EXPLORING GLOBAL RESEARCH TRENDS OF URBAN HEAT ISLAND BASED ON A BIBLIOMETRIC ANALYSIS

Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) * iD

Besna AYDEMİR (MSC.) ** iD

ABSTRACT

Urban heat island has gained significant attention in recent years due to its detrimental impact on the environment and public health. In this study, bibliometric analysis—a quantitative literature evaluation that reveals intellectual structure, collaboration patterns, and thematic areas in a field—will assess UHI research, identify trends, and predict future research paths by identifying research gaps. The study examined 5621 articles published in Scopus and 2777 articles published in Web of Science on urban heat islands between 2000 and 2023. R-supported VOSviewer and Biblioshiny were used for data processing and visualization. The countries in which urban heat island studies dominate are China, the United States, Italy, and India, as indicated by the study's findings. It is evident that the majority of research is focused on the measurement of the urban heat island and the analysis of related factors, while there is a lack of research on comprehensive mitigation strategies for implementation.

Keywords: Urban Heat Island, Bibliometric Analysis, VOSviewer, Biblioshiny, Web of Science, Scopus.

Jel Codes: 018, 021, Q54

1. INTRODUCTION

The urban heat island (UHI) phenomenon is a well- documented and widely studied topic in the field of urban climate research. The UHI concept, which is characterised by air temperature in urban areas being significantly higher than the surrounding rural or suburban areas, has become a much more prominent concept in this period of significant changes in the global climate (Hong, Wang, Gu, 2023: 2; Wong, Nichol, Kwok, 2009: 1-7; Molina, Morales, Carrión, 2020:181). The most important reason for the formation of UHI can be defined as urbanisation. As urbanisation accelerates and land use changes, the UHI effect intensifies, leading to an increase in urban temperatures and changes in local air circulation and microclimate (Wang, Zhou, Wang, 2019: 2). Here, the temperature difference is largely attributed to the replacement of natural, vegetated surfaces with impervious surfaces such as

---

* İzmir Demokrasi University, Faculty of Architecture, Department of Landscape Architecture, İzmir/ Türkiye, E-mail: nurdan.erdogan@idu.edu.tr.
** İzmir Demokrasi University, Faculty of Architecture, Department of Landscape Architecture, İzmir/ Türkiye, E-mail:besnaaydemir11@gmail.com.

93

pavements and buildings (Kullberg, Feeley, 2023: 3). It is also noted that cities have a different configuration in terms of characteristics such as albedo, vegetation cover, moisture and surface energy compared to rural areas, which increases the warming potential as a cumulative effect (Feranec, Holec, Šťastný, Szatmári, Kopecká, 2019; Mohamed and Zahidi, 2024). Other factors affecting UHI formation include natural variables such as slope, aspect, elevation, soil properties (Mokhtari, Barghjelveh, Sayahnia, Qureshi, Russo, 2022:6) as well as urban geometry (Krüger, Minella, Rasia, 2011: 621-634), urban morphology (Steeneveld, Koopmans, Heusinkveld, Van Hove, Holtslag, 2011:1-14), land use/land cover characteristics (Grigoraş and Uriţescu, 2019: 115-126) and socio-economic characteristics (Li, Sun, Li, Gao, 2020).

Although it varies according to the regional climate characteristics where the city is located, in cities with more than one million inhabitants, the annual average daytime temperature difference compared to the countryside can be 1-3°C and up to 12°C at night (EPA, 2008). The UHI effect is seen as one of the main urban vulnerabilities with its direct effects on reducing the quality of urban life and increasing the need for energy use (Santamouris, Cartalis, Synnefa, Kolokotsa, 2015:119-124; Urquizo, Calderón, James, 2017:193-206; Zhou, Wang, Zhu, Li, Li, Zhou, Pei, Zhang, 2022: 1) as well as its indirect negative effects on other systems (public health, water, green space, air, soil, food) Schauser, Otto, Schneiderbauer, Harvey, Hodgson, Robrecht, McCallum, 2010: 14; Zhou, Zhao, Zhang, Sun, Liu, 2015: 1; Hong, Hong, Kwon, Yoon, 2019: 1; Todeschi, Javanroodi, Castello, Mohajeri, Mutani, Scartezzini, 2022). Therefore, researchers emphasise the importance of addressing the UHI impact due to its significant impact on urban sustainability along with climate change (Niu et al., 2020). In this context, in recent years, efforts to analyse and understand UHI impacts have been carried out globally with studies focusing on different regions such as China, USA, Turkey, Egypt, Taiwan and Macedonia (Sun, Gao, Li, Wang, Liu, 2019). In particular, many studies have investigated the spatial and temporal variations of UHI in urban areas using remote sensing techniques and satellite imagery, and investigated the complex relationships between the factors affecting the formation of UHI (Yang, Guangrong, Chen, Hao, Zhouyiling, Shan, 2022.). In recent years, it is observed that studies to evaluate the effects of potential mitigation strategies such as increasing the amount of green space, improving surface albedo and optimising urban morphology to mitigate the impact of UHI and promote sustainable urban development on case study areas have gained momentum (Xu, Wang, Zhu, 2024: 2; Jiang, Li, Huang, 2022). In addition, studies on the use of tools such as ENVI-met, which enable the optimisation of these mitigation strategies by 3D modelling and thus aim to support decision-making processes with information, have gained momentum (Tsoka, Tsikaloudaki,Theodosiou, 2018: 55-76). However, the case studies examined show that these mitigation processes can be addressed with limited scales and approaches (Wong, Nichol, Kwok, 2009: 1-7; Molina et al., 2020:181).

Climate change-induced temperature increases are expected to exacerbate the UHI impact. Moreover, according to the latest UN estimates, the urban population worldwide is expected to reach 66

per cent by 2030 and 82 per cent in Europe. This indicates that more people will be exposed to more severe CIA impact in the near future. Therefore, it is imperative that strategies to mitigate the urban heat island effect should be effectively incorporated into decision-making processes within public administration. In this study, bibliometric analysis of publications in the literature is aimed to evaluate the development of UHI research, to identify emerging trends, and to reveal study gaps in accessing more effective and cumulative strategies for mitigation. Bibliometric analysis, which involves the quantitative examination of published literature, can provide valuable information about the intellectual structure, collaboration models and thematic focal points in a particular field of study (Sirmaçek, Gupta, Mallor, Azizpour, Ban, Eivazi, Fang, Golzar, Melsion, Smith, Fuso Nerini, Vinuesa, 2023; Wicki, Parlow, Feigenwinter, 2018). By examining the temporal and spatial distribution of publications, the most influential authors and institutions, and the relationships between different research themes, a bibliometric study can reveal the current state of UHI research, helping to highlight areas that require further research. Furthermore, bibliometric analysis can help researchers and public administrators to better understand the existing knowledge base, identify knowledge gaps and prioritise future research efforts to address the pressing challenges posed by the UHI effect (Wong et al., 2009; Molina et al., 2020).

2. MATERIAL and METHODOLOGY

Main objective of this study is to identify research trends, influential publications and important topics by analysing the existing literature in the field of UHI through bibliometric analysis methods. In this context, the material of the study consists of articles on UHI from Web of Science and Scopus databases between 2000 and 2023. Web of Science and Scopus databases were selected as search engines since they are the most widely accepted and frequently used databases for the analysis of scientific publications (Zhang, Xu, Zhang, Wang, He, Zhou, 2020). As a search strategy, both databases were searched as ('urban heat island' OR 'urban heat islands' OR UHI OR 'heat island') to access the literature on the urban heat island effect and the publications obtained were analysed in terms of title, abstract and keywords (Figure 1). Article searches were carried out in both databases on 10.04.2024. Since the focus was on the temporal change of study trends within the scope of the UHI, the number of data was very high in the first search due to a general search. For this reason, papers, book chapters, editorial material were excluded from the scope of the search and filtered to include only studies in article type and English language. In addition, the data set was customised by selecting articles using the keywords 'urban heat island, urban heat islands, heat island, heat island effect, urban heat island effects'. The studies in the data set formed by restricting the screening frame covered the studies between 2000-2023.

A total of 2777 articles from the Web of Science database and 5621 articles from the Scopus database were examined as part of the study. Despite the fact that there were 1704 articles that were

included in both databases, these publications were retained in both databases since the articles that belonged to both databases were assessed separately inside each database. VOSviewer and Biblioshiny tool supported by R package were used in the data analysis and visualisation process. These software are used for various purposes such as analysing academic metadata from scientific databases such as Scopus, Web of Science, Pubmed, Dimensions, examining subject and citation relationships in the literature, and distribution of keywords (Moral-Muñoz, Herrera-Viedma, Santisteban-Espejo, Cobo, 2020: 1).

