

Climate Adaptation Strategy via Urban Green Space: A Bibliometric Analysis

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Abstract: Urban green space has rapidly emerged as a key urban climate change adaptation strategy. In the past decade, numerous studies have highlighted the beneficial effects of urban green space on climate change mitigation and adaptation. These studies have shown that urban green spaces reduce air pollution, enhance biodiversity and ecosystem services, promote health and well-being, and protect urban areas from extreme weather events or disasters such as heatwaves, droughts, and floods. As such, this paper will examine and report Scopus-indexed articles on climate adaptation strategy through urban green space. As of October 5th, 2022, 257 documents have been retrieved and evaluated. This article summarizes the research productivity, most active source title, distribution of publications by countries, most active institutions, most productive authors, and citation analyses using established bibliometric indicators. The results show a fluctuated growth rate of literature on climate adaptation strategies through urban green space from 2012 to 2022. A total of 240 authors from 65 countries and 243 institutions have collaborated on numerous studies published in various journals. The results of this study can help guide future research on integrating climate change adaptation strategies and disaster resilience through green spaces in urban areas.

Keywords: Bibliometric Analysis; Climate Adaptation Strategy; Urban Green Space

1.0 Introduction

Urban areas are currently home to 55% of the world's population; by 2050, this percentage is predicted to rise to 68% (United Nations, 2019). As a result of this growth in urban populations, cities are increasingly becoming at the forefront of addressing climate change challenges (Leal Filho et al., 2019). According to McDonald et al. (2018) and Kumar (2021), urban areas are considered hotspots of climate change, simultaneously acting as significant drivers of greenhouse gas emissions and being particularly vulnerable to climate change. If inappropriate urbanisation is seen as a barrier to developing urban green spaces, such planning outcomes can be expected to slow the pace of implementing climate change adaptation (Guenat et al., 2021).

To adapt to the challenges of climate change and urbanisation in the context of sustainable cities and communities, urban areas increasingly rely on the existence of urban green spaces and their associated ecosystem services (Nasir et al., 2022; Veerkamp et al., 2021). As a result, urban green space plays a crucial role in regulating urban climate and can contribute to climate change mitigation, adaptation, and resilience strategy (Haq et al., 2021; Reynolds et al., 2020; Su et al., 2021). Some potential benefits of incorporating urban green spaces into climate change adaptation strategy include protecting and building resilience to natural hazards such as floods, storms, heat waves, droughts, landslides etc. (Bernello et al., 2022; Vinh et al., 2020). Other benefits include increasing air and water quality, reducing air pollution, promoting biodiversity, and enhancing the willingness to engage in sustainability or stewardship actions (Jaung et al., 2020; Nasir & Rahim, 2021). However, despite these benefits, urban green spaces can also increase the impacts of climate change if poorly designed or managed.

In the past decade, we have seen a growing trend in urban green spaces becoming increasingly crucial for mitigating and adapting to climate change. Urban green space strategies should consider an integrated approach to adaptation and mitigation in all dimensions, including transport, waste, resource consumption, etc. (Santos et al., 2021). Despite this growing interest, there is still a lack of a clear understanding of the connection between urban green space and climate adaptation. According to Haq et al. (2021), adaptation involves preparing for and responding to actual and expected environmental changes. To address this gap in the literature, we conducted a bibliometric analysis to identify research on this topic and gauge the current level of activity in this field. Therefore, this paper performs a bibliometric analysis of the Climate Change Adaptation Strategy via Urban Green Spaces, with a focus on three main research questions (RQs):

RQ1: How has research on Climate Adaptation Strategy via Urban Green Space developed and been disseminated?

RQ2: What key topics have been addressed in Climate Adaptation Strategy via Urban Green Space research?

RQ3: Who are the major participants of the Climate Adaptation Strategy via Urban Green Space research?

2.0 Methodology

In answering the research questions mentioned, this study utilised the data extracted from Scopus based on the search conducted on the 7th of October, 2022. Scopus is an efficient indexed database that can export metadata and publication data for various research fields. Next, considering the concept of research field maturity, this analysis restricted the screening process to articles published from 2012 until 5th October 2022. Three sets of keywords were used to search relevant articles related to this study contained in the research title, abstract and keyword. The first set of keywords (*climate* and *disaster*) is used to identify articles associated with climate change contexts and adaptation strategies, the second set of keywords (*green space*, *greenspace*, and *green park*) to identify articles related to the areas, and the third keywords (*urban* and *city*) to focus the search within an urban context. Results were restricted to research articles published in journals and subject areas (social sciences). There were no restrictions regarding article language. In answering our research questions, we analysed the results in various ways to get input. Some findings were achieved directly from Scopus using the search result analysis function. Additional results were manually entered or transferred as part of the data sets to a new Excel file in the CSV formats. The file containing the results was analysed for data, including percentages and the cumulative percentage. VOSviewer was also used to visualise the bibliometric networks since it is a freely accessible tool for constructing and visualising the networks (Ahmi & Mohd Nasir, 2019). Hopefully, this paper can enrich the valuable insights on the trends shown in publications on climate change adaptation strategy via urban green space.

