



A Bibliometric Analysis on Climate Change and Built Environments

İklim Değişikliği ve Yapılı Çevreler Üzerine Bibliyometrik Bir Analiz

Selen ÖZTÜRK AKBIYIK¹
Semra ARSLAN SELÇUK²

¹Department of Architecture,
Kırıkkale University, Faculty of
Engineering and Architecture,
Kırıkkale, Turkey

²Department of Architecture, Gazi
University, Faculty of Architecture,
Ankara, Turkey

ABSTRACT

Today, some precautions are taken while designing the built environment in order to adapt to the climate change and reduce the existing effects, and various researches are carried out on this subject. Although there are bibliometric studies on climate change in the literature, there is no bibliometric study that investigates the research areas of architecture, construction building technology, or urban study. This study aims to determine in which direction the research trends on climate change have evolved in the literature, how they diversified, and in what way researchers cooperated considering the research areas of architecture, construction building technology, or urban studies. Clarivate Analytics' Web of Science database is used to filter the publications, and VOSviewer, SankeyMATIC, and Photoshop programs are used to visualize the data. The publications filtered according to the research areas are evaluated under nine different headings. These headings include publication and citation numbers, research areas, document types, publication titles, publication numbers of countries, author and co-authorship analysis, keyword analysis, and the most cited publications between 2018 and 2022. As a result of the study, it is concluded that the most up-to-date studies in the filtered research areas include keywords related to information technologies and urban studies.

Keywords: Architecture, bibliometric analysis, climate change, construction building technology, urban studies

ÖZ

Günümüzde iklim değişikliğine uyum sağlamak ve mevcut etkileri azaltmak için yapıları çevre tasarlanırken bazı önlemler alınmakta ve bu konuda çeşitli araştırmalar yapılmaktadır. Literatürde iklim değişikliği ile ilgili bibliyometrik çalışmalar olmasına rağmen mimarlık, inşaat yapı teknolojisi veya kentsel çalışmanın araştırma alanlarını inceleyen bibliyometrik çalışma bulunmamaktadır. Bu çalışma, literatürde iklim değişikliği ile ilgili araştırma eğilimlerinin hangi yönde geliştiğini, nasıl çeşitlendiğini ve mimari, yapı yapı teknolojisi veya kentsel çalışmalar alanlarında araştırmacıların ne şekilde işbirliği yaptığını belirlemeyi amaçlamaktadır. Yayınları filtrelemek için Clarivate Analytics' in Web of Science veri tabanı ve verileri görselleştirmek için VOSviewer, SankeyMATIC, Photoshop programları kullanılmıştır. Araştırma alanlarına göre filtrelenen yayınlar 9 farklı başlık altında değerlendirilmiştir. Bu başlıklar; yayın ve alıntı sayıları, araştırma alanları, döküman tipleri, yayın başlıkları, ülkelere göre yayın sayıları, yazar ve ortak yazarlık analizi, anahtar kelime analizi, ve 2018–2022 yılları arasında en çok alıntılanan yayınlardır. Filtrelenmiş araştırma alanlarındaki en güncel çalışmalar, bilgi teknolojileri ve şehir çalışmaları ile ilgili anahtar kelimeleri içermektedir.

Anahtar Kelimeler: Mimarlık, bibliyometrik analiz, iklim değişikliği, yapı bilgi teknolojisi, kentsel çalışmalar

Introduction

Today, cities have begun to enter the planning process for adaptation to climate change. Cities are affected in many areas by climate change, which has effects on both the natural and socioeconomic environment (Wilby, 2008; Haddad et. al., 2020). The city effects of climate change are worrying because human settlement, changes in transport networks, and the rate of energy use are rising so rapidly, and their feedback can lead to much more complex cycles.



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Sorumlu Yazar/Corresponding Author:
Selen ÖZTÜRK AKBIYIK
E-mail: selenozturk93@gmail.com

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As a result of analytical studies of energy institutions, it has been reported that buildings are responsible for 40% of direct and indirect CO₂ emissions (IEA, 2021). The fact that construction is so effective in energy consumption has increased awareness about the need to take precautions. This increasing awareness has revealed solutions based on optimizing energy efficiency while minimizing environmental impact. The structures designed with optimum efficiency reduce the energy consumption throughout the life cycle of the building and minimize the environmental and human health issues.

Bibliometrics allow scientists to arrange and transfer data into mathematical and statistical methods for different contexts (Pritchard, 1969). Research trends and the application of them are interpreted, and quantitative data are used for documents in bibliometric studies. The documents can be diversified such as records, texts, and books. Data of the documents can be varied as reading percentage of the publications, organizations that work on the subject, or content changes over years according to keyword analysis. Currently, metric studies are rising in academic studies. Sajovic et al. (2018) clarify the reason of this rise by suggesting the increasing demands for statistical algorithms by comprehensively using computer, database, and internet connections.

This review article is structured as follows: The section “Materials and Methods” presents the research methodology and visualization tools used, the section “Findings” explains the emerging trends in the literature by sharing extensive analyses on publications at the intersection of building information modelling and architecture, and the section “Results and Potential Study Areas” provides the results and potential areas of study.

Methods

This study addresses a bibliometric analysis to determine in which direction the research trends on climate change have evolved in the literature, how they diversified, and in what way researchers cooperated considering the research areas of architecture, construction building technology, or urban studies.

Clarivate Analytics' Web of Science database is preferred in this study due to developed search queries and high-quality data the database has. Web of Science is one of the world's most outstanding platform that provides access to various researches, analytical information, and scientific citations (Chavarro et al., 2018; Li et al., 2018).

Figure 1 illustrates the flowchart of the analysis. After determining the database, the second step is to perform a search query based on keywords. The selected keyword is climate change*. Climate change keyword as a topic is filtered for the research areas architecture or construction building technology or urban studies. The Web of Science database search parameter is visualized in Figure 2. At the end of the filtered search, 9421 publications are found. These publications are analyzed and interpreted under the titles of publication and citation numbers, research areas, document types, publication numbers of countries, author and co-authorship analysis, document and citation numbers of organizations, keyword analysis, and the most cited publications between 2018 and 2022.

To visualize the similarities and differences of the collected data for the bibliometric analysis, science mapping techniques and algorithms are used. This visualization generates a network analysis which scientifically indicates the relationship between research trends using internet and computer technology (Smiraglia, 2015).

