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A Detailed Bibliometric Analysis Examining the Research Trends in the Field of "Urban Green Spaces" from 1973 To 2023, along with an Exploration of Future Research Directions

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Abstract: The world's growing urbanization has made the development of urban green spaces (UGSs) a primary priority for urban planning. In addition to offering a wide range of ecological services, these areas improve residents' overall well-being. For sustainable urban development, it is essential to comprehend how UGS are developed and the methods used to conserve biodiversity there. However, the current literature still noticeably lacks a thorough systematic evaluation of the biodiversity research conducted in urban green spaces. This paper reviewed and analysed 7838 research articles (OPEN ACCESS) related to urban green spaces from 1973 to 2023 using the Lens dataset. For the scientific bibliometric analysis and visual analysis, the VOS viewer software was used. It also examined the fundamental traits, research hotspots, frontier trends, and literature co-citation analysis. The results demonstrate that the research's intellectual foundation is indicated by 11 co-citation clusters. Additionally, 20 primary keywords with a high centrality and 19 high-frequency keywords were retrieved.

Keywords: Urban Green Space • Bibliometric analysis • VOSViewer • Lens dataset.

Introduction

The global trend toward urbanization is accelerating at an unprecedented pace. By 2050, it is projected that nearly 70% of the world's population will reside in urban areas, a significant rise from 46.6% in 2000 (Lee & Maheswaran 2011; Vlahov & Galea 2002). This rapid urban growth has profound implications for urban infrastructure, public health, and environmental sustainability. Key concerns include the emergence of urban heat islands, increased pollution, climate-related risks, and compromised safety. As cities continue to expand, addressing these challenges requires integrated, multisectoral strategies that promote sustainable development and foster healthier urban environments. One promising solution is the expansion and equitable distribution of urban green spaces (UGS), which offer a practical, accessible, and highly beneficial means of improving urban resilience and quality of life.

Urban green spaces, originally defined as urban land with minimal built-up area (less than one-twentieth occupied by structures), encompass both green and grey components. Green elements include vegetated surfaces such as grass, trees, and gardens, while grey areas refer to hard, impermeable surfaces like pavements and buildings (Swanwick et al 2003). These green infrastructures support diverse ecosystems, including parks, forests, residential yards, green roofs, and rain gardens. They provide a range of ecological, social, and health-related benefits to urban populations (Anguluri & Narayanan 2017; Aronson et al 2017). The concept of UGS may vary by context, but commonly includes natural woodlands, wetlands, parks, community gardens, and street vegetation,

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whether publicly accessible or privately maintained (Adjei Mensah 2014).

Public green spaces consist of parks, sports fields, reserves, community gardens, greenways, riparian corridors, and tree-lined streets. These areas are crucial for enhancing urban ecology and fostering community well-being (Richardson et al 2013; Roy et al 2012). Private green spaces, which include residential gardens, shared yards, and institutional landscapes, are equally important for sustaining ecological health and improving the quality of urban life (Richardson et al 2013).

A practical framework gaining attention in urban planning is the 3-30-300 rule, designed to optimize green space access and quality. This rule suggests that every urban resident should be able to see at least three mature trees from their home, live within 300 meters of a public green space of at least 0.5 hectares, and have 30% tree canopy coverage in their neighborhood (Browning et al 2024; Gangwisch & Matzarakis 2024). This model not only promotes physical and mental well-being but also encourages urban biodiversity and environmental justice (Browning et al 2024).

Extensive evidence supports the environmental, social, and health benefits of UGS. These spaces enhance air quality, reduce urban temperatures, serve as wildlife habitats, and facilitate water infiltration and noise reduction. More importantly, they serve as catalysts for community engagement, recreational activities, and improved public health (Donovan & Butry 2009). Multiple studies have demonstrated that access to green areas correlates strongly with enhanced mental health, reduced stress, increased physical activity, and greater overall well-being (Maas et al 2006).