In bibliometric studies, VOSviewer is often used in thematic, cartographic and cluster analysis, and can quickly search and analyse bibliometric networks such as publications, countries, organisations and journals (Van Eck and Waltman, 2017:1053-1070). In this study, VOSviewer was used to identify clusters and relationships between keywords. In this approach, which is also called network visualisation analysis, in the keyword relationship map created, the circle and label size of an item are determined according to the weight of the item. The colour of an item is determined by the cluster to which the item belongs. The lines between the elements represent the links (Tanınmış Yücememiş and Özdemir Altınışık, 2022: 296). For the citaiton analysis, co-citaiton analysis and bibliographic coupling analyses performed in the study, 'bibliometrix', an R-based library, and 'biblioshiny', the web-based interface of 'bibliometrix', were used. Bibliometric analysis was carried out using Biblioshiny, an open-source bibliometric programme from RStudio. Biblioshiny's advantage above other bibliometric tools stems from its comprehensive set of statistical techniques and visualizations, which allow for both conceptual mapping of the subject of study and performance analysis (Thangavel and Bibhas Chandra, 2023: 3).

Figure 1. Framework of the Review Paper
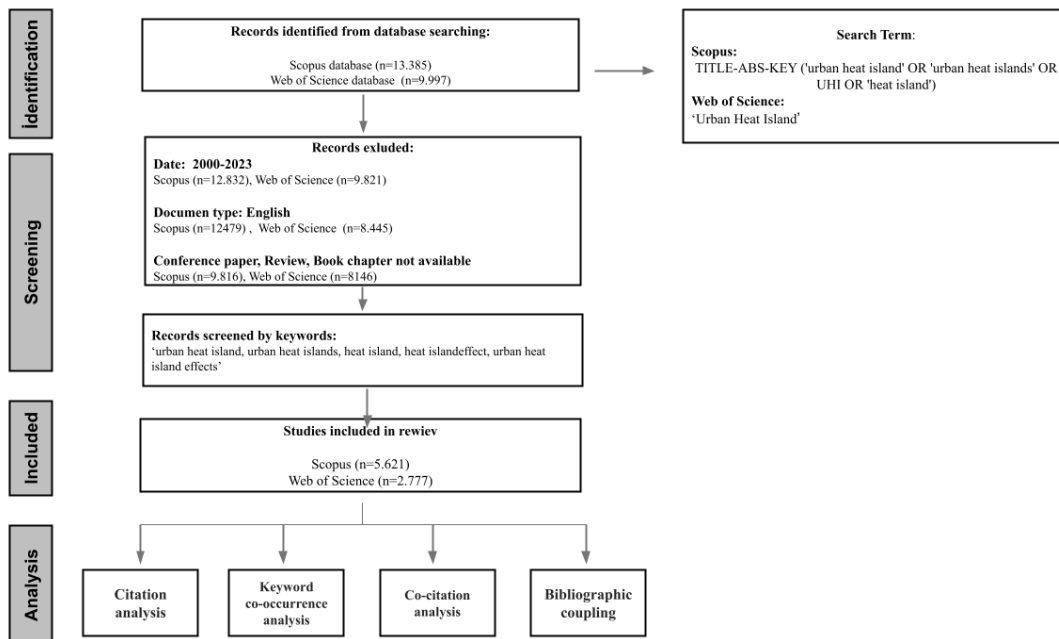
3. FINDINGS

Table 1 presents a summary of articles published on the topic of UHI from 2000 to 2023. It is evident that there were 2777 studies published in the WoS database and 5621 research published in the Scopus database. The average annual publication rate for WoS is 13.96% and for Scopus is 13.18%. The near values observed in both assessed databases can be viewed as evidence of the subject's development occurring in similar ways on a worldwide scale. Furthermore, it was ascertained that these scientific articles were authored by 7354 and 11777 researchers, respectively. The limited number of single-authored works (83 in WOS, 283 in Scopus) and the average author count of 4.2 in both databases indicate the extensive span of the subject. The issue of UHI necessitates the integration of various disciplines, including urban planning, environmental science, sustainability, remote sensing, climate science, and building. This interdisciplinary approach accounts for the abundance of research with multiple authors. The presence of international joint studies in around 30% of the papers in both databases is significant in terms of highlighting the transnational aspect of the subject.

Table 1. Main Information on Datasets

Description	Web of Science	Scopus
Main Information About Data		
Timespan	2000-2024	2000-2024
Document Types	Article	Article
Documents	2777	5621
Annual Growth Rate	%13.96	%13.18
References	61805	215561
Document Contents		
Author's Keywords	5450	9964
Authors		
Authors	7354	11774
Single-authored docs	87	283
Co-Authors per Doc	4.25	4.22
International co-authorships %	31.83	27.84

3.1 Annual Scientific Production in Urban Heat Island Studies

Upon analyzing the annual scientific production graph of studies on UHI, it is evident that both data sets exhibit a consistent upward trend (Figure 2). Between 2005 and 2010, there was a noticeable acceleration in the growth of both databases. Within this particular framework, the quantity of articles included in the SCOPUS and WoS databases, which amounted to 49 and 14 respectively in 2005, has already escalated to 660 and 348 by the year 2023. When examining the graphical findings, it becomes evident that research on UHI is a significant and continuously expanding area of study. It is anticipated that this trend will persist and further intensify in the future. Notably, the quantity of articles in the WoS database declined from 369 in 2022 to 348 in 2023.

Figure 2. Annual Scientific Production
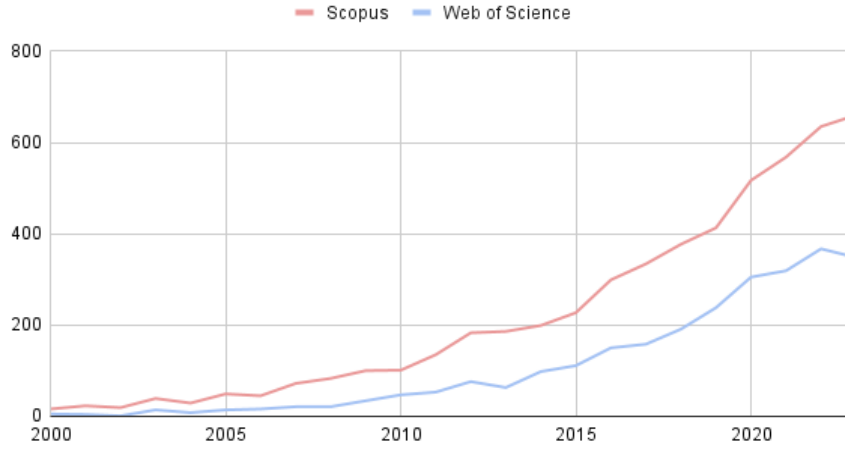
3.2 The Most Relevant Journals for Urban Heat Island Studies

When analyzing the most often published journals, it becomes obvious that publications focusing on the structural environment, urban and human relations, and strategies for fostering a sustainable and resilient environment, city, and society are particularly prominent (Table 2). The journals 'Sustainable Cities and Society', 'Building and Environment', 'Sustainability (Switzerland)', and 'Science of the Total Environment', which can be evaluated in this context, are journals suitable for the multidisciplinary structure of the study subject. In addition, the fact that the concept of UHI has been considered as a kind of human-induced climate change and associated with urban air pollution in recent years explains the publication of the subject in 'Urban Climate', 'Atmosphere', 'Theoretical and Applied Climatology', Journal of Applied Meteorology and Climatology' journals.

Table 2. Most Relevant Journals

| Journals	Articles	h-index
SUSTAINABLE CITIES AND SOCIETY	310	56
BUILDING AND ENVIRONMENT	301	73
SUSTAINABILITY (SWITZERLAND)	262	36
URBAN CLIMATE	223	42
SCIENCE OF THE TOTAL ENVIRONMENT	189	62
ENERGY AND BUILDINGS	136	50
ATMOSPHERE	133	21
THEORETICAL AND APPLIED CLIMATOLOGY	131	45
JOURNAL OF APPLIED METEOROLOGY AND CLIMATOLOGY	114	46

3.3. Scientific Production of Countries in Urban Heat Island Research

When analyzing the scientific output of countries in the subject of UHI research, it becomes evident that certain countries dominate in this area. Based on the findings derived from the Scopus database, China, USA, and Italy appear as the pioneers in terms of publications (Figure 3). The considerable scientific output of these nations can be linked to various significant aspects. The robust academic and research infrastructure in these nations facilitates comprehensive research on specialized subjects, such as the UHI phenomenon. Moreover, the extensive and highly populated areas in these nations give rise to locations where the UHI phenomenon is more prominent. This serves as a catalyst for the advancement of research and policy focused on finding solutions. The governments in these nations are adopting strategic measures, such as sustainable urban planning and green infrastructure practices, to counteract the adverse effects of UHI phenomenon. The countries that have a strong scientific production play a dual role: they produce practical solutions to address current challenges and ensure long-term urban sustainability. Based on the Web of Science dataset, China and the USA are the leading countries in terms of scientific output in the field of UHI studies, which is consistent with the findings of the Scopus dataset (Figure 4). Nevertheless, India's position as the third-ranked country in this dataset shows its growing scientific research capabilities and the significant urbanization it has seen in recent years.