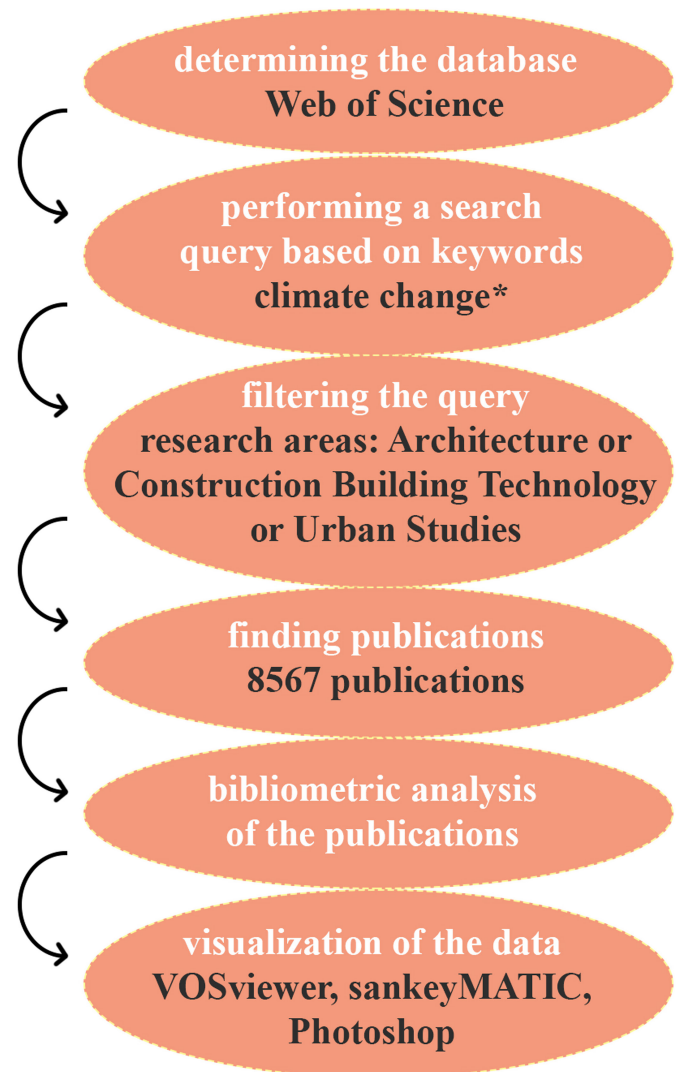


Figure 1.
Flowchart of the Bibliometric Analysis.

As the internet and computer technology have been developing rapidly, the hidden relationships between trends can be discovered in the literature (Li et al., 2017).

Tools like VOSviewer, SankeyMATIC, Citespace, Gephi, and nodeXL can be used for the visualization of the network analysis. In this study, the VOSviewer tool that enables the researchers to work with different databases and SankeyMATIC are used. In the VOSviewer tool, clusters which are defined with different colors, maps, and charts are produced from network data using labels, links, and circles to express the relationships between the data. Graphical and metadata metric studies universally use the VOSviewer tool to generate the visual documents for analyzed studies (Aghimien et al., 2019; Akinlolu et al., 2020; Wu et al., 2020). SankeyMATIC makes it easy to see the data flow by creating Sankey diagrams. With a Sankey diagram, many different data and information can be expressed in a single figure with the help of colors and arrows expressing the flow (Riehmman et al., 2005).

Results

In this study, the Web of Science database is selected to approach the publications to be analyzed. The keyword climate change* as

9,421 results from Web of Science Core Collection for:

Q climate change* (All Fields)

Analyze Results Citation Report Create Alert

Refined By: Research Areas: Architecture or Construction Building Technology X Clear all

Figure 2.
Web of Science Search Parameter.

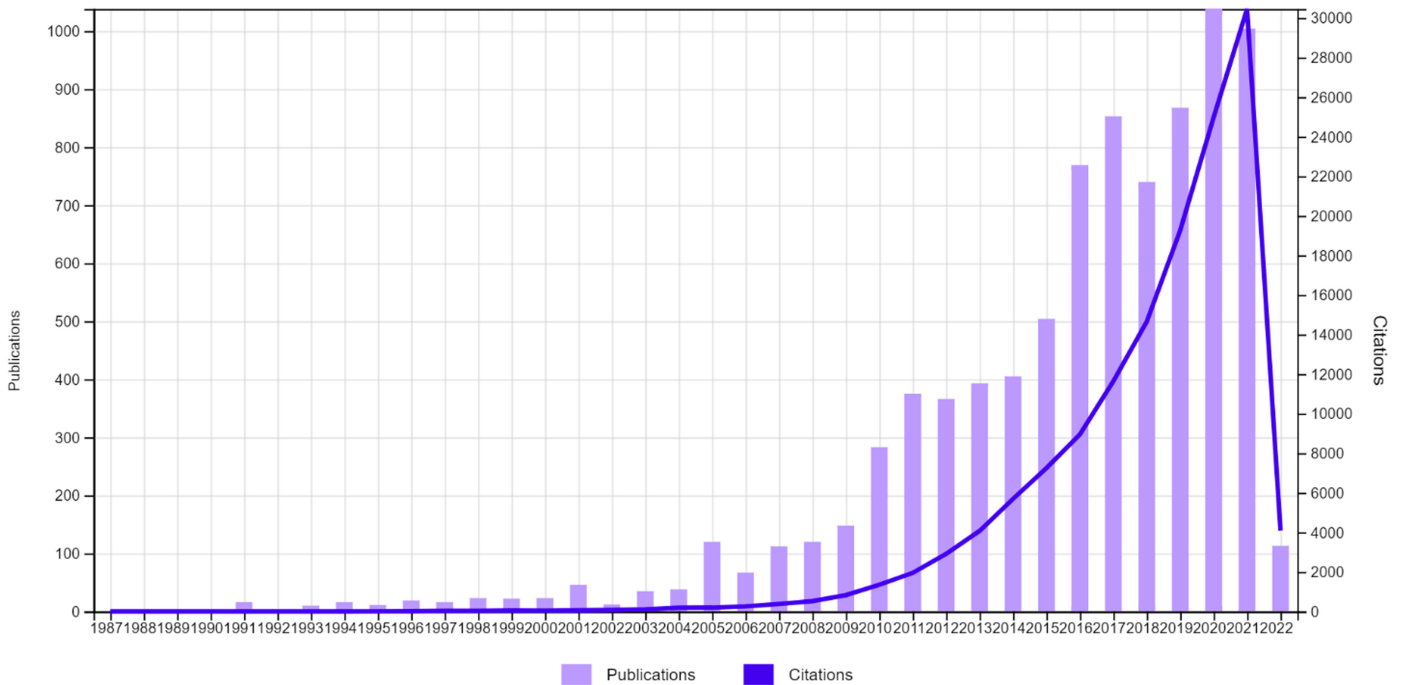


Figure 3.
Publication and Citation Numbers for Each Year.

a topic under the research areas of architecture or construction building technology, or urban studies are filtered. Publication and citation numbers, research areas, document types, publication numbers of countries, author and co-authorship analysis, document and citation numbers of organizations, keyword analysis for 9421 publications, and the most cited publications between 2018 and 2022 are presented. The most cited publications since last 5 years are identified to find out the current topics in detail.