Furthermore, UGS contribute to urban food security, foster biodiversity, and play a vital role in climate resilience. They assist in regulating urban microclimates, filtering pollutants, supporting groundwater recharge, and reducing the adverse effects of flooding. These functions position green spaces as integral components of sustainable urban development (Escobedo et al 2019; Groenewegen et al 2006). Research also shows that exposure to UGS can significantly alleviate stress and anxiety, providing psychological comfort in densely populated urban settings (Grahn & Stigsdotter 2010; Nielsen & Hansen 2007; Schipperijn et al 2010).

To systematically understand research patterns in UGS, bibliometric tools like VOSviewer are increasingly used. These tools visualize scholarly outputs, highlight emerging trends, and reveal knowledge gaps by analyzing co-authorship networks, keyword occurrences, and citation data (Chen 2017). While such tools are adept at mapping scientific knowledge, they often require complementary qualitative insights for comprehensive understanding.

Given the growing academic and policy focus on UGS and equitable access, bibliometric assessments can reveal key developments, influential research themes, and future directions (Yan et al 2024). This study uses bibliometric techniques alongside VOSviewer to explore research landscapes and pinpoint priority areas for further investigation.

Research Methodology

The main source of data for our investigation was the Lens dataset (Fig. 1). We only looked into OPEN ACCESS articles and review articles (henceforth referred to as "articles") that were published between 1973 and 2023 in order to determine the kinds of documents to be examined. The study included only articles that contained the term "urban green space (UGS)" in the title, abstract, or keywords (Bahuguna et al 2024). The following are the query details: Academic Papers (9896 = Title: (Urban AND (Green AND Space)) OR (Abstract: (Urban AND (Green AND Space)) OR Keyword: (Urban AND (Green AND (Space))). Since, authors didn't use any

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synonyms to avoid confusion, we consistently refer to all of the above-described categories of places in this research as "urban green space."