Figure 3. Country Scientific Production, Scopus
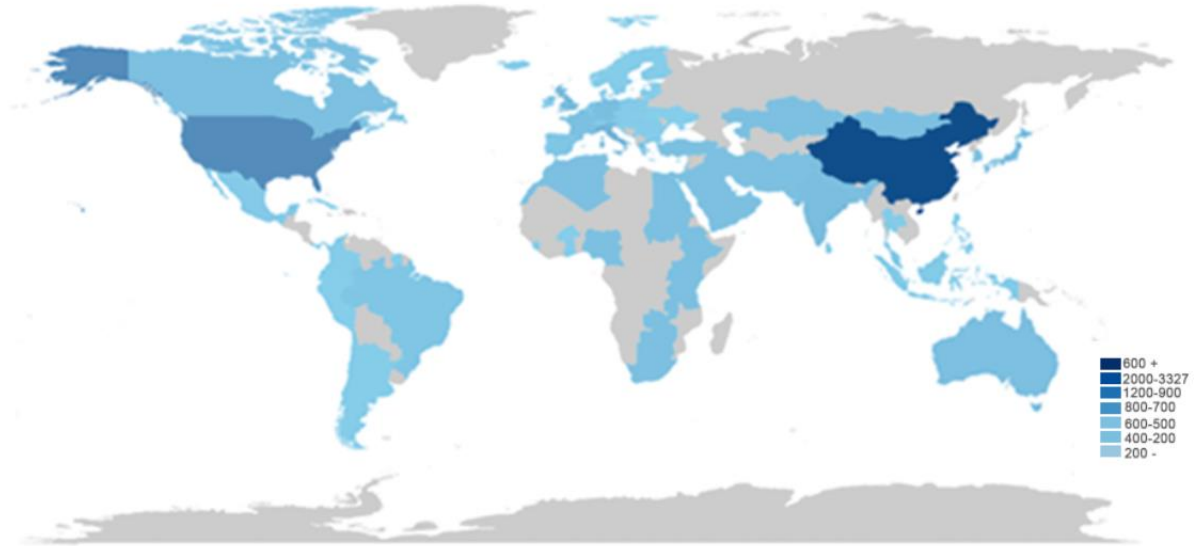
**Figure 4. Country Scientific Production, Web of Science**
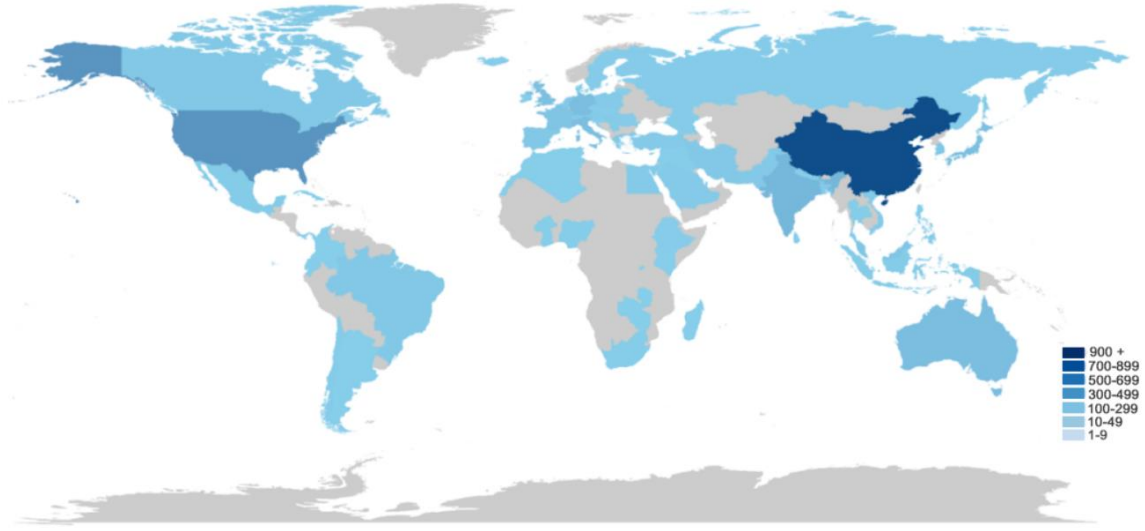
However, nations that have a lower number of publications on the topic of UHI tend to be developing countries or countries with limited research resources. The limited scientific output in these countries may be attributed to inadequate infrastructure and constrained financial resources. Nevertheless, these countries also encompass areas where the potential consequences of the UHI effect have not been thoroughly investigated, therefore presenting significant prospects for future research. This implies that enhanced international collaboration and dissemination of knowledge could help foster a more comprehensive and general comprehension of the UHI phenomenon.

Turkey maintains the 21st place in this ranking. It indicates that there is a lack of extensive research on UHI in the country. It is evident that Turkey's level of awareness and research output on UHI is still below its desired standard in comparison to leading countries. Nevertheless, Turkey, classified as a developing nation, has the potential to elevate its scientific output in this domain through the expansion of its research infrastructure and allocation of additional resources.

Upon analyzing papers categorized by country, it becomes evident that transnational studies are very prominent (Figure 5). This situation emphasizes the significance of enhancing global collaboration and exchange of knowledge to comprehend the phenomenon of UHI, which is regarded as a worldwide issue, and to provide remedies. Developing countries, with a limited number of research on the subject, can enhance their efforts to establish sustainable cities by growing their scientific productivity in this sector through transnational cooperation. This can be achieved by gaining a better understanding of the UHI impacts.

Figure 5. Corresponding Author's Countries

SCP: Single Country Publications, MCP: Multiple Country Publications
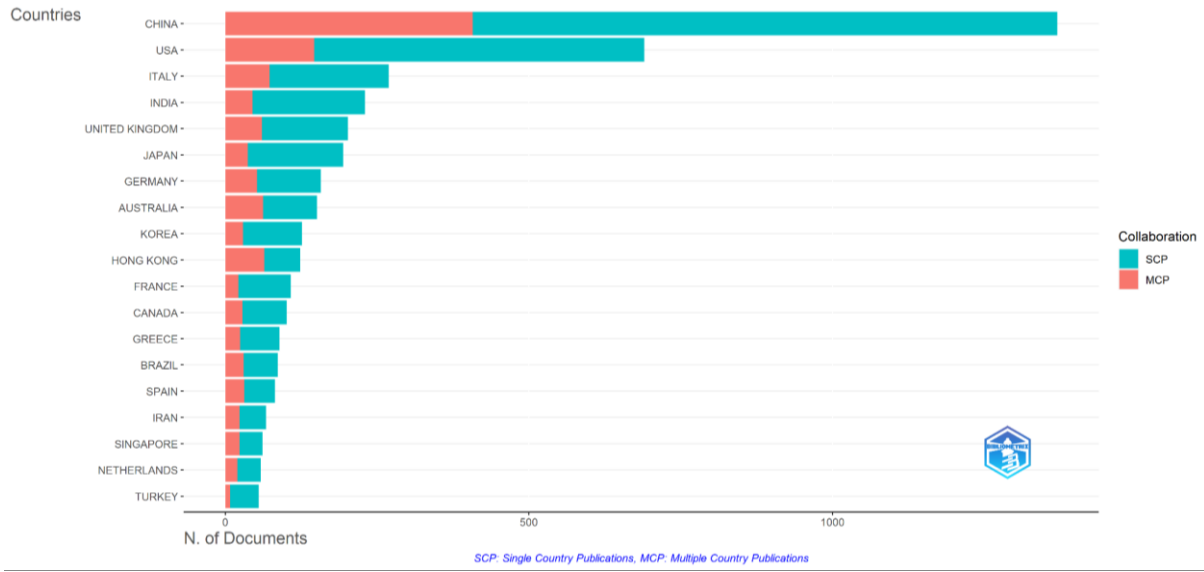
## 3.4. Most Cited Publications in Urban Heat Island Research

Scientific studies on the UHI effect hold significant importance in both the academic literature and real-world implementations. The widely cited papers in this topic have significantly contributed to the accumulation of knowledge and established a strong basis for future research (Table 3). The analysis of two databases revealed that the most often cited publication on the study of UHI is the article titled '*Two Decades of Urban Climate Research: A Review of Turbulence, Exchanges of Energy and Water, and The Urban Heat Island*', published in 2012. This paper provides a complete evaluation of conceptual advancements and research findings in the subject of urban climatology. It specifically focuses on turbulence, energy and water exchange mechanisms in the urban atmosphere, as well as the dynamics of UHI. The publication is often recognized because it serves as a reference point in the topic of urban climate, offering researchers a comprehensive synthesis of the existing literature. This paper provides a solid basis for future research and offers an in-depth perspective on the peculiarities of urban climate.