Publication and Citation Numbers

Publication and citation numbers for each year are shown in Figure 3. The first publication was published in 1987. Based on the data presented, the year with the highest number of publications between 1987 and 2022 was 2020, with a total of 1038 publications. The year 2020 is followed by 2021 with 1004 publications. Publications have increased the fastest between the years 2010 and 2020. It can be argued that there has been a predominant increase in the number of publications from 1987 to the present, there has been a general increase in the number of publications. Scientific impact of an article in all times is defined as citation (Guo et al., 2019). It can be stated that the number of citations in publications has increased continuously until today. According to the figure, the year 2021 is the most cited year with 30,486 citations.

Research Areas

Research areas for the publications that are searched with the keyword climate change* are selected as architecture or

construction building technology or urban studies. Seven additional research areas were identified through the overlap of the specified research areas. In Table 1, these research areas are specified as engineering, environmental sciences ecology, energy fuels, public administration, science technology, geography, and materials science. In total, there are 4441 publications in construction building technology, 3475 publications in urban studies, 3117 publications in engineering, 2239 publications in environmental sciences ecology, 1459 publications in energy fuels, 1449

Table 1.
Research Areas and Numbers of the Publications

Research Areas	Publication Numbers
Construction building technology	4441
Urban studies	3475
Engineering	3117
Environmental sciences ecology	2239
Energy fuels	1459
Public administration	1449
Science technology	1432
Architecture	1067
Geography	887
Materials science	509

Table 2.
Document Types and Numbers of the Publications

Document Types	Publication Numbers
Articles	6098
Proceedings papers	1904
Book chapters	650
Review articles	270
Editorial materials	241
Early access	104
Book reviews	91
Books	36
Corrections	8
News items	8
Meeting abstracts	4
Reprints	4
Letters	3

Table 3.
Top 10 Publication Titles and Numbers

Publication Titles	Publication Numbers
<i>Energy and Buildings</i>	725
<i>Building and Environment</i>	531
<i>Sustainable Cities and Society</i>	435
<i>Landscape and Urban Planning</i>	312
<i>Local Environment</i>	273
<i>Urban Forestry Urban Greening</i>	244
<i>IOP Conference Series Earth and Environmental Science</i>	165
<i>Cities</i>	162
<i>Building Research and Information</i>	158
<i>Construction and Building Materials</i>	154

publications in public administration, 1432 publications in science technology, 1067 publications in architecture, 887 publications in geography, and 509 publications in materials science. Filtered publications are highly related to the engineering field, apart from construction building technology and urban studies.

Document Types

In Table 2, 9421 publications are listed which belonged to 13 different document types. According to the data obtained, there are 6098 articles, 1904 proceedings papers, 650 book chapters, 270 review articles, 241 editorial materials, 104 early access, 91 book reviews, 36 books, 8 corrections, 8 news items, 4 meeting abstracts, 4 reprints, and 3 letters. It can be stated that the majority of the 9421 publications analyzed were published as articles.

Publication Titles

In the previous section, it is concluded that publications mostly belonged to the document type articles or proceedings papers. It is claimed in Table 3 that 9 of the top 10 publication titles according to the publication numbers are journals and one of them is a conference. The journal *Energy and Buildings* is in the first place with 725 publications. Publication titles are represented as follows: *Building and Environment* (531 publications), *Sustainable Cities and Society* (435 publications), *Landscape and Urban Planning* (312 publications), *Local Environment* (273 publications), *Urban Forestry Urban Greening* (244 publications), *IOP Conference Series Earth and Environmental Science* (165 publications), *Cities* (162 publications), *Building Research and Information* (158 publications), and *Construction and Building Materials* (154 publications).

Publication Numbers of Countries

The distribution of 9421 publications, according to the countries in which they were published, is examined in this study. According to Figure 4, The USA has the highest number of publications (1577 publications). The UK (1075 publications) and China (1024 publications) follow the USA with regard to ranking. After China, there are countries such as Australia (666 publications), Italy (479