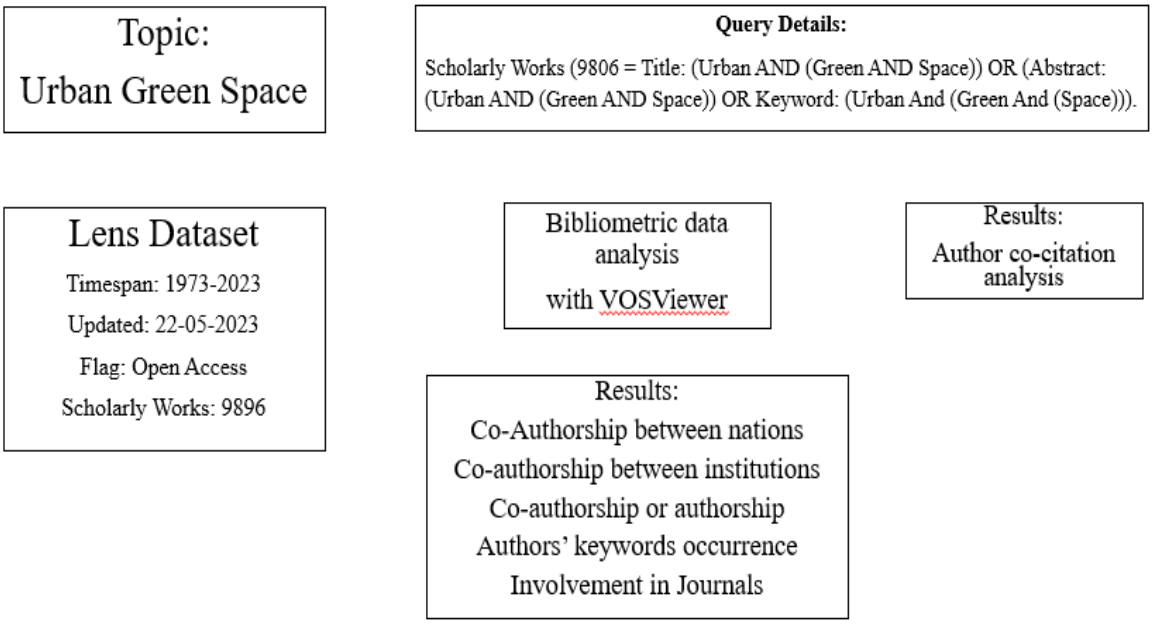

Fig 1: Research Method for the bibliometric analysis

Bibliometric analysis method

The term bibliometric analysis was coined by Groos and Pritchard (1969), defining it as research aimed at quantifying all written communication processes (Gokhale et al 2020; Rojas-Sánchez et al 2023). The authors initiated a bibliometric study in May 2024 to conduct an exhaustive literature review on UGS in Africa. This study includes a comprehensive analysis of the publicly available Lens Database, irrespective of the year of release. The objective was to create an up-to-date and comprehensive synthesis of knowledge by systematically examining various repositories, thereby enhancing the understanding of UGS in recent years and contemporary discourse.

A thorough search was conducted for English-language research papers published in peer-reviewed, open-access journals containing designated terms in their abstracts, titles, or keywords (Muhoza & Zhou 2024). The application of quantitative bibliometric analysis is crucial in determining dominant research trends and clarifying the status of a particular field. VOSviewer, a software program designed for bibliometric mapping and analysis, was utilized for this study. Keyword co-occurrence analysis, essential for identifying research focal points and thematic developments, was conducted using VOSviewer 1.6.20 (Meng et al 2020). This software, developed by Van Eck and Waltman at Leiden University (Netherlands), specializes in mapping bibliometric networks, analyzing co-citation, coupling, and co-authoring dynamics to depict relationships among journals, researchers, keywords, and publications (Dissanayake & Weerasinghe 2021). VOSviewer also provides detailed visualizations, aiding in the interpretation of underlying scholarly patterns (Waltman et al 2010).

This study is based on literature evidence examining the relationship between urban space and citizens' health. It utilizes CiteSpace and VOSviewer to create an associated knowledge map through quantitative bibliometric analysis. In addition to presenting recent developments, hotspots, and

evolutionary trends in residents' health research and urban space (Muhoza & Zhou 2024), this study aims to uncover core knowledge in the field. These insights serve as valuable resources and a strong foundation for future domestic research projects and scholarly investigations.

Results and Discussion

Our findings indicate that interest in UGS has increased significantly since 2010, with a sharp rise after 2016 and a slight decline in the past two years. The adoption of Sustainable Development Goals (SDG), particularly indicator 11.7 of SDG 11, which emphasizes universal access to secure and inclusive green spaces, has driven this sustainable growth. The reported decline may be linked to the impact of the COVID-19 pandemic (Farkas et al 2023). A comprehensive literature review on urban green spaces revealed a recurring global trend (Farkas et al 2023).

Trends and Patterns

For this study, we identified 9,896 research publications, with 7,838 meeting our inclusion criteria for studying urban green space (UGS) after bibliometric data correction. The annual trend in total publications is shown in Fig 2. Notably, the number of articles has steadily increased since the last decade, peaking significantly in 2012. Our analysis reveals that 72.75% of the reviewed articles were published in the last five years (2019–2023), emphasizing the growing relevance of UGS. During this period, 86.21% of the documents were journal articles, including volumes and issues. To ensure comprehensive bibliometric analysis, we included all available document categories from the Lens.org database, such as books, journals, preprints, chapters, dissertations, conference proceedings, editorials, reports, and news articles. The increasing diversity of document types underscores the expanding interest and significance of UGS research.