Table 3. Most Cited Publications

Document	Country	Year	Citations
Two decades of urban climate research: a review of turbulence, exchanges of energy and water, and the urban heat island	USA	2012	4054
Local Climate Zones for Urban Temperature Studies	Canada	2012	3753
Estimation of land surface temperature–vegetation abundance relationship for urban heat island studies	USA	2004	3077
A review on the generation, determination and mitigation of Urban Heat Island	China	2008	2183
Remote sensing image-based analysis of the relationship between urban heat island and land use/cover changes	USA	2006	2053
Comparison of impervious surface area and normalized difference vegetation index as indicators of surface urban heat island effects in Landsat imagery	USA	2007	1871
Remote sensing of the urban heat island effect across biomes in the continental USA	USA	2010	1557
Surface Urban Heat Island Across 419 Global Big Cities	Multiple Country	2012	1206

The paper titled 'Local Climate Zones for Urban Temperature Studies' is the second most frequently referenced publication. This work presents a novel classification method to define climatic characteristics in various places inside the city, focusing on the concept of local climate zones. This categorization aids in implementing specific measures to mitigate or stabilize the impacts of the UHI phenomenon, as it precisely delineates variations in microclimate. This study prioritizes practical applications over theoretical frameworks in the field of UHI research. (Figure 6). The publication presents an alternative approach to the commonly emphasized LST concept in monitoring UHI formation. It proposes a classification method based on urban characteristics such as surface structure, surface cover, surface texture, and surface metabolism. The study aims to establish a standardized classification system for the UHI concept, which will enable more consistent and comprehensive urban climate studies. This system will facilitate comparative studies across different cities and regions worldwide. Therefore, this approach may be applied worldwide and offers a universally standardized viewpoint on the UHI concept. The study suggests using physical characteristics to assess temperature disparities between urban and rural locations, providing a valuable alternative to previous studies that relied on field measurements and remote sensing methods. By being grounded in physical qualities, this approach allows for the creation of urban designs that are more equipped to withstand the impacts of climate change, while also being more realistic and practical.

Figure 6. Local Climate Zones Identified by Stewart
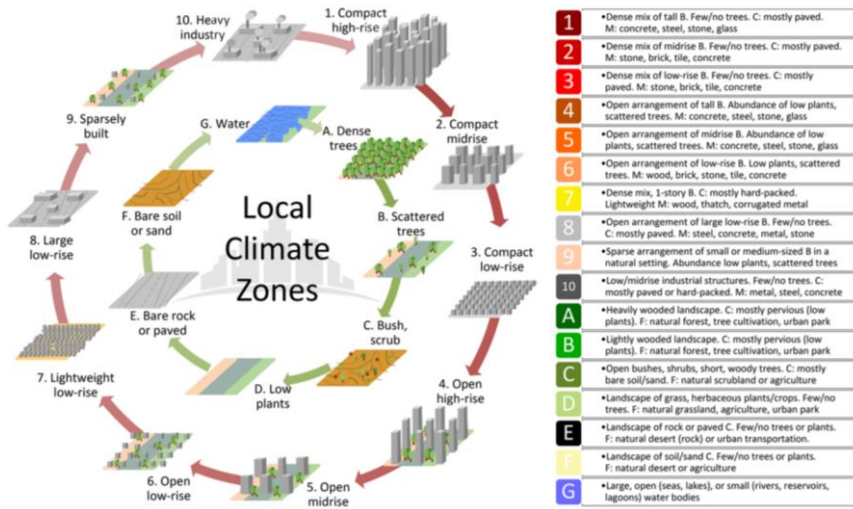
Source: Stewart and Oke, 2012, Bechtel et al., 2017.

Upon analyzing the other highly referenced articles, it becomes evident that there are research that serve as the foundation for strategies aimed at mitigating the UHI phenomenon. Specifically, there are studies that investigate the absence of green-blue infrastructure in urban areas, which is identified as a significant factor contributing to the UHI effect. This highlights the relevance of changes in land use and land cover. In this context, the study 'Estimation of land surface temperature-vegetation abundance relationship for urban heat island studies', which investigated the relationship between NDVI and LST at different spatial resolutions for Indianapolis City, IN, USA, concluded that the spatial variability of the texture in land surface temperature (LST) has a positive correlation with the normalised difference vegetation index (NDVI) and vegetation abundance. Similarly, in the study 'Comparison of impervious surface area and normalised', the relationships between LST and percent impervious surface and NDVI were investigated using Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) data for the Twin Cities, Minnesota, metropolitan area. In the study titled 'Remote sensing image-based analysis of the relationship between urban heat island and land use/cover changes', in order to analyse the relationship between UHI and land cover changes, more comprehensive indices were considered, Normalised Difference Vegetation Index (NDVI), It attempted to use a quantitative approach to investigate the relationship between temperature and various indices, including Normalised Difference in Water Index (NDWI), Normalised Difference in Bare Index (NDBaI) and Normalised Difference in Deposition Index (NDBI). It was found that the correlations between NDVI, NDWI, NDBaI and temperature were negative when NDVI was within a limited range, but NDBI showed a positive correlation with temperature. In parallel with the results obtained in these studies, in the study titled 'Surface Urban Heat Island Across 419 Global Big Cities', the surface urban heat island was analysed in 419 big city samples and the presence of vegetation and thus the effects of land use/land cover changes

were confirmed. The aforementioned studies and similar ones have started to prioritise concepts such as green infrastructure and nature-based solutions among the strategies to reduce the UHI effect.

3.5. Keyword Analysis in Urban Heat Island Research

Within the realm of bibliometric analysis, examining keywords provides insights about the main subjects within a specific area of research and the connections among them. Therefore, it offers scholars a foundation for assessing patterns in the current body of literature and formulating approaches for future investigations. Within this context, the initial step involves presenting the most often appearing keywords in studies on UHI in the form of a word cloud. 50 word repetition was considered as the limit and analyses were performed separately for both databases and similar results were obtained. Within the realm of bibliometric analysis, examining keywords provides insights about the main subjects within a specific area of research and the connections among them. Therefore, it offers scholars a foundation for assessing patterns in the current body of literature and formulating approaches for future investigations. Within this context, the initial step involves presenting the most often appearing keywords in studies on UHI in the form of a word cloud. The limit for word repetition was set at 50, and independent analyses were conducted for each database. The results obtained were identical in both cases (Figure 7, Figure 8). The research indicates that the concept of 'land surface temperature (LST)' is highly significant in detecting UHI. LST is typically derived from satellite imagery and is widely employed in studies focused on UHI detection. Furthermore, the term 'remote sensing' is also a significant factor in the computation of LST. Nevertheless, the utilization of 'air temperature', an alternative approach employed in UHI identification, is still limited. Recently, there has been a growing recognition that the phenomenon of UHI is closely linked to the rising temperatures caused by climate change. The concept of UHI is intrinsically linked to urbanization, which brings the concepts of 'urbanization' and 'urban planning' to the forefront. Specifically, the conclusions derived from the studies serve the purpose of providing guidance for urban planning processes. The principles of green infrastructure and cooling impact, which are regarded as mitigation techniques, are often overlooked.

Figure 7. Word Cloud, Scopus

Figure 8. Word Cloud, Web of Science

Network visualisation analysis to meuasure keywords co-occurrence was conducted using VOSviewer software for both databases to examine how the keywords identified in the word cloud are addressed in UHI research. In the map generated from this analysis, each keyword is represented by a circle. The diameter corresponds to the quantity of connections with other keywords. Consequently, larger circles indicate a greater number of connections with other keywords. The thickness of the lines corresponds to the frequency of occurrence of keywords together. Based on the examination of the SCOPUS database, studies on UHI may be classified into five distinct groups (Figure 9). The 'urban heat island' focus group discusses many ideas that are directly associated with the UHI phenomenon. These concepts include 'albedo', 'vegetation', and 'anthropogenic heat'. Additionally, the group explores potential solutions such as 'mitigation', 'green roof', and the use of the 'ENVI-met' modeling tool. While the frequency of both notions is similar, when considering the density of mentions, it can be concluded that the concept of 'outdoors thermal comfort' holds a more prominent place as the primary objective to be attained. The focal area shown in blue on the map prominently features the concepts of 'land surface temperature' and 'remote sensing' for the detection of UHI, similar to the word cloud. Furthermore, it can be deduced that the utilization of 'landsat' and 'modis' satellite photos is prevalent in this context, and the adoption of cutting-edge techniques like 'machine learning' in the analysis of satellite images has become popular. The findings of detection investigations are assessed using techniques such as landscape metrics, and the relationship with landscape patterns is analyzed. Additionally, there are studies conducted on the cooling effect. The third category of studies pertains to 'climate change'. The research discussed here pertain to urban features such as urban planning, urban design, and urban form.

