboration. Conversely, Figure 6 showcases the institutions that actively collaborate, and co-author works on urban sprawl and environmental degradation. Out of 298 items, 135 in Figure 5 are unlinked, emphasizing the lack of collaboration, whereas Figure 6 illustrates the limited but existing collaborative efforts among the remaining institutions in this field.

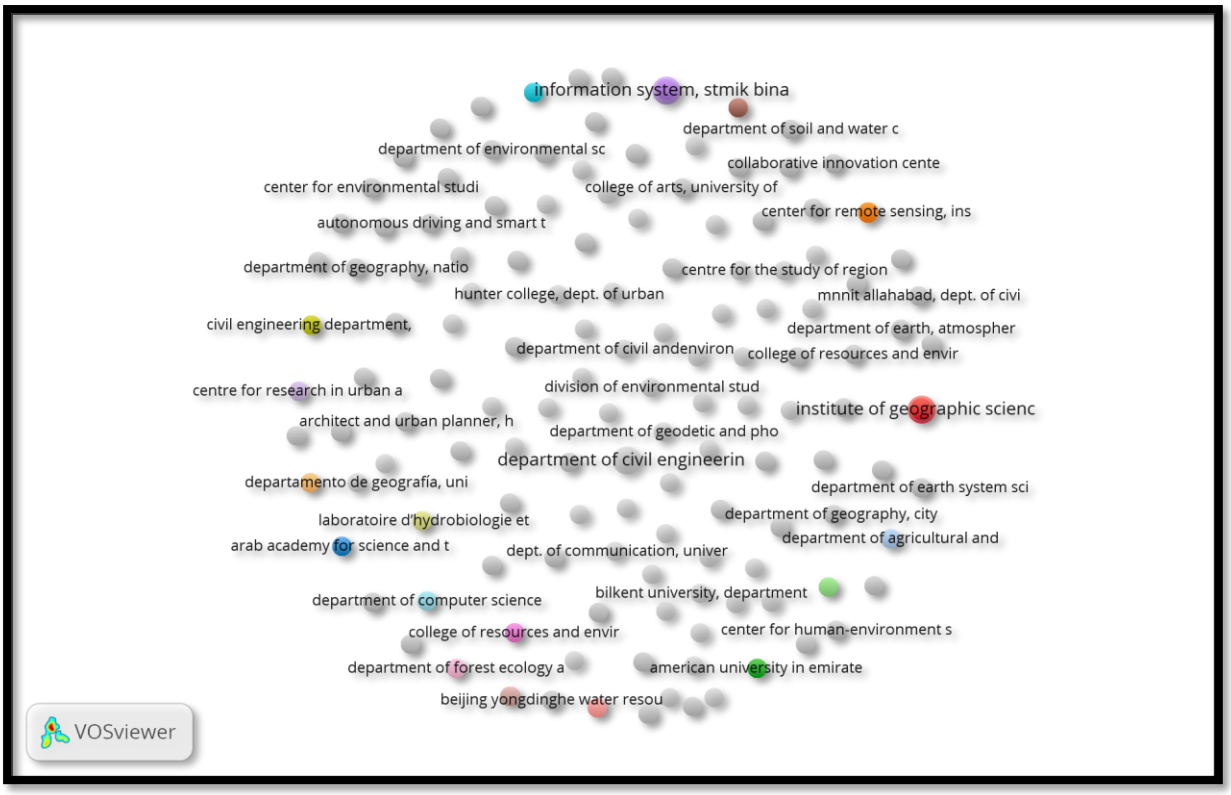


Figure 4: Co-authorship and Organization Network highlighting a collaboration gap, stressing the need for stronger partnerships