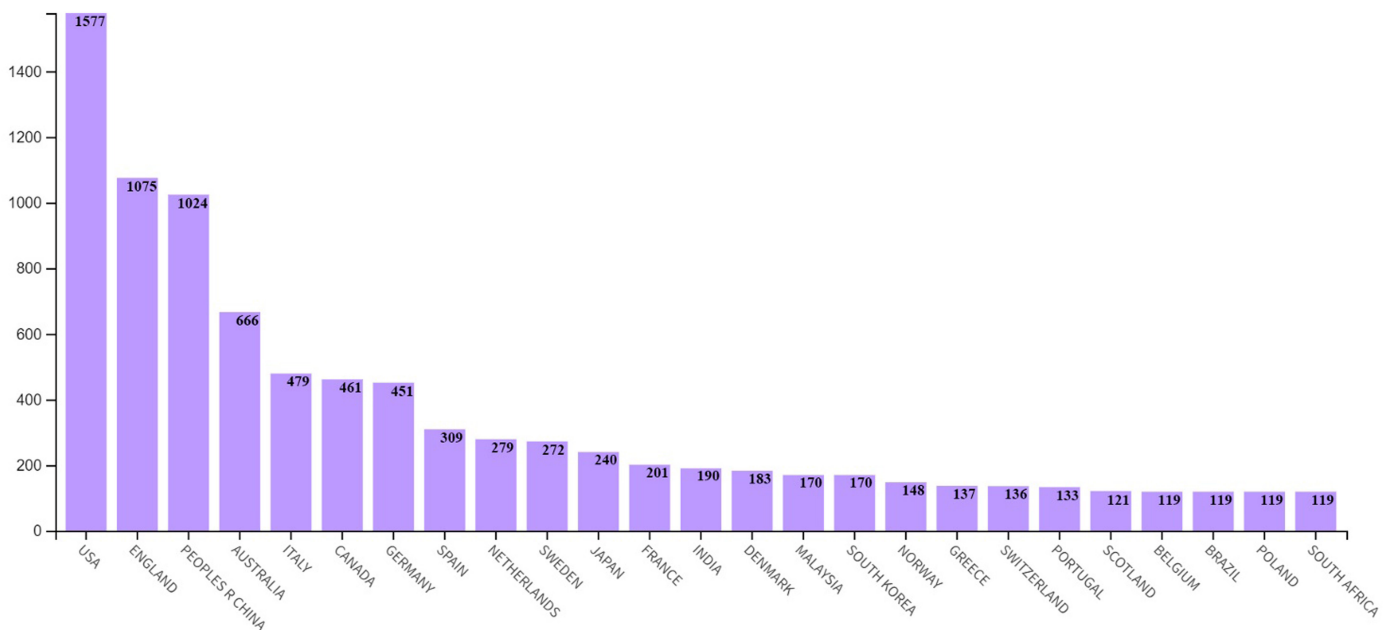


Figure 4.
Publication Numbers of Countries.

Table 4.
The Most Productive 10 Authors, Document and Citation Numbers

Author	Documents	Citations
Bulkeley, Harriet	35	1379
Broto, Vanesa Castan	21	375
Cabeza, Luisa F.	21	614
Hang, Jian	20	192
Kalamees, Targo	19	340
Cox, Je	18	8
Fritz, Marco	18	324
Yang, Liu	17	254
Nik, Vahid M.	16	382
Alexander, David	16	0

publications), Canada (461 publications), Germany (451 publications), Spain (309 publications), the Netherlands (279 publications), Sweden (272 publications), Japan (240 publications), France (201 publications), India (190 publications), Denmark (183 publications), Malaysia (170 publications), South Korea (170 publications), Norway (148 publications), Greece (137 publications), Switzerland (136 publications), Portugal (133 publications), Scotland (121 publications), Belgium (119 publications), Brazil (119 publications), Poland (119 publications), and South Africa (119 publications), as shown in the figure.

Author and Co-authorship Analysis

Preminent authors, the organizations they belong to, collaboration networks with other authors, and country information are evaluated in co-authorship analysis (Fonseca et al., 2016). In this study, the minimum number of publications per author is set as

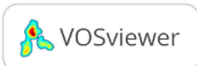


Figure 5.
Co-authorship Network and Author Collaborations.

10 in the VOSviewer program for author and co-authorship analysis and 53 authors are listed.

Table 4 indicates the most productive 10 authors over 53, the document, and citation numbers. Bulkeley H. is the first author considering both document and citation numbers (35 documents and 1379 citations). Broto V.C. (21 documents and 375 citations), Cabeza L.F. (21 documents and 614 citations), Hang J. (20 documents and 192 citations), Kalamees T. (19 documents and 340 citations), Cox J. (18 documents and 8 citations), Fritz M. (18 documents and 324 citations), Yang L. (17 documents and 254 citations), Nik V.M. (16 documents and 382 citations), and Alexander D (16 documents and 0 citations) follow Bulkeley H., according to the list in Table 4.

Figure 5 analyzes a co-authorship network that has been developed for authors. Author collaborations are depicted with lines between the authors (Van Eck & Waltman, 2010). There are 13 co-authorship clusters with 31 authors in the figure. Accordingly, authors and their collaboration networks are presented between Tian W., De Wilde P., Nik V.M.; Kershaw T., Colley D., Natarajan S.; Liu W., Yang L., Liu J.; Cox J., Miro C.; Zhu Y., DeDear R.; Van Der Heijden J., Bulkeley H., Edwards G., Broto V.; Bienvenido-Huertas D., Rubio-Bellido C.; Cabeza L., De Gracia A.; Davies M., Mavrogiani A.; Kyte R., Pradhan S.; lam C., Hang J.; and Pelling M., Roberts D., and Yao R., Li B.

In Figure 6, authors are visualized according to their actively publishing years. The authors working on the most recent