These studies primarily focus on urban resilience topics such as adaptation, vulnerability, health, and environmental justice. Furthermore, it is acknowledged that this particular area of attention is closely connected to the study of 'urban climate', which seeks to comprehend the climate within urban environments. It is acknowledged that the other two main areas of focus, namely 'urban climate' and 'cooling effect', are not as advanced as the other areas of focus.

Figure 9. Network Visualisation Keyword Co-Occurance, Scopus
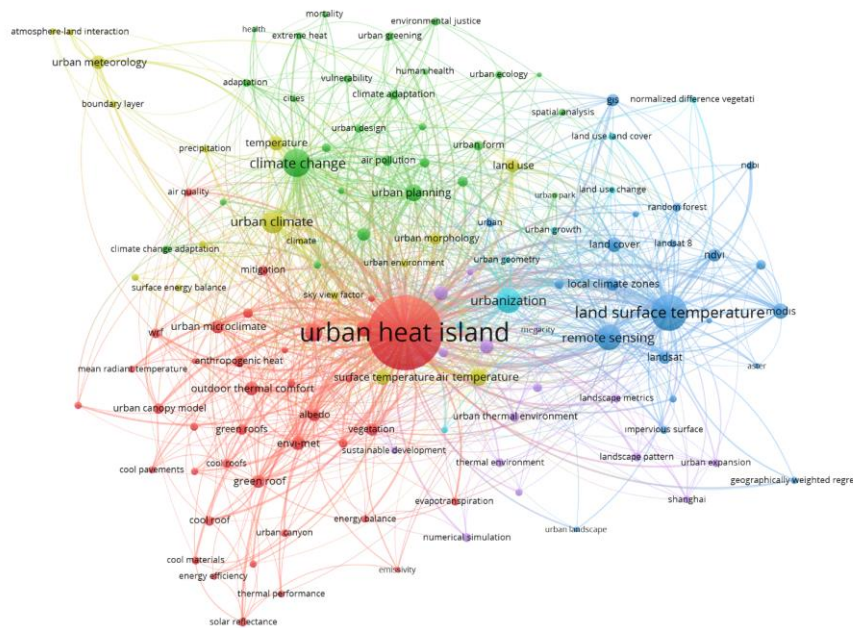
When doing network visualization analysis to assess the simultaneity of keywords in articles retrieved from the WoS database, it is observed that identical keywords are grouped together in different research areas (Figure 10). While the study focus on 'urban heat island' remains same, it is evident that 'climate change' is addressed within this focus in papers found in the WoS database. Furthermore, these articles also incorporate words such as 'heat waves', 'heat stress', and 'energy consumption' that are associated with these two concepts. The second study topic, highlighted in green on the map, emphasizes the concepts of 'remote sensing', 'land use', 'urban climate', and 'urban morphology', with a greater emphasis on urban variables. The distribution of the lines indicates that the third research emphasis, which concentrates on factors and methods for detection such as 'Landsat', 'Modis', 'NDVI', 'NDBI', and 'GIS', is connected to the analysis of urban features in the second research area. The fourth research focus, which includes analysis methods such as 'machine learning', 'artificial intelligence', 'geographically weighted regression', focuses on the relationship between concepts such as 'land use/land cover' and 'urban expansion' and UHI. Within the realm of urban planning study, specifically in the context of landscape pattern and landscape metrics, there is a notable emphasis on topics relating to the cooling effect. The latest study area of interest is centered around the concept of 'thermal comfort'

and its connection to mitigation strategies such as 'land use/land cover', 'green infrastructure', 'vegetation', and 'cool roof'.

**Figure 10. Network Visualisation Keyword Co-Occurance, Web of Science**
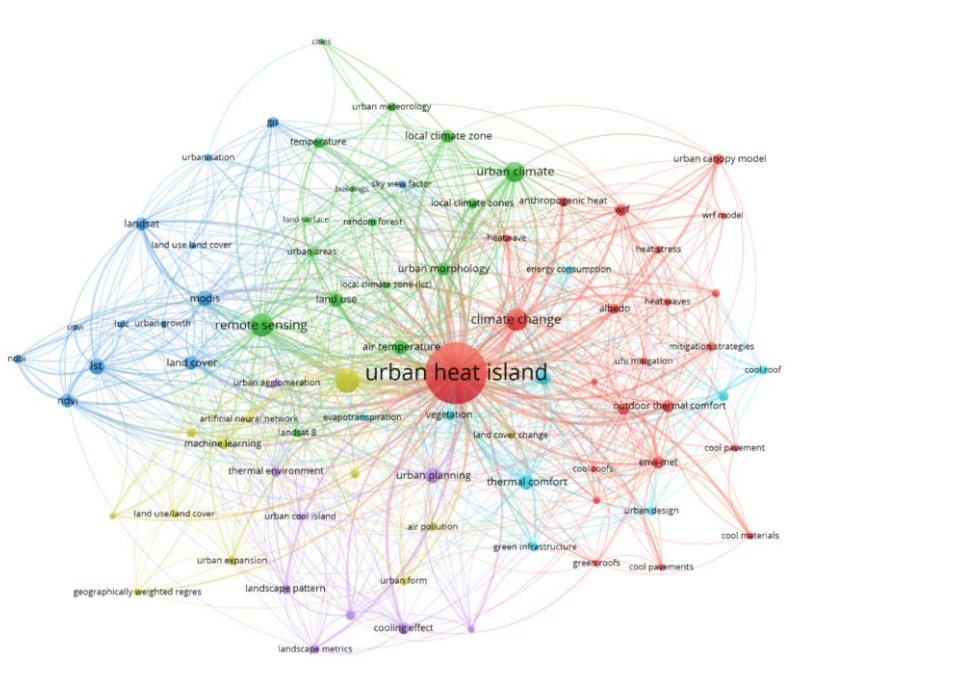
### 3.6. Trend Topics in Urban Heat Island Researches

Examining trends in UHI research enables researchers and policymakers to comprehend the temporal changes in research areas of interest and methodological methods within this subject. Therefore, it is possible to formulate a forecast for contemporary and innovative methodologies. Figure 11 and Figure 12 display significant topics and patterns in UHI research using the Scopus and Web of Science datasets. The most often occurring concepts in the database are 'land surface temperature', 'climate change', 'remote sensing', 'thermal comfort', 'urbanisation', 'urban climate', and 'air temperature'. However, it is seen that these repetitions are primarily focused between the years 2015 and 2022. The Sustainable Development Goals are a highly researched subject in the current publications inside the Scopus collection. This circumstance demonstrates the increasing momentum in studies focused on addressing the UHI impacts, which is a crucial issue in reaching sustainable development goals. Environmental justice is the second most studied topic in the SCOPUS database. It primarily examines the equitable management of the impacts of UHI on various social groups and aims to address and eliminate any inequities in this regard. Furthermore, subjects such as urban parks, tree cover, and urban morphology are also of primary importance. Another significant concern in current study pertains to the utilization of ENVI-met software. The software facilitates the simulation of strategies aimed at mitigating the UHI effect. It allows for the creation of 3D models of these strategies, which can be evaluated and optimized before implementation. When analyzing the research trends in the WoS

database, it is evident that there are research investigations exploring the correlation between the urban agglomeration idea, which refers to a cluster of cities characterized by dense spatial arrangement and strong economic connections, and the UHI phenomenon. The present focus of research in the WoS database about the UHI phenomenon includes studies on mitigation techniques, analysis of morphological spatial patterns, and investigations into the properties of the thermal environment. Machine learning is a notable topic in this table. It is becoming more commonly utilized in the analysis and modeling of data in research on urban heat islands, providing novel solutions in this area.