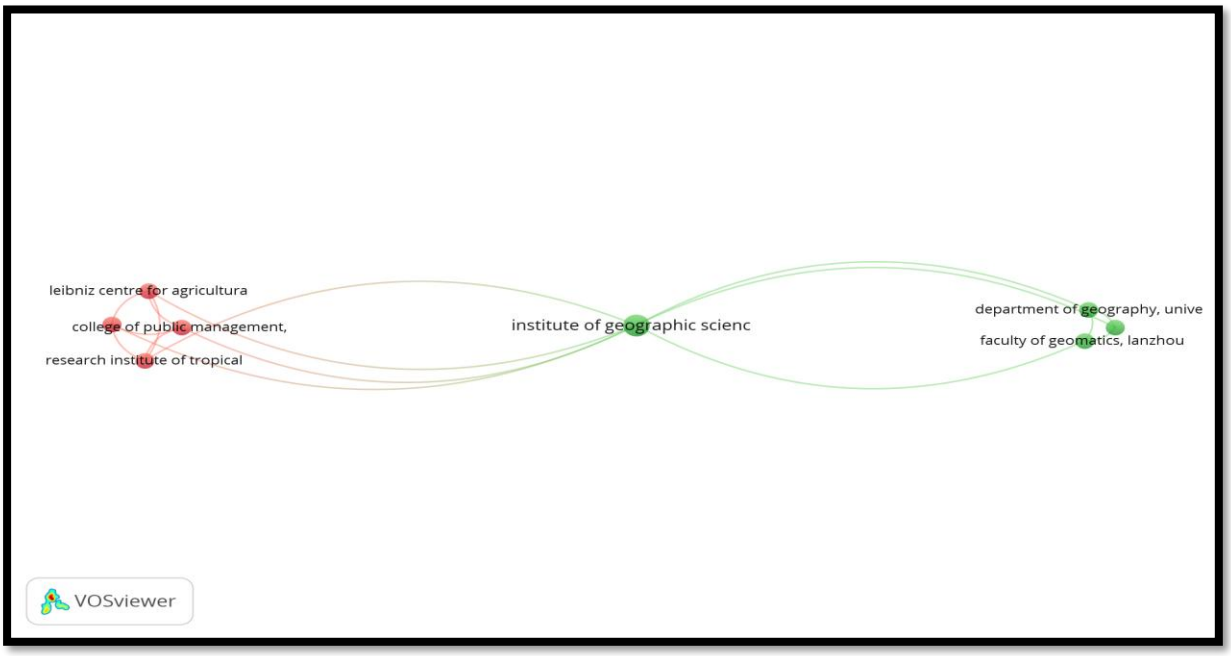


Figure 5: Co-authorship and Organization showing the institutions that actively collaborate on urban sprawl and environmental degradation

The bibliometric data highlights a significant lack of international collaboration in the study of urban sprawl and environmental degradation, as evidenced by the zero total link strength for all countries listed. While countries like China, the United States, and India dominate research outputs and citations—accounting for the bulk of studies with 28, 24, and 21 documents

respectively. The data reveals isolated research efforts with no co-authorship networks. This fragmented approach undermines the potential for exchanging methodologies and insights across regions, particularly in addressing global challenges. The geographical gap is also stark, with underrepresentation of African countries except for Kenya, which contributed only two documents. Nigeria, despite its rapid urbanization and pronounced environmental degradation, is notably absent, reflecting a critical void in localized research efforts. This lack of focus on Nigerian urban centers such as Lagos or Abuja not only limits the understanding of socio-political and environmental dynamics but also hinders the development of context-specific solutions. To address these challenges, fostering international collaboration and encouraging research in underrepresented regions like Nigeria is essential to bridge knowledge gaps and enhance global strategies for sustainable urban development as shown in Figure 6.