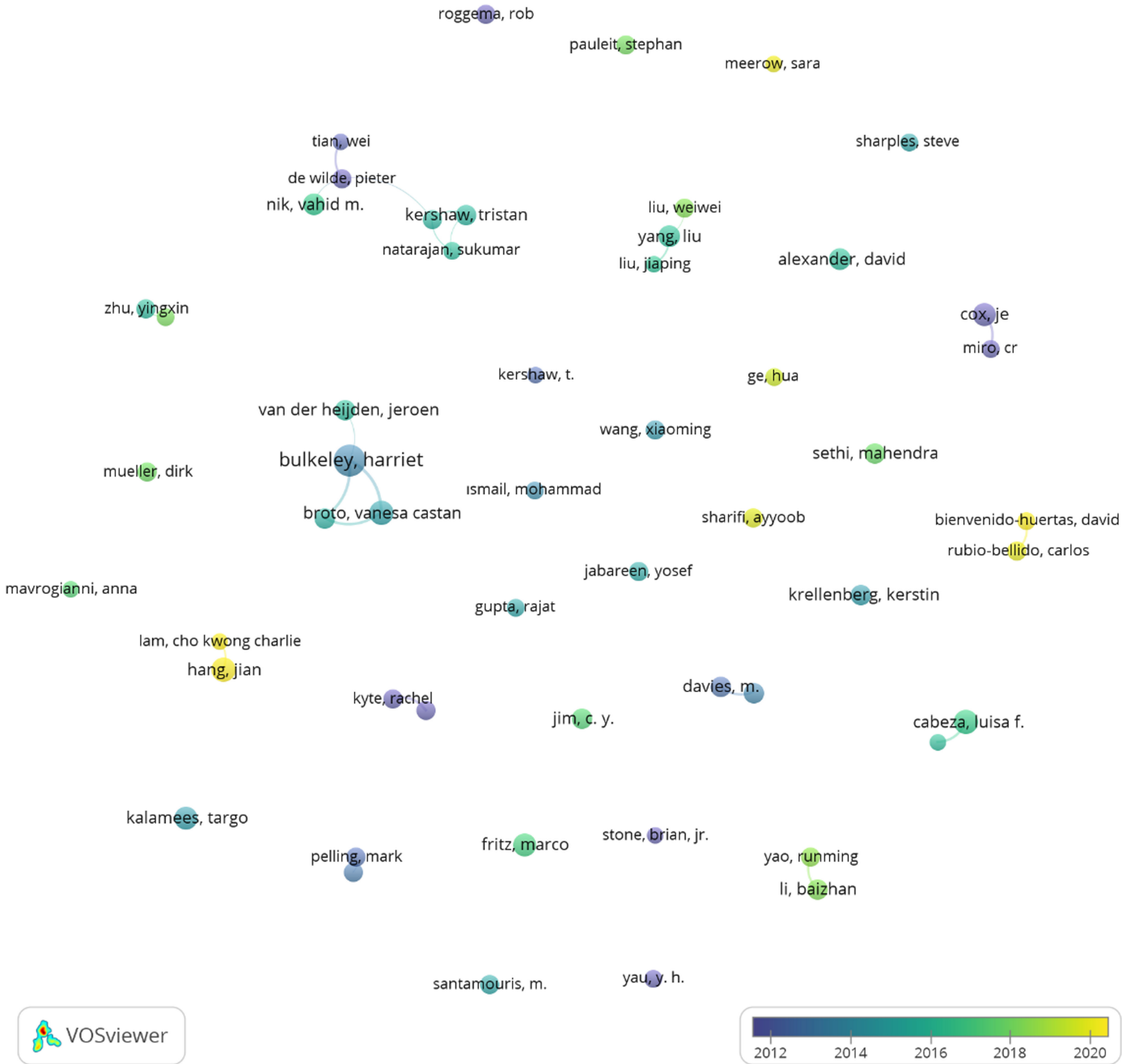


Figure 6. Productive Years for the Authors.

Table 5.
Organizations with at least 50 Documents

Organization	Documents	Citations
University College London	131	2781
Arizona State University	92	1870
University of Manchester	84	2754
University of Melbourne	83	1915
Tsinghua University	71	2268
University of Hong Kong	71	1818
Technical University Of Denmark	70	2991
University of Sheffield	70	1201
University of California, Berkeley	67	4348
University of British Columbia	59	2040
Hong Kong Polytechnic University	57	1195
Chinese Academy of Sciences	57	1235
National University of Singapore	55	1116
University of Durham	52	1659
RMIT University	52	731
Delft University Technology	52	1040

RMIT, Royal Melbourne Institute of Technology University

publications are Meerow S., Ge H., Bienvenido-Huertas D., Rubio-Bellido C., Sharifi A., Lam C., and Hang J.

Document and Citation Numbers of Organizations

Among all organizations where the filtered publications are studies, those with at least 50 documents are listed in Table 5. Document numbers show that University College London (131 publications and 2781 citations), Arizona State University (92 publications and 1870 citations), and University of Manchester (84 publications and 2754 citations) are in the first three places. The most cited organization is University of California, Berkeley, with 4348 citations.

Keyword Analysis

The basis of a publication is mainly revealed with keywords (Xiang et al., 2017). In the VOSviewer program, the content of 9421 publications is analyzed with the co-occurrence option. As a result of the analysis, the keywords are obtained. Co-occurrence refers to the common presence or closeness of the keywords in the texts. Coexistence can also include keywords that are not the same in meaning but are used on the same subject. The degree of coexistence and the proximity of keywords are related to each other (Lozano et al., 2019).

The minimum repeat number of keywords is set as 10 and 360 keywords are found. The VOSviewer program automatically divides the keywords into clusters according to their closeness. In Figure 7, there are nine clusters which are visualized with different colors.

Cluster 1 is represented with red in Figure 7. In the cluster, there are 95 keywords including adaptive thermal comfort, air change rate, air conditioning, building, building design, building energy, building energy consumption, building energy efficiency, building energy performance, building energy simulation, building energy use, building envelope, building performance, building performance simulation, building simulation, carbon dioxide, cfd, co2, computational fluid dynamics, condensation, cooling,

cooling load, daylighting, dwellings, dynamic simulation, energy conservation, energy consumption, energy efficiency, energy performance, energy poverty, energy retrofit, energy saving, energy simulation, energy use, energyplus, formaldehyde, free cooling, future climate, heat transfer, heating, heating demand, heatwave, humidity, hvac, hygrothermal performance, indoor air quality, indoor climate, indoor environmental quality, indoor thermal comfort, indoor thermal environment, machine learning, measurement, mediterranean climate, moisture, monitoring, natural ventilation, night ventilation, numerical simulation, nzeb, occupant behavior, office building, optimization, overheating, overheating risk, ozone, passive cooling, passive design, passive house, passivhaus, pcm, perceived air quality, permafrost, permeability, phase change material, productivity, relative humidity, renewable energy, residential building, sensitivity analysis, simulation, solar energy, stormwater, sustainable building, temperature, thermal comfort, thermal conductivity, thermal energy storage, thermal insulation, thermal mass, thermal performance, thermal simulation, trnsys, urban environment, ventilation, and weather data. This cluster can be summarized under the title thermal comfort and simulation.

Cluster 2 is shown with 74 keywords in green. These keywords are agriculture, air quality, air temperature, biodiversity, carbon emission, carbon sequestration, carbon storage, china, cooling effect, drought, ecosystem services, envi-met, environmental governance, evaporative cooling, evapotranspiration, gis, green infrastructure, green roof, green space, heat island, heat stress, Hong Kong, hydrology, Iran, land cover, land surface temperature, land use, land use change, landscape architecture, landscape metrics, landscape planning, mean radiant temperature, microclimate, nature-based solutions, neutral temperature, outdoor comfort, outdoor thermal comfort, public space, remote sensing, shading, skin temperature, sky view factor, solar radiation, spatial analysis, stormwater management, strategic planning, street trees, surface temperature, sustainable cities, thermal adaptation, thermal environment, thermal sensation, urban areas, urban climate, urban design, urban development, urban ecology, urban forest, urban forestry, urban form, urban green infrastructure, urban green space, urban greening, urban heat island, urban heat island effect, urban microclimate, urban morphology, urban planning, urban sprawl, urban transformation, urban trees, urban vegetation, utci, and vegetation. Cluster 2 is titled as urban studies and information technologies.

There are 68 keywords in Cluster 3, shown in blue. These keywords are Adaptation, adaptive capacity, Africa, agency, architecture, assessment, Bangladesh, barriers, circular economy, cities, city, climate adaptation, climate change, climate change adaptation, climate justice, community, community resilience, covid-19, development, disaster, education, environment, environmental justice, equity, flood risk, flooding, floods, gender, ghana, governance, India, Indonesia, informal settlements, infrastructure, innovation, justice, land use planning, learning, migration, mobility, participation, poverty, quality of life, resilience, risk, risk assessment, sensitivity, smart cities, social capital, social vulnerability, spatial planning, sustainability, sustainable, sustainable development, sustainable urban development, transformation, transport, urban, urban flooding, urban governance, urban health, urban policy, urban regeneration, urban resilience, urbanization, Vietnam, vulnerability, and vulnerability assessment. This cluster can be summarized under the title of climate change and adaptation.