Figure 11. Trend Topics, Scopus
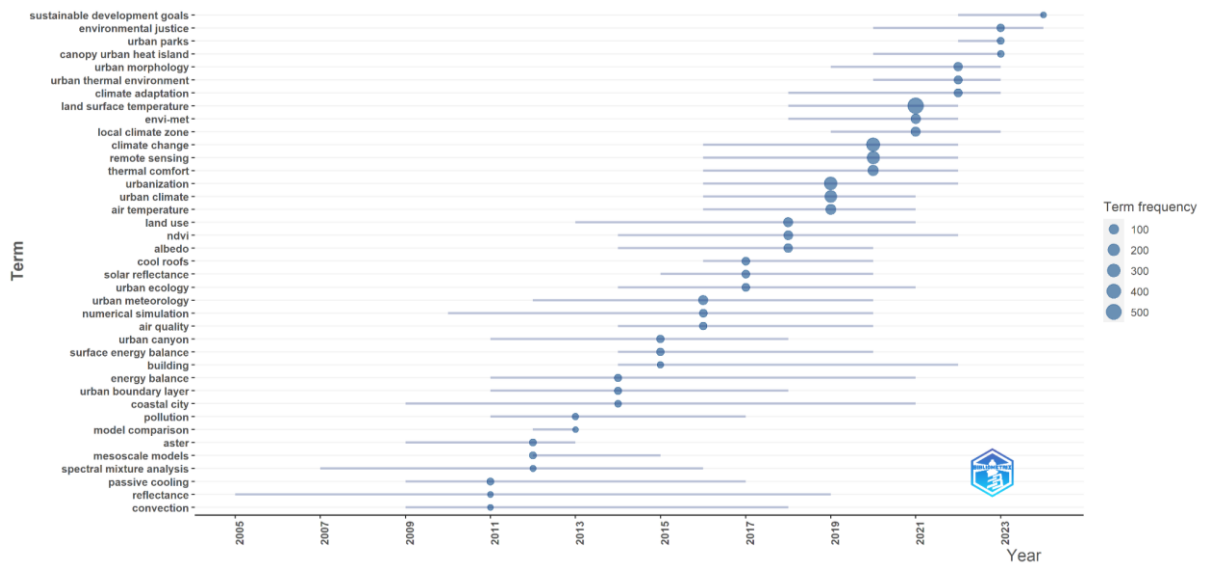
Figure 12. Trend Topics, Web of Science
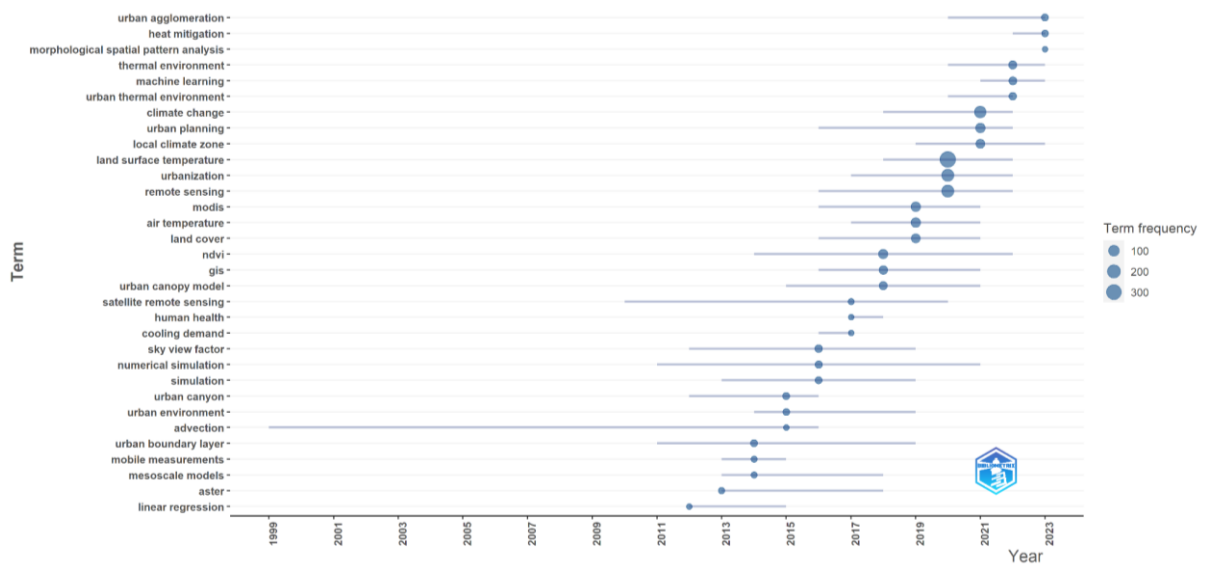
4. CONCLUSION

The UHI phenomenon, which has gained attention in recent years due to the rapid urbanization and the impacts of climate change, has emerged as a significant concern due to its detrimental consequences on the environment, society, and economy. Nevertheless, it has been noted that the theoretical knowledge acquired on the subject cannot be efficiently applied to decision-making processes in the context of public administration. This study intends to analyze the temporal and content variations in studies related to UHI, identify research gaps for practical application, and determine future research directions and requirements. Within this particular framework, a total of 2777 articles were examined in the Web of Science database, while 5621 articles were analyzed in the SCOPUS database. The findings indicate a significant and quick growth in UHI research, particularly since 2005. Huan and Lu (2018) attribute the rise in publication numbers to concerns regarding the rapid rate of urbanization and the increasing influence of climate change. They also suggest that this increase may be linked to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2001 and the implementation of the Kyoto Agreement in 2005.

The average number of authors in the studies is approximately 4.2 in both databases, which is consistent with the subject's high level of expertise and disciplined structure. When examining the journals with the highest publication rates and high h-index, it is evident that the journals on the subject can be classified into two groups. The first group of journals are publications that focus on urban environmental characteristics and examine analysis, technology, and approaches for creating more sustainable and resilient cities. The second group of journals mostly focuses on publishing in the field of atmosphere and climate. This situation confirms that UHI is perceived as a problem that threatens the health and future of cities and their residents, and is considered a topic of climate change.

When examining the countries where articles are produced, it is observed that China, the United States, Italy, and India stand out. This situation may also be attributed to the intense experience of UHI effect, in addition to the scientific and research infrastructure of the mentioned countries. For example, a study conducted for 371 cities in China, which accounted for 56% of global cement production in 2018 (Andrew, 2019:1675–1710), revealed that it led to dramatic changes in the urban thermal environment due to rapid urbanization (Qiao, Lu, He, Wu, Xu, Liu, Wang, Sun, Han, 2023). However, there is significant spatial heterogeneity in UHI intensity due to geographical and socioeconomic differences among rapidly urbanizing countries (Cui, Xu, Dong, Qin, 2016). Comparative studies are crucial to understand how different urbanization patterns and different climatic conditions affect UHI impacts and can contribute to the development of region-specific mitigation strategies. Presenting a comprehensive assessment of surface UHI in 419 global cities, Peng et al. (2011) evaluated the major biophysical and socio-economic factors affecting the emergence of surface urban heat island. Accordingly, biophysical factors are vegetation cover and albedo, while socio-economic factors are population density and economic activity, land use and development intensity. Manoli et al. (2019) emphasize that UHI

intensity varies significantly with population size and precipitation levels, indicating that geographical and climatic factors play a critical role in shaping UHI characteristics. These studies suggest that while there is spatial heterogeneity in UHI density, it is driven by very similar factors and requires interventions based on local climate and landscape characteristics.

When examining the most cited articles, it is evident that articles focusing on the formation and measurement of UHI, as well as their relationship with green spaces and land use/land cover patterns, provide a profound understanding. In fact, this situation becomes more meaningful through the examination of the keywords of the published articles. It is observed that articles emphasize the keywords related to measuring UHI and understanding its relationship with different factors, especially green areas and land use/land cover. Research trends indicate that since 2020, there has been a significant increase in research focusing on strategies to mitigate the UHI effect. However, as Hien (2016:276-278) points out, despite numerous studies on mitigating UHI effects, it is important to recognize that the effectiveness of these measures can differ based on the climate and urban structure of specific areas. Moreover, the impacts of UHI are not limited to small areas, but spread across entire urban regions, necessitating a comprehensive mitigation approach at larger spatial scales. However, highlighting the need for fine-scale modelling studies to understand the impacts of urbanization on regional climates, it shows that insights from small-scale projects can actually inform larger-scale strategies (Peng et al., 2011). This is in line with the findings of Lai et al. who discuss the importance of land cover and surface materials in urban areas and suggest that optimizing these factors can have significant implications for UHI mitigation at both local and urban scales (Lai, Leone, Zoppi, 2020). In this context, the ability of tools such as ENVI-met software, a micro-scale application, to simulate and optimize UHI mitigation scenarios at the micro-level is important. Despite this importance, there is a growing need for tools that can be integrated into broader urban planning frameworks.