Table 1: Document type obtained from Lens Database

Sr. No.	Document Type	Total Count
1.	*Journal	8531
2.	Preprint	475
3.	*Conference	287
4.	*Book	244
5.	*Other	216
6.	Dissertation	89
7.	Report	33
8.	Editorial	17
9.	News	4

Source: Lens Database

In the study, we use Microsoft Excel to remove duplicates and conduct qualitative bibliometric analyses in the theme of UGS. Primary bibliometric analysis of the document types was realised from the analysis section available on lens.org. In addition, the VOSviewer software was selected to perform a co-occurrence and overlay visualisation analysis of obtained keywords (Farkas et al 2023), authors and their average year of publication and keyword network (H. Yan et al., 2022). Additionally, the most active author working on urban green space issues was also identified with the aid of the descriptive analysis of the bibliometric data.

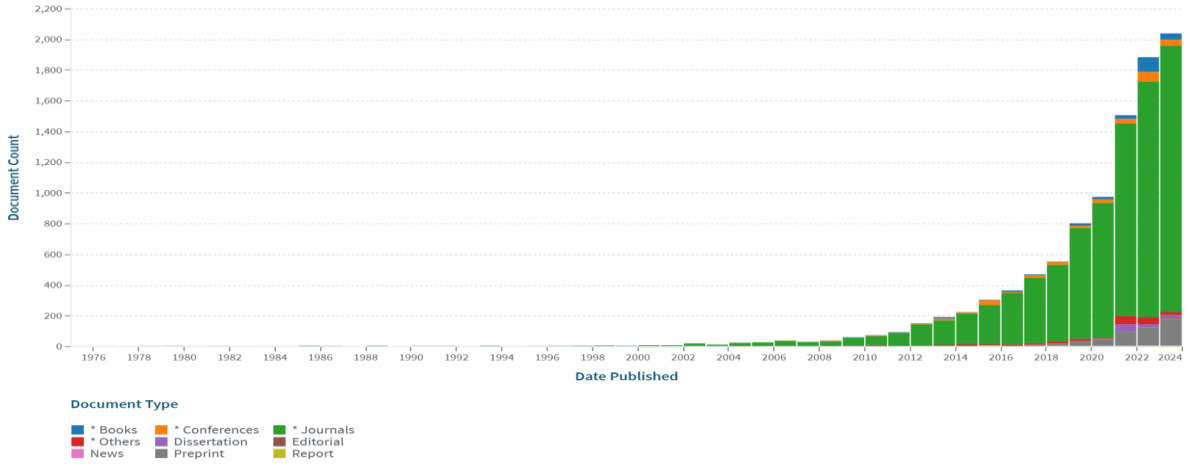

Fig 2: Vertical Bar Graph showing the Document types

Most active countries

The most active countries in document counts were identified as China (1127), the United States-US (811), and the United Kingdom-UK (690), with both countries accounting for around 14.31% and 10.30% of total world published documents, respectively. In contrast, Indonesia and Germany have published a total of 489 and 349 articles on the theme of global published publications on urban green space, respectively (Table 2)

Table 2: The most active countries in document counts

Sr.No.	Institution Country/Region	Document Count	In %
1.	China	1127	14.31
2.	United States	811	10.30
3.	United Kingdom	690	8.76
4.	Indonesia	489	6.21
5.	Germany	349	4.43
6.	Australia	334	4.24
7.	Italy	225	2.86
8.	Netherlands	187	2.37
9.	Spain	186	2.36
10.	Canada	167	2.12

Most active authors

With 39 publications—nearly 16% of the total number of documents—*Mark J. Nieuwenhuijsen* was the most often cited author in terms of published document counts pertaining to urban green space followed by *Dagmar Haase and Nadja Kabisch*. Dagmar Hasse and Nadja Kabisch, who account for roughly 30 (12.24%) and 20 (8.16%) publications, respectively, come after him. A thorough summary of the top 10 authors most often cited in proportion to the quantity of published papers is given in the accompanying table. The display names of the authors and the average number of papers assigned to each are shown in Table 3.