3.0 Results and Discussion

Using Scopus-indexed database, we analysed the bibliometric attributes such as research productivity, most active source title, distribution of publications by countries, most active universities, most productive authors, and citation analyses. The data analysis was divided into sections according to the research questions.

3.1 Research Question 1 - How has research on Climate Adaptation Strategy via Urban Green Space developed and been disseminated?

The first research question of this study aims to investigate how climate change adaptation strategy via urban green space research has developed and been disseminated by interpreting (a) publications by languages and (b) productivity in research.

Publications by Languages

Table 1 showed that English was the most common language, which accounted for 91.8% of 236 publications. Chinese became the second language in publication but only reported 4.3%, followed by the German language with only 1.1%. The other documents were published in four different languages: French, Persian, Spanish, and Slovak. However, these languages accounted for less than one per cent respectively. Generally, the papers published in English would have the advantage of being encountered in scientific community journals as English is a legally recognised lingua franca of all scientific fields (Bornmann et al., 2012).

Table 1: Type of Languages

Language	Total Publications (TP)	Percentage (%)
English	236	91.8
Chinese	11	4.3
German	3	1.1
French	2	0.8
Persian	2	0.8
Spanish	2	0.8
Slovak	1	0.4
Total	257	100.0

Productivity in Research

The second analysis analysed productivity in research in terms of the number of documents published each year. According to Ahmi and Mohd Nasir (2019), the study allows the researcher to track the pattern and prominence of the research subject over time. As shown in Table 2, the highest number of publications on climate-related strategy via urban green space was in 2021, and we believe this trend will continue. The number of cited publications rose yearly, with 2021 having the highest number of cited publications (44). Nevertheless, Figure 1 indicates that the number of cited publications on climate adaptation via urban green space fluctuated between 2012 and 2017 before showing a decreased pattern from 2017 to 2022. The table provides an overview of the publication's year of climate adaptation strategy via urban green space from 2012 until 2022. Based on the number of publications, climate change and urban green space seem to be widely discussed among academics.

Table 2: Publications by Year

Year	TP	NCP	TC	C/P	C/CP	h
2012	7	7	107	15.3	15.3	5
2013	7	7	165	23.6	23.6	5
2014	15	14	824	54.9	58.9	11
2015	10	10	638	63.8	63.8	8
2016	18	17	640	35.6	37.6	11
2017	30	30	1142	38.1	38.1	20
2018	18	18	690	38.3	38.3	13
2019	34	31	610	17.9	19.7	13
2020	33	30	407	12.3	13.6	12
2021	48	44	298	6.2	6.8	9
2022	37	20	52	1.4	2.6	3
Total	257					

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index.

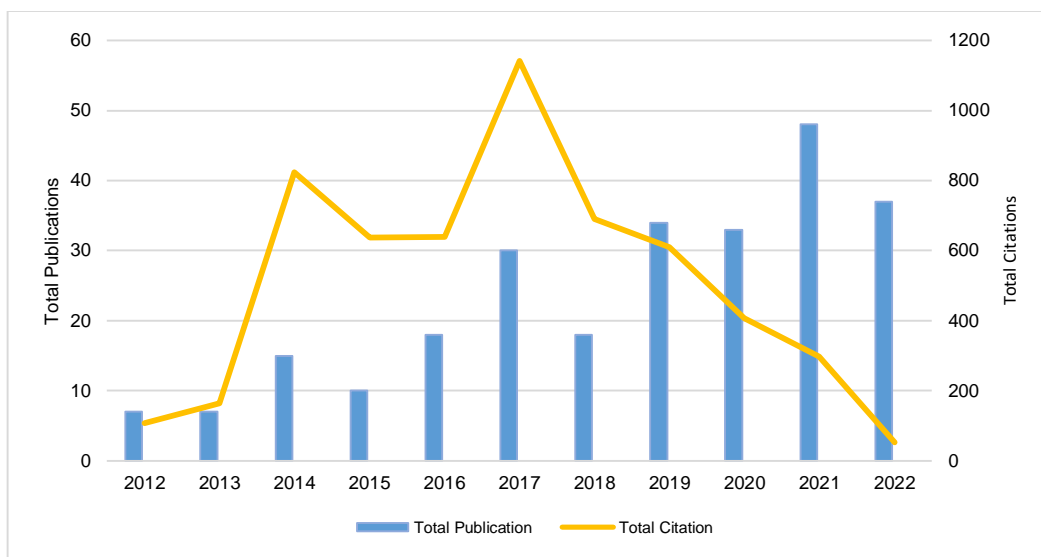


Figure 1: Total Publications and Citations per Year

3.2 Research Question 2 - What key topics have been addressed in Climate Adaptation Strategy via Urban Green Space research?