Cluster 4 is shown with yellow with 35 keywords. The cluster containing the keywords biomimicry, building materials, built environment, carbonation, climate, climate change mitigation, co2 emission, compressive strength, concrete, construction, corrosion, degradation, durability, ecology, efficiency, embodied carbon, embodies energy, emissions, environmental impact, fly ash, genetic algorithm, global warming, green building, lca, lead, mechanical properties, microstructure, modelling, multi-objective optimization, performance, service life, south Africa, standards, strength, and sustainable design is expressed under the title built environment life cycle assessment.

Cluster 5 is identified in purple in Figure 7. There are 32 keywords in the cluster: behavior change, buildings, climate policy, community engagement, decarbonization, diversity, electricity, energy management, environmental sustainability, ethics, extreme heat, flood, greenhouse gasses, infrastructure, landscape, local government, management, municipalities, planning, policy, public policy, regional planning, regulation, resiliency, scenarios, sea level rise, strategy, transportation, uncertainty, urban growth,

urban sustainability, and water. This cluster can be titled as planning and policies.

There are 27 keywords which are expressed with light blue in Cluster 6. The cluster containing the keywords air pollution, Brazil, building stock, co-benefits, co2 reduction, design, developing countries, disaster risk reduction, energy, energy policy, evaluation, ghg emissions, greenhouse gas, heat pump, heritage, housing, housing policy, insulation, low carbon, mitigation, refurbishment, renovation, residential, retrofit, retrofitting, social housing, and UK can be analyzed under the title social housing and retrofit.

Cluster 7 is expressed with 15 keywords which are shown in orange. These keywords are Australia, carbon neutrality, case study, climate changes, climate resilience, energy transition, greenhouse gas emission, health, heat, review, survey, sustainable development, Sweden, urban agriculture, and wind. Cluster 7 is summarized under the heading sustainable development.

Cluster 8 consists of eight keywords which are shown in brown. In Figure 7, there are the words adaptive behavior, adaptive comfort,

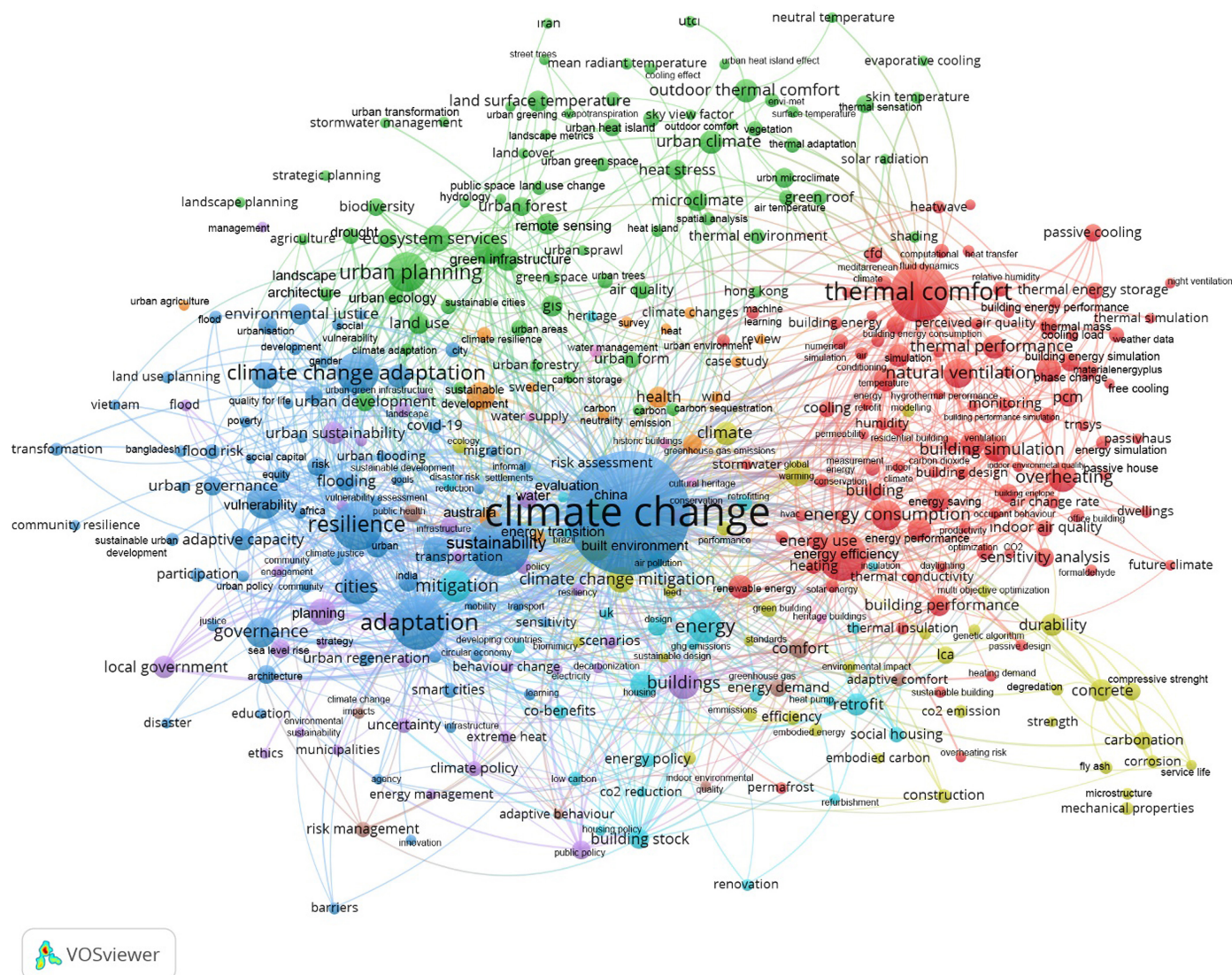


Figure 7. Keyword Network Analysis.

climate change impacts, comfort, energy demand, indoor environmental quality, public health, and risk management. This cluster is expressed as the title impacts and management.

Cluster 9 is shown in pink in Figure 7. The cluster includes six keywords which are conservation, cultural heritage, Heritage buildings, historic buildings, water management, and water supply. Cluster 9 is referred as the title conservation and heritage.