Table 3: Most often cited in proportion to the quantity of published papers

Sr.No.	Author Display Name Exact	Document Count	In %
1.	Mark J Nieuwenhuijsen	39	15.92
2.	Dagmar Haase	30	12.24
3.	Nadja Kabisch	20	8.16
4.	Kevin J Gaston	13	5.31
5.	Philip James	11	4.49
6.	Richard Mitchell	11	4.49
7.	Alessandro Rigolon	10	4.08

8.	Catharine Ward Thompson	10	4.08
9.	Jakub Kronenberg	10	4.08
10.	Marco Moretti	10	4.08

Top Journals

The *"Sustainability"* and *"IOP Conference Series:EES"* are the top two journal publishers, accounting for roughly 20.27% and 12.24% of the total number of documents, respectively, followed by *IJERPH, Land, and Urban Forestry & Urban Greening,* with 10.39%, 9.47%, and 6.08% of the total number of documents published in these journals, respectively. A comprehensive list of the publishers, including their names and the average number of the published documents in each journal, is provided in Table 4.

Table 4: comprehensive list of the publishers, including their names and the average number of the published documents

Source Title Exact	Document Count	In %
Sustainability	550	20.27
IOP Conference Series: Earth and Environmental Science (EES)	332	12.24
IJERPH	282	10.39
Land	257	9.47
Urban Forestry & Urban Greening	165	6.08
Forests	136	5.01
Ecological Indicators	117	4.31
Landscape and Urban Planning	101	3.72
Remote Sensing	101	3.72
E3S Web of Conferences	99	3.65

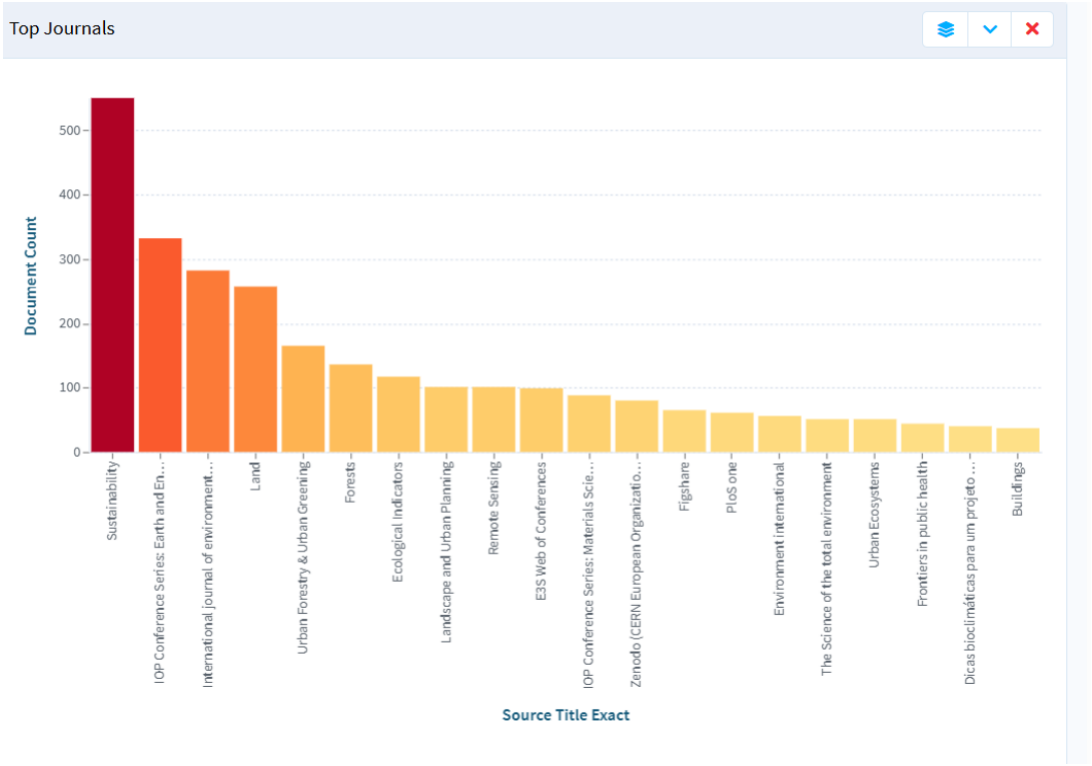

Fig. 3: Top Journals publication on the theme of Urban Green Space

Mapping Co-Citation Analysis

The citations to scientific publications show how scientific knowledge is passed down and used, as well as how different events in the framework of scientific advancement are connected and developed. Co-citation analysis