The second research question of this study aims to resolve top keywords and co-occurrence analysis. We used top keyword and co-occurrence analysis to examine the citation networks of 257 articles. According to Bazm et al. (2016) and Shmagun et al. (2020), Keyword co-occurrence analysis is a powerful method of effectively mapping the strength and the degree of association between keywords in literature. This study identifies the keyword most frequently used among scholars on climate adaptation strategy via urban green space research. The keywords from the 257 studies were summarised and presented in Table 3. "Greenspace", a keyword representing 64.6%, was revealed as the most intermittently used keyword in the climate adaptation strategy literature. The second most repeatedly used keyword is "climate change" (38.1%). This finding is logical since urban green space plays a vital role in climate change mitigation and adaptation approaches. For example, the cooling capacity of urban green areas constitutes a key measure for cities to mitigate heat events (Kraemer et al., 2022). Other popular keywords coming out over 50 times were "urban area" and "urban planning".

Table 3: Top 10 Keywords

Author Keywords	Total Publications (TP)	Percentage (%)
Greenspace	166	64.6
Climate Change	98	38.1
Urban Area	92	35.8
Urban Planning	76	29.6
Ecosystem Service	47	18.3
Urban Ecosystem	46	17.9
Green Infrastructure	42	16.3
Urbanisation	39	15.2
Heat Island	36	14.0
City	31	12.1

Moreover, VOSviewer was used to map the author's keywords. Figure 3 shows a network visualisation of the author keywords, each with at least two occurrences. Of the 940 keywords in total, 133 words met the criteria. Those keywords were divided into 15 clusters, and the size of the nodes depicts the frequency of keywords. Meanwhile, the different colour of the node represents the other cluster to which it belongs. The first cluster, highlighted in red, is associated with urban planning, urban resilience, urban microclimate, retention, green roofs, heat island mitigations, and urban vegetation. The second cluster, denoted by the green colour, includes the keywords of ecosystem service, carbon emission, carbon sequestration, land use, and urban biodiversity. The third cluster, highlighted in blue, is associated with green infrastructure, biodiversity conservation, nature-based solutions, sustainable cities, and cultural ecosystem services. The "green infrastructure", the most prominent node, was nearest to the "urban green space" node, and the close distance of both keywords means a strong connection between each other. Besides, keyword analysis provides meaningful insight into a specific issue's popularity or importance in a given research domain (Kamarrudin et al., 2022). In another respect, analysis of authors, their affiliation and h-index could indicate the authors' prominence of the article authorship (Ahmi & Mohamad Nasr, 2019).

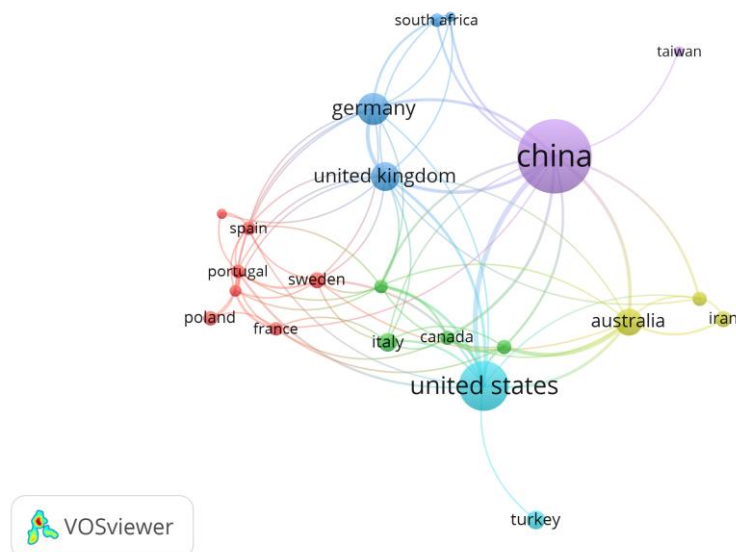


Figure 3: Network Visualization Map of The Citation by Country

4.0 Conclusions

This study examines the trend of research on climate change adaptation strategy via urban green spaces using bibliometric analysis. From the study, it is evident that climate adaptation strategies through urban green areas are becoming increasingly popular and that there is a growing number of studies on this topic. The findings of this study showed a noticeable increase in the number of publications by year in the past decade. However, the citations for the publications in this study are decreasing. As this body of research continues to grow, citation indexes will also be expected to grow. In addition, this study has certain limitations that must be referred to convey a clear vision to the readers. Future research may include additional databases such as Google Scholar and Web of Science. Lastly, further analysis can be included to provide a comprehensive finding.

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