Figure 8 depicts nine clusters which are constituted with the VOSviewer program and divided into subheadings according to common topics. The clusters are expressed with a visual Sankey diagram.

Except the keyword climate change (1346 repetitions—Cluster 3), the most repeated keywords in the analyzed publications were sustainability (309 repetitions—Cluster 3), thermal comfort (302 repetitions—Cluster 1), adaptation (255 repetitions—Cluster 3), resilience (214 repetitions—Cluster 3), and energy efficiency (209 repetitions—Cluster 1). When the clusters are examined, most of the keywords are gathered under the titles climate change and adaptation and thermal comfort and simulation.

In Figure 9, the change of the most used keywords in the publications made from 1987 until today is expressed according to the years. A categorization is made with reference to four color groups: navy blue, turquoise, green, and yellow.

Keywords of the most trending topic publications include case study, circular economy, cooling effect, city, covid-19, outdoor thermal comfort, urban heat island effect, urban green space, urban forest, urban trees, urban form, urban agriculture, urban governance, thermal adaptation, heat stress, microclimate, land surface temperature, machine learning, smart cities, infrastructure, extreme heat, decarbonization, ghg emissions, embodied carbon, optimization, reduction, survey, climate changes, computational fluid dynamics, passive design,

permafrost, climate justice, energy use, climate resilience, ecosystem services, heat, community resilience, social housing, carbonation, strength, microstructure, heritage buildings heat pump, stormwater, building energy simulation, climate changes, Utci, building energy performance, heatwave, multi objective optimization, heat pump, stormwater management, equity, mobility, building performance simulation, and building energy. According to the clusters, it is seen that the most studied heading today is urban studies and information technologies.

The Most Cited Publications Between 2018 and 2022

Lastly, the most cited 10 publications between 2018 and 2022 are listed and analyzed in the study. Five of the 10 most cited publications in the last 5 years are reviews. These publications are analyzed to give a general information about the topics. Accordingly,

- Pérez-Lombard, Ortiz & Pout (2008) analyzes the relationship between energy consumption and HVAC systems in buildings.
- Today, problems such as climate change, rapid growth, congestion, and oil dependency are driving states and regions to make decisions for controlled automobile use. The purpose of the analysis in Ewing & Cervero’s (2010) study is to search the relationship between the built environment and transportation use—travel demand.
- McGrahan, Balk & Anderson(2007) conducted the primary global assessment of the distribution of population and urban settlements within the Low Elevation Coastal Zone.
- Bowler et al. (2010) studied investigating the effects of green areas on temperatures. It has been concluded that parks and trees can cool the environment on a local scale.
- Meerow, Newell & Stults (2016) reviewed the literature using the term “urban resilience.” As a result, the definition of the term is discussed while proposing some alternative explanations.

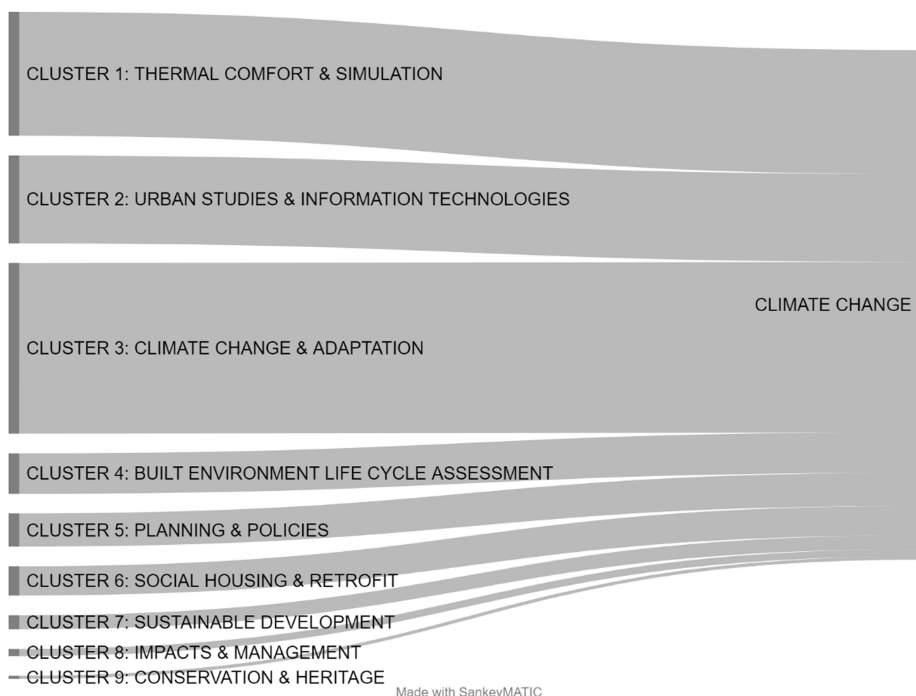


Figure 8. Keyword Clusters Visualized with Sankey Diagram.