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uses statistical and library science techniques to evaluate, examine, and group the co-citation phenomenon in scientific publications. This method finds new trends in the research landscape and helps one comprehend the relationships between academic works on a deeper level (Zhao et al 2022). Initially, the following method of analysis was selected for the co-citation analysis in the bibliometric software VOSViewer: Citation used full counting as the counting method (Yu 2021), and documents served as the analytical unit. Association Strength was used as the normalization technique, and citation counts were used to determine the visualization weights. Two important thresholds were defined before the bibliometric analysis was carried out: the minimum number of citations that a document had to have been 250, and the number of citation linkages for each of the 143 elements that were found was determined. Documents with the most citation links were therefore chosen, and they were then arranged into six somewhat marginal groups and five core clusters. The accompanying graphic displays the hierarchical relationships between the chosen documents and the findings of the VOSviewer bibliometric analysis.

Cluster analysis of keyword co-occurrence: Network visualization

To further understand the connections between the keywords that exist in the title, abstract, and author keywords of publications, a cluster analysis of keyword co-occurrence was carried out (Bahuguna et al 2024). From the aforementioned lens.org database components, 139 pertinent keywords with at least five keyword occurrences were selected out of a total of 3431 terms. These keywords were then arranged into five main and five relatively peripheral clusters. Afterwards for each of the 139 keywords, subsequently the total strength of the keyword co-occurrence links with other obtained keywords were determined. Then the authors chose the obtained keywords with the highest overall link strength (Bahuguna et al 2024).