These findings indicate that despite the increasing interest in the concept of UHI in the literature, there is still a lack of adequate solutions for its implementation. Due to the concentration of studies in specific regions of the world, it is uncertain whether the proposed solutions will be suitable for the geographical, urban, and social characteristics of cities in different regions of the world. For instance, studies investigating the compatibility and effectiveness of developed reduction strategies in tropical regions are insufficient (Hien, 2016: 276-278). Furthermore, modeling and optimization studies that can enhance urban cooling by increasing the cumulative impact of developed solutions are still insufficient (Zhang, Murray, Turner II, 2017: 162-171). Given the circumstances, there is a significant demand for modeling and optimization research on the cooling and sustainability assessments of cities across various global locations. Since the urban heat island effect is a multifaceted phenomenon influenced by various factors such as urbanization, land use changes, and climate variability, more interdisciplinary approaches and multi-scale studies are needed, including social, economic, and environmental dimensions of the issue (Hien, 2016). The development of approaches that enable the integration of

remote sensing technologies into urban planning strategies (Kosherbay, Mussagaliyeva, Strobl, 2022) and tools for analyzing energy consumption patterns in large cities (Liao, Li, Wang, Sheng, 2017), exploring assessment possibilities with modeling approaches that predict UHI dynamics under various urbanization scenarios, and increasing research exploring the relationship between landscape connectivity and UHI mitigation strategies (Chen, 2023) are crucial to develop comprehensive strategies that not only reduce UHI impacts but also enhance urban resilience to climate change.

Urban Heat Island (UHI) research in Turkey has also gained momentum in recent years and has focused on various cities to understand the dynamics and impacts of this phenomenon. Studies have utilized a variety of methodologies including remote sensing, geographic information systems (GIS) and field measurements to assess UHI impacts in different urban environments. Istanbul, the largest metropolis in Turkey, stands out in this context. Karaca, Anteplioğlu and Karsan (1995) identified significant UHI impacts in the city and attributed them to rapid urbanization and the reduction of green areas. Furthermore, Khorrami and Gündüz (2019) also investigated UHI occurrence and associated factors for Istanbul. According to the study, land use and plant density were identified as the most important factors affecting UHI occurrence. Another study by Baykara (2023) evaluated the long-term UHI impacts on Istanbul's climate by analyzing air temperature data from 1951 to 2020. The study revealed significant increasing trends in temperatures at both urban and rural stations, with more pronounced increases in urban areas. In a comprehensive assessment, Dihkan, Karsli, Guneroglu and Guneroglu (2018) analyzed UHI impacts in seven cities in Turkey: Istanbul, Bursa, Ankara, Izmir, Izmir, Gaziantep, Erzurum and Trabzon. The study used remote sensing techniques to model daytime and nighttime surface urban heat island (SUHI) effects from 1984 to 2011. The findings revealed that both atmospheric UHI and SUHI were present in all cities and showed a significant increase over the study period. In addition, studies to frame the problem and develop and model solutions are gaining importance in Turkey's major cities, especially Izmir (Erdogan, Kesgin Atak, 2023), Ankara (Cakir, 2022), Aydin (Ersoy Tonyaloglu, Kesgin Atak, 2021), Eskisehir (Kaplan, Avdan, Avdan, 2019), Erzurum (Guller and Toy, 2024). However, studies on the scaling and optimization of solutions for the whole city are limited.

The fact that the urban heat island (UHI) phenomenon has significant impacts on public health, urban planning and environmental management is one of the reasons why it has attracted so much attention in recent years. However, between 2000 and 2023, there seems to be a gap in translating the findings of the studies into actionable strategies for public administration and decision-making processes. Research has consistently shown that urban heat islands exacerbate heat-related health problems, especially in densely populated areas (Tan et al., 2009; Gosling, Lowe, McGregor, Pelling, Malamud, 2008). These findings suggest that public health policies should prioritize interventions in urban areas to reduce the health impacts of UHI. Also well documented in studies is the role of urban green spaces in reducing UHI impacts, emphasizing the need for urban planning strategies that

incorporate green infrastructure (Zhou et al., 2021; Li, 2024). Such evidence supports the argument that there is a need to review land-use planning strategies and that the systematic integration of green spaces into urban planning can serve as a practical strategy for public administration to combat UHI. In terms of urban planning and policy, several studies have proposed specific strategies to mitigate UHI impacts. Moreover, the literature emphasizes that wind and natural ventilation landscape features that can affect urban heating and cooling should be given special attention in urban planning. Moreover, smart city applications, such as city-wide implementation of low-cost sensors for UHI assessment, can facilitate real-time monitoring of UHI impacts and data-driven decision making, enabling timely interventions that can significantly improve urban heat resilience (Sun, Kato, Gou, 2019).

The study, which aims to analyze the temporal and contextual differences of the UHI phenomenon, used VOSviewer and Biblioshiny software, which are used in thematic, cartographic and cluster analysis and can quickly search and analyze bibliometric networks such as publications, countries, organizations and journals (Van Eck and Waltman, 2017: 1053-1070). Although these tools are widely used to visualize and analyze bibliometric data, they have inherent limitations. In particular, they focus primarily on specific types of relationships, such as co-citation and co-occurrence, and may not capture the full range of interactions and influences within a research field. For example, Aung and Hallinger (2022) note that VOSviewer is limited to analyzing relationships that can be measured through co-citation and could potentially overlook other relevant connections that may exist outside of this framework. Due to this limitation, while VOSviewer can effectively visualize certain aspects of the literature, it may not fully represent the complexity of relationships between authors, concepts or disciplines. Furthermore, Ragazou, Passas, Garefalakis and Dimou (2022) argue that, despite the advantages of bibliometric analysis in handling large volumes of data, categorizing published documents according to specific criteria may prevent the coverage of all relevant dimensions of research trends. Predefined criteria can limit analysis to only those relationships that fit within the software's specified parameters, thus limiting the depth of insight that can be gained from the data. Rahmah (2022) notes that VOSviewer can create maps based on co-occurrence data, but this approach is inherently limited to the relationships defined by the keywords and citations present in the dataset. As a result, the analysis may miss important contextual factors or emerging trends that do not fit existing keyword frames. In light of these limitations, there is a need for studies that enhance the findings from VOSviewer and Biblioshiny with qualitative analyses or alternative methodologies that can provide a more comprehensive understanding of the research environment. For example, integrating systematic literature reviews or expert interviews can enrich the analysis by capturing nuances that bibliometric tools may miss.

REFERENCES

Acemoğlu, D. (2003) "Root Causes: A Historical Approach to Assessing The Role of Institutions in Economic Development", Finance and Developments, June, 27-30.

Acemoğlu, D. and Robinson, J. A. (2008) "The Role of Institutions in Growth and Development", World Bank Working Paper, No: 10.

Acemoğlu, D. and Robinson, J. A. (2013) "Ulusların Düşüşü", (Çev. F. R. Velioğlu), İstanbul: Doğan Kitap.

Acemoğlu, D., Johnson, S. and Robinson, J. A. (2001) "The Colonial Origins of Comparative Development: An Empirical Investigation", The American Economic Review, 91(5): 1369-1401.

Afonso, A., and Jalles, J. T. (2016) "Economic Performance, Government Size and Institutional Quality", Empirica, 43: 83-109.

Akçay, S. (2002) "Corruption and Economic Growth: Across-National Study". Ankara Üniversitesi Siyasal Bilgiler Fakültesi Dergisi, 57(1): 1-13.

Aktan, C. C. and Yay, S. (2018) "Nobel Ekonomi Ödülü Sahibi Douglass C. North'un İktisat Bilimine Katkıları: Yeni İktisat Tarihi ve Kurumsal İktisat", Hukuk ve İktisat Araştırmaları Dergisi, 10(2): 62-82.

Aktan, C. C. and Yay, S. (2019), "Kurallar ve Kurumlar". Ankara: Seçkin Yayıncılık.

Alesina, A. and Perotti, R. (1996) "Income Distribution, Political Stability and Investment", European Economic Review, 40(6): 1203-1228.

Alesina, A. and Wagner, A. (2003) "Choosing and Reneging on Exchange Rate Regimes", NBER Working Paper, No: 9809.

Alexiou, C., Tsaliki, P., and Osman, H. (2014) "Institutional Quality and Economic Growth: Empirical Evidence from the Sudanese Economy.", Economic Annals, 9: 119-137.

Anderson, J. E. and Marcouiller, D. (2000) "Insecurity and the Pattern of Trade: An Empirical Investigation", NBER Working Paper, No: 7000.

Arellano, M. and Bond, S. (1991) "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", Review of Economic Studies, 58, 277-297.

Aron, J. (2000) "Growth and Institutions: A Review of the Evidence", The World Bank Research Observer, 15(1): 99-135.

Artan, S., Hayaloğlu, P., and Demirel, S. K. (2017) "Gelişmiş ve Gelişmekte Olan Ülkelerde Kamu Kesimi Büyüklüğü, Kurumsal Kalite ve Ekonomik Büyüme İlişkisi", İşletme ve İktisat Çalışmaları Dergisi, 5(3): 1-9.

Aygün, E. and Şahbaz Kılınç, N. (2023) "Kurumsal Kalite ve Ekonomik Büyüme İlişkisi: Ekonometrik Bir Uygulama", Ekonomi İşletme Siyaset ve Uluslararası İlişkiler Dergisi, 9(1): 107-125.