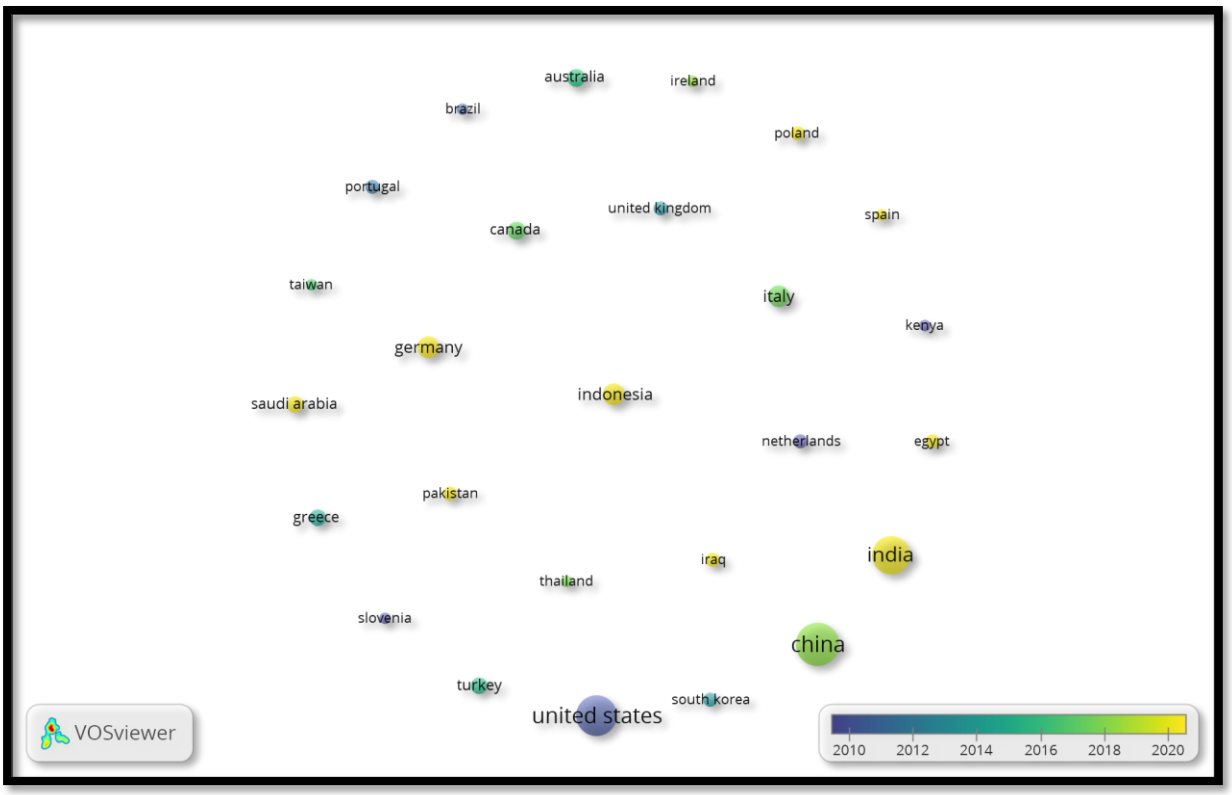


Figure 6: Citation and Country

Findings

The bibliometric analysis reveals several critical insights into the current state of research on urban sprawl and environmental degradation. First, studies predominantly focus on regions such as India, Ghana, and other parts of Asia and Africa, utilizing advanced geospatial and machine learning techniques to analyze urbanization patterns and their environmental impacts. However, there is a significant geographical gap, particularly in the Nigerian context, where rapid urbanization is occurring without adequate research focus. For example, urban centers such as Lagos and Abuja, known for unplanned growth, remain underrepresented in academic literature.

Furthermore, the analysis underscores the importance of methodologies such as spatiotemporal analysis, object-based image analysis (OBIA), and remote sensing. These tools

have proven effective in monitoring land use changes, green space depletion, and coastal management in other regions. Despite these advancements, Nigeria lacks similar research applications, leaving critical environmental challenges unaddressed. Additionally, there is no recorded international collaboration or citation network related to Nigerian studies, emphasizing the need for increased research integration within global frameworks.

Recommendations

To address the identified gaps, future research should prioritize localized studies in Nigerian urban centers to better understand the socio-environmental dynamics of urban sprawl. Leveraging geospatial technologies and machine learning can provide actionable insights for sustainable urban planning and environmental management. Policymakers and academic institutions should also foster international collaborations to incorporate Nigeria into global research networks. These efforts can enhance data availability, inform evidence-based policies, and support the development of resilient and sustainable urban landscapes in the face of rapid urbanization and climate challenges.

Conclusions

The bibliometric analysis highlights significant advancements in the use of geospatial and machine learning techniques to address the interlinked challenges of urban sprawl and environmental degradation. However, a substantial geographical gap exists, particularly in the Nigerian context, where rapid urbanization and environmental challenges are inadequately explored. While global studies provide valuable insights into urban green space depletion, spatiotemporal analysis, and sustainable land use planning, these approaches remain underutilized in Nigeria. The absence of research collaboration networks and a lack of localized studies further exacerbates this gap. Addressing these deficiencies is critical for developing evidence-based policies and sustainable urban planning strategies tailored to the unique socio-political and environmental dynamics of Nigerian cities. This study underscores the urgent need for interdisciplinary approaches and increased global integration to bridge these knowledge gaps and mitigate the adverse impacts of urbanization.

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