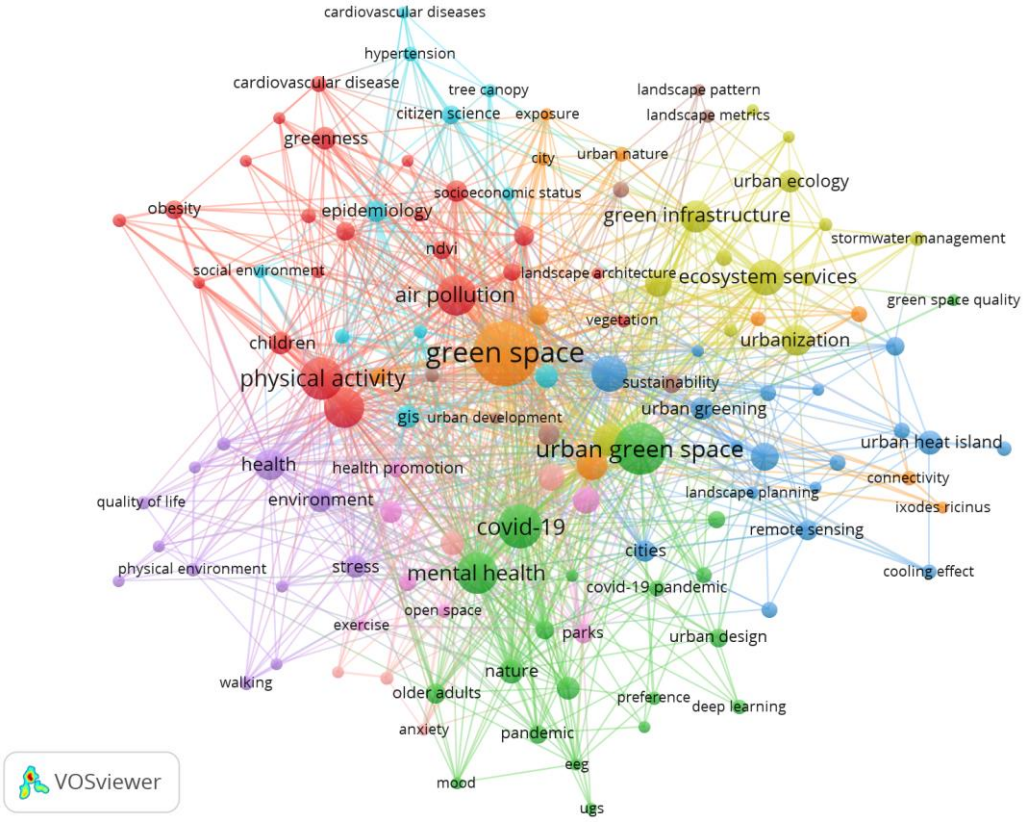

Fig 4: Network Visualization of Keyword co-occurrence

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With a total of 139 terms, the keywords with the highest co-occurrence in Cluster I (red) were physical activity, air pollution and build environment. This suggest that globally the urban green space research is more focused on the human health and environment. In Cluster II (green), the keywords with most occurrence were urban green space, Covid-19 and mental health. In cluster III (blue), the most often used keywords were public health, climate change and urban heat island. Ecosystem service, green infrastructure and urban planning was then observed at the Custer IV (yellow). In Cluster V (purple) concentrates on the health, environment and stress. In cluster VI (skyblue), the most often used keywords were environmental justice, epidemiology and GIS (geographic information system), whereas in cluster VII (orange), the most frequently used keywords were green space, urban and blue space. Following that, in Cluster VIII (brown) sustainability, urban heat and ageing. Urban parks, accessibility and parks were the most frequently occurring keyword in cluster IX (lavender). In the end Cluster X (peach red) urban environment and depression and heat impact assessment were the keyword with most co-occurrence based on VOSViewer bibliometric analysis.