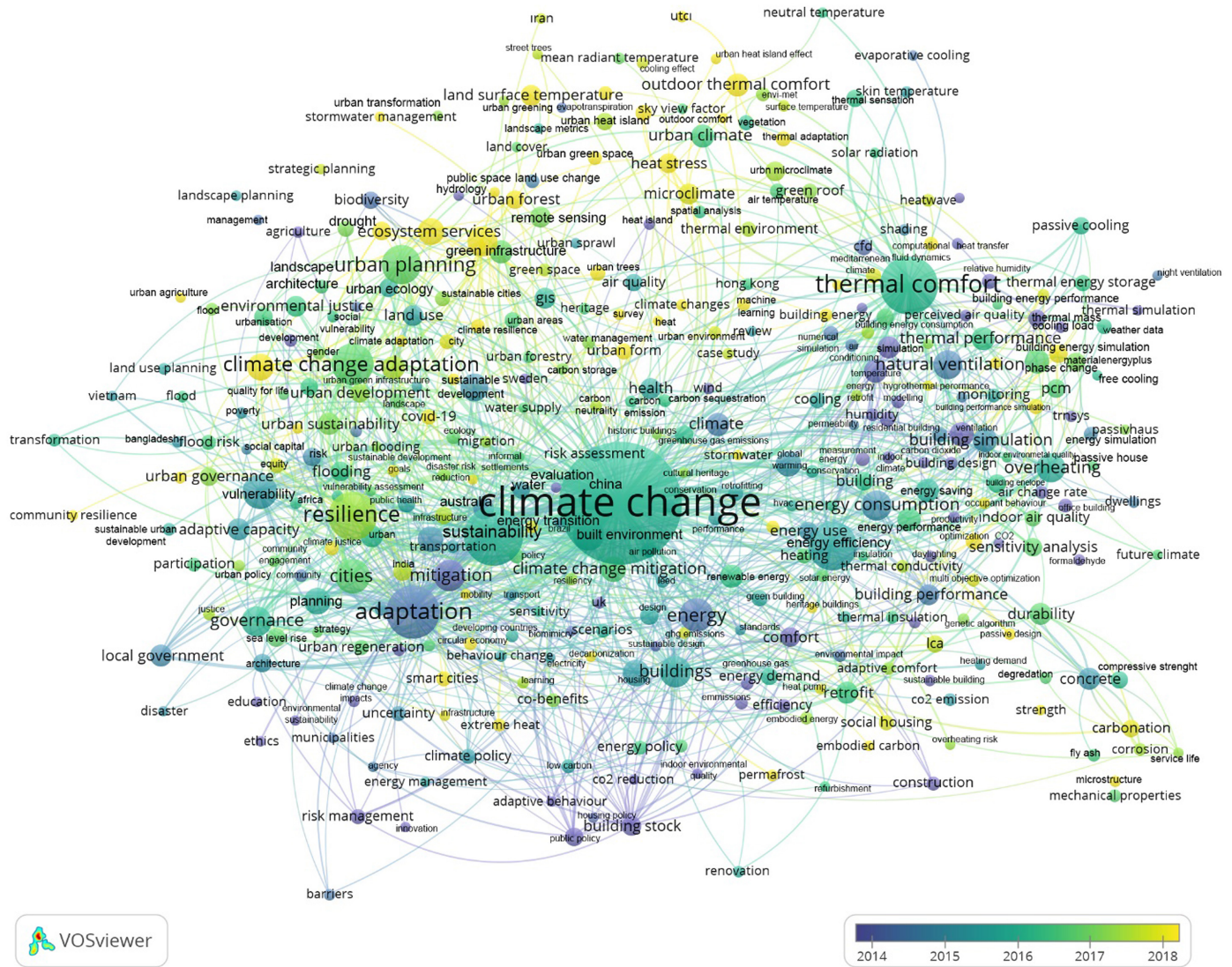


Figure 9.
The Most Used Keywords Over Years.

- In Damtoft et al. (2008), it is argued that effects of climate change on the built environment can be positively changed with different methods of cement and concrete usage.
- Using phase change materials (PCMs) in structures is one of the methods that can be used to reduce energy consumption. In Baetens, Jelle & Gustavsen (2010) study, structures in which PCMs were applied were examined and current studies were evaluated.
- Ali-Toudert & Mayer (2006) discusses the effect of street design related with solar orientation and microclimate development. The research was carried out by simulating microclimate changes in urban environments.
- Frontczak & Wargocki (2011) conducted a literature research on the effects of building interior on human comfort. A questionnaire was created to collect indoor data.
- Glaeser & Kahn (2008) measured carbon dioxide emissions associated with new construction for different locations in the USA. The results revealed that there is a negative relationship between emissions and land use planning. Cities mostly have lower emissions than suburban areas.

Results and Potential Study Areas

In this study, a bibliometric analysis is conducted using Web of Science database with the keyword climate change*. Keyword as a topic is filtered for the research areas architecture or construction building technology or urban studies, and 9421 publications are found. These publications are analyzed and interpreted under the titles of publication and citation numbers, research areas, document types, publication titles, publication numbers of countries, author and co-authorship analysis, keyword analysis, and the most cited publications between 2018 and 2022 Figure 10.

From 1987 to 2022, most of the publications were published in 2020. Year 2021 comes in the second place. The period in which the number of publications increased the fastest is between 2010 and 2020. It has been stated that the number of publications cited in the examined area has increased continuously since the first publication. The year 2021 has been the most cited year.

Apart from research areas of architecture, construction building technology, and urban studies, there are other research areas

PUBLICATIONS	CITATIONS
A review on buildings energy consumption information. Perez-Lombard, L; Ortiz, J and Pout, C, 2008 ENERGY AND BUILDINGS 40 (3) , pp.394-398	3,330
Travel and the Built Environment. Ewing, R and Cervero, R, 2010 JOURNAL OF THE AMERICAN PLANNING ASSOCIATION 76 (3) , pp.265-294	2,011
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Numerical study on the effects of aspect ratio and orientation of an urban street canyon on outdoor thermal comfort in hot and dry climate. Ali-Toudert, F and Mayer, H, 2006 BUILDING AND ENVIRONMENT 41 (2) , pp.94-108	509
Literature survey on how different factors influence human comfort in indoor environments. Frontczak, M and Wargocki, P, 2011 BUILDING AND ENVIRONMENT 46 (4) , pp.922-937	474
The greenness of cities: Carbon dioxide emissions and urban development. Glaeser, EL and Kahn, ME 2010 JOURNAL OF URBAN ECONOMICS 67 (3) , pp.404-418	453

Figure 10.
The Most Cited Publications Between 2018 and 2022.

that publications are related to, namely engineering, environmental sciences ecology, energy fuels, public administration, science technology, geography, and materials sciences.

Most of the 9421 publications analyzed are categorized under the type articles.

Considering publication numbers, 9 of the top 10 references are journals and one is a conference article.

When the number of publications by countries is examined, the USA is the country that publishes the most on the researched subject. In this ranking, the USA is followed by the UK and China.

Bulkeley H., Broto V., and Cabeza L. are in the top three ranks among the most productive writers in the field studied between 1987 and 2022. Thirteen co-authorship clusters are identified with 31 authors. Most current authors include Meerow S., Ge H.,

Bienvenido-Huertas D., Rubio-Bellido C., Sharifi A., Iam C., and Hang J.

According to the document numbers, University College London, Arizona State University, and University of Manchester are in the first three places, respectively.

For keyword analysis of this study, 355 keywords divided into nine clusters are used. Except for the keyword climate change (1346 repetitions—Cluster 3), the most repeated keywords in the analyzed publications are sustainability (309 repetitions—Cluster 3), thermal comfort (302 repetitions—1), adaptation (255 repetitions—Cluster 3), resilience (214 repetitions—Cluster 3), and energy efficiency (209 repetitions—Cluster 1). When the clusters are examined, the most used keywords are gathered under the headings of climate change and adaptation and thermal comfort and simulation.

Lastly, according to the clusters, it is seen that the most studied topic today is urban studies and information technologies, and 5 of the 10 most cited publications in the last 5 years are reviews.

Peer-review: Externally peer-reviewed.

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