Aytun, C., and Akın, C. S. (2014) "Kurumsal Kalite ve Ekonomik Büyüme: Panel Nedensellik Analizi", Çukurova Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 18(1): 89-100.

Baltagi, B.H, (2005) "Econometric Analysis of Panel Data", New York: John Wiley and Sons Inc.

Barro, R. J. (1996) "Determinants of Economic Growth: A Cross-country Empirical Study", NBER Working Paper, No: 5698.

Bussiere, M. and Mulder, C. (1999) "Political Instability and Economic Vulnerability", IMF Working Paper, No: WP/99/46

Campos, N. F. (2000) "Context is Everything: Measuring Institutional Change in Transition Economies", World Bank Policy Working Paper, No: 2269.

Chong, A. and Calderon C. (2000) "Causality and Feedback between Institutional Measures and Economic Growth", Economics and Politics, 12(1): 69-81.

Drukker, D. M. (2003) "Testing for Serial Correlation in Linear Panel-data Models", The Stata Journal, 3(2): 1-10.

Du, J. (2010) "Institutional Quality and Economic Crises", The Review of Economics and Statistics, 92(1): 173–179.

Faruq, H. A. (2011) "How Institutions Affect Export Quality", Economic Systems, 35: 586-606.

Figankaplan, T. (2017) "Ekonomik Büyüme ve Kurumsal Kalite İlişkisi: Bir Panel Veri Analizi", BDDK Bankacılık ve Finansal Piyasalar Dergisi, 11(1): 65-91.

Glaeser, E. L., La Porta, R., Lopez-de-Silanes, F., and Shleifer, A. (2004) "Do Institutions Cause Growth?", Journal of Economic Growth, 9: 271-303.

Greene, W. (2000) "Econometric Analysis", New York: Prentice-Hall.

Hall, R. and Jones, C. (1998) "Why Do Some Countries Produce So Much More Output Per Worker Than Others?", The Quarterly Journal of Economics, 114 (1): 83-116.

Hausman, J. A. (1978) "Specification Tests in Econometrics", Econometrica, 46: 1251–1271.

Hill, R.C., Griffiths, W.E. and Lim, G.C. (2011) "Principles of Econometrics", USA: John Wiley and Sons Inc.

Huynh, K., P. and Chavez, D., T. (2009) "Growth and Governance: A Nonparametric Analysis", Journal of Comparative Economics, 37 (1): 121-143.

Keskin, İ., and Yıldırım, E. (2021) "Kurumsal Kalite ve Dışa Açıklık Ekonomik Büyümeyi Nasıl Etkiler? Sermaye ve İşgücü Maliyetleri Işığında Gelişmiş Ülkeler Üzerine Panel Veri Kanıtları", Journal of Research in Economics, 5(2): 146-171.

Kilishi, A. A., Mobolaji, H. I., Yaru, M. A., and Yakubu, A. T. (2013) "Institutions and Economic Performance in Sub-Saharan Africa: A Dynamic Panel Data Analysis", Journal of African Development, 15(2): 91-119.

Knack, S. and Keefer, P. (1995) "Institutions and Economic Performance: Cross Country Tests Using Alternative Institutional Measures", Economics and Politics, 7(3): 207-227.

Knack, S. and Keefer, P. (1997) "Does Social Capital Have an Economic Pay off? A Cross-Country Investigation", The Quarterly Journal of Economics, 112(4): 1251-1288.

Knack, S. and Keefer, P. (1998) "Why Don't Poor Countries Catch Up? A Cross National Test of An Institutional Explanation", Center For Institutional Reform and The Informal Sector, 590-602.

Kneller, R., Bleaney, M. and Gemmell, N. (1999) "Fiscal Policy and Growth: Evidence from OECD Countries", Journal of Public Economics, 74: 171-190.

Martin, S. X. (1997) "I Just Ran Two Million Regressions", American Economic Review, 87(2): 178–183.

Mauro, P. (1995) "Corruption and Growth", The Quarterly Journal of Economics, 110(3), 681-712.

Nawaz, S., Iqbal, N., and Khan, M. (2014) "The Impact of Institutional Quality on Economic Growth: Panel Evidence", The Pakistan Development Review, 55(1): 15-31.

North, D. C., (1989) "Institutions and Economic Growth: An Historical Introduction", World Development, 17 (9): 1319-1332.

North, D. C. (1990) "Institutions, Institutional Change and Economic Performance", Cambridge: Cambridge University Press

North, D. C. (1991) "Institutions", Journal of Economic Perspectives, 5(1): 97- 112.

North. D. C. (1994) "Economic Performance through Time", American Economic Review, 84(3): 359-368.

North, D. C. (1995) "Douglass C. North, in: W. Breit and R. W. Spencer (ed.), "Lives of the Laureates: Thirteen Nobel Economists", Cambridge, Mass.: MIT Press. 251-267.

North D. C. (1997) "The Process of Economic Change", UNU World Institute for Development Economics Research Discussion Paper. No: 128.

North, D. C., (1999) "Institutions, Institutional Change and Economic Performance", Cambridge: Cambridge University Press.

North, D. C. (2005) "Understanding the Process of Economic Change", Princeton: Princeton University Press.

North, D. C., (2010) "Kurumlar, Kurumsal Değişim ve Ekonomik Performans", (Çev. G. Ç. Güven). İstanbul: Sabancı Üniversitesi Yayınları.

Osman, R. H., Alexiou, C., and Tsaliki, P. (2011) "The Role of Institutions in Economic Development: Evidence from 27 Sub-Saharan African Countries", International Journal of Social Economics, 39 (1/2): 142-160.

Rigobon, R. and Rodrik, D. (2004) "Rule of Law, Democracy, Openness, and Income: Estimating the Interrelationships", National Bureau Economic Research Working Paper. No: 10750.

Rivera-Batiz, L. A. and Oliva, M. A. (2002) "Political Institutions, Capital Flows, and Developing Country Growth: An Empirical Investigation", Review of Development Economics, 6: 248-262

Roodman, D. (2009) "How to do xtabond2: An Introduction to Difference and System GMM in Stata", The Stata Journal, 9(1): 86-136.

Şahin, D. (2018) "MENA Ülkelerinde Kurumsal Kalite ve Ekonomik Büyüme İlişkisinin Analizi", "İktisadi Yenilik Dergisi", 5(1): 1-9.

Shimpalee, P. and Breuer, J. (2006) "Currency Crises and Institutions", Journal of International Money and Finance", 25 (1): 125-145.

Sobhee, S. K. (2012) "Quality of Institutions and Economic Growth in Developing Economies", Social Sciences Research Network Papers.

Tanzi, V. and Davoodi, H. (1997) "Corruption, Public Investment and Growth", IMF Working Paper. No: 139.

Tarı, R. (2014) "Ekonometri", Kocaeli: Umuttepe Yayınları.

Tornell, A. (1997) "Economic Growth and Decline with Endogenous Rights", Journal of Economic Growth, 2: 219-250.

Wooldridge, J. M. (2002) "Econometric Analysis of Cross Section and Panel Data", Cambridge, Massachusetts: The MIT Press.

Yapraklı, S. (2008) "Kurumsal Yapının Ekonomik Büyümeye Etkisi: Üst Orta Gelir Düzeyindeki Ülkeler Üzerine Bir Uygulama", Ege Akademik Bakış, 8(1): 301-317.

Yay, S., (2019) "Hukuk, Kurumlar ve İktisat", İzmir: SOBİAD Hukuk ve İktisat Araştırmaları Merkezi Yayınları.

Yerdelen Tatoğlu, F. (2018) "Panel Veri Ekonometrisi: Stata Uygulamalı", İstanbul: Beta Yayıncılık.

KATKI ORANI / *CONTRIBUTION RATE*	AÇIKLAMA / *EXPLANATION*	KATKIDA BULUNANLAR / *CONTRIBUTORS*
Fikir veya Kavram / *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak / *Form the research hypothesis or idea*	Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) Besna AYDEMİR (MSC.)
Tasarım / *Design*	Yöntemi, ölçeği ve deseni tasarlamak / *Designing method, scale and pattern*	Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) Besna AYDEMİR (MSC.)
Veri Toplama ve İşleme / *Data Collecting and Processing*	Verileri toplamak, düzenlenmek ve raporlamak / *Collecting, organizing and reporting data*	Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) Besna AYDEMİR (MSC.)
Tartışma ve Yorum / *Discussion and Interpretation*	Bulguların değerlendirilmesinde ve sonuçlandırılmasında sorumluluk almak / *Taking responsibility in evaluating and finalizing the findings*	Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) Besna AYDEMİR (MSC.)
Literatür Taraması / *Literature Review*	Çalışma için gerekli literatürü taramak / *Review the literature required for the study*	Assoc. Prof. Nurdan ERDOĞAN (Ph.D.) Besna AYDEMİR (MSC.)