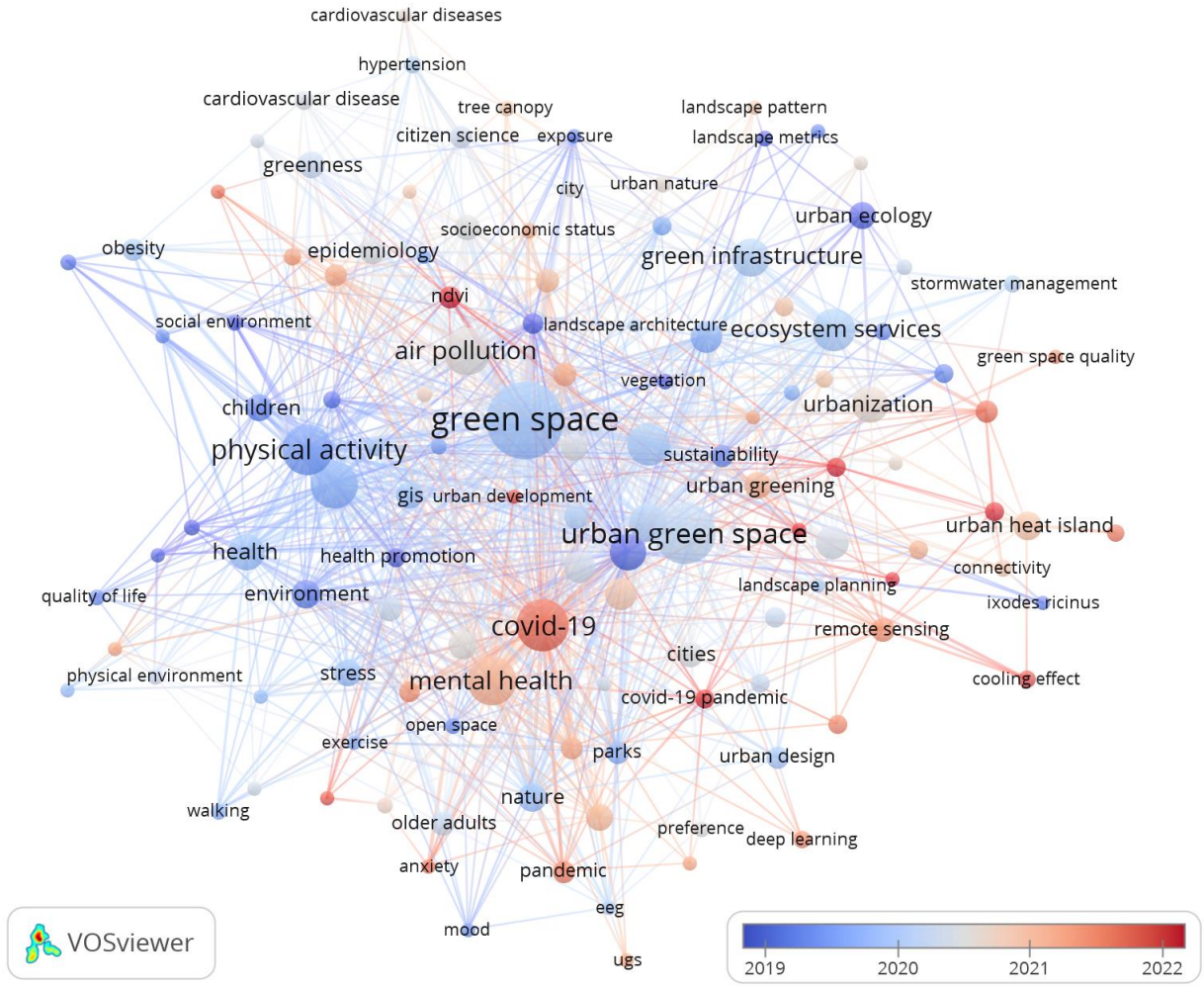

Fig. 2: Overlay Visualization of Keyword co-occurrence

Cluster analysis of keyword co-occurrence: Overlay visualization

The result obtained from VOSViewer by plotting overlay visualization were shown in the FIGURE. The map is based on keyword co-occurrences. This visualization map highlights various trends related to globally published document on the theme of urban

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green space. The average publishing year was 2022 for themes like as urban green infrastructure, NDVI, Covid-19 pandemic, machine learning, and healthy city. Following that, the most popular keywords for 2021 were identified as Covid-19, mental health, urban greening, well-being, and environmental health; at the same time, keywords co-occurring such as deep learning and remote sensing were also identified during the same time period, indicating academics' growing interest in using modern sophisticated methods and technology to provide better and more sustainable solutions. In 2020, the most common co-occurrence keywords were urban green space, air pollution, urbanisation, ecosystem services, urban planning, and green infrastructure.

Limitation

A significant number of keywords are absent from the majority of research articles that are retrieved from the Lens database. As a result, this study exclusively looks at open-access publications that are completely accessible via the Lens.org database. Additionally, the scoping review method can only be analyzed using its bibliometric database, which limits the capabilities to evaluate the quality of the supporting the evidence or the dependability of particular articles. Furthermore, there are a lot of missing terms in the downloaded Lens database, which might result in variations in the analysis's outcomes depending on the preliminary results.

Conclusion

According to bibliometric data from the Lens.org database, the number of published papers on urban green space (UGS) grew significantly from one in 1975 to 2,038 in 2023. The journals "Sustainability" and "IOP Conference Series: Earth and Environment" had the highest number of publications. The most influential studies focused on public health, green space accessibility, and environmental concerns. Analytical reports identified geography, environmental planning, environmental sciences, and urban planning as the top research fields. China (1,127) and the United States (811) were the most active contributors, representing 14.31% and 10.30% of global publications, respectively. Leading institutions included the Chinese Academy of Sciences, Central South University, Wuhan University, and the University of Hong Kong. Using VOSViewer, we conducted a major keyword co-occurrence analysis, revealing frequently recurring terms such as urban green space, green space, COVID-19, physical activity, mental health, and air pollution.

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