

Characteristics and Trends of Urban Waterfront Human Settlements Based on CiteSpace

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Abstract: Urban waterfront human settlements have gradually become a hot topic for research in recent years. Using CiteSpace, 597 publications from 2017 to 2023 that were retrieved from the Web of Science were analyzed and sorted out, and the following characteristics were found: (1) The research hotspots transitioned from thermal comfort evaluation to the functional mechanism of water bodies, and then to the impact on the environment and residents' behavior. (2) The integration of disciplines has promoted the diversification of perspectives on urban waterfront human settlements, and the content has become more concentrated in interdisciplinary fields. Research on corresponding technology and methods of urban waterfront human settlement has improved, and so has the extensiveness of the experiments. (3) The research on urban waterfront human settlement from the perspective of ecology has been improving. The research focuses more on the harmonious coexistence of ecological and cultural values and human beings.

Keywords: Urban waterfront living environment; Bibliometric analysis; Urban thermal environment; Ecological civilization construction

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1. Introduction

Urban waterfront human settlement is one of the most dynamic areas in the city. It is not only an important part of urban human settlement but also an area with both natural landscape and artificial scenery^[1]. The research on urban waterfront human settlements started around 2010 and this type of research has increased locally and abroad ever since^[2-6]. In particular, the ecological environment has been increasingly emphasized, focusing on the harmonious coexistence between man and nature.

Due to the limited literature data available before 2017, which lacks statistical significance, this paper focuses on selecting literature related to the urban waterfront living environment published on Web of Science from 2017 to 2023. Utilizing CiteSpace, this study analyzes representative countries, authors, keywords, and co-cited documents from various levels and perspectives. A comparison is made between the research status at home and abroad, and the hot frontiers of related research fields since 2017 are summarized, along with

potential future development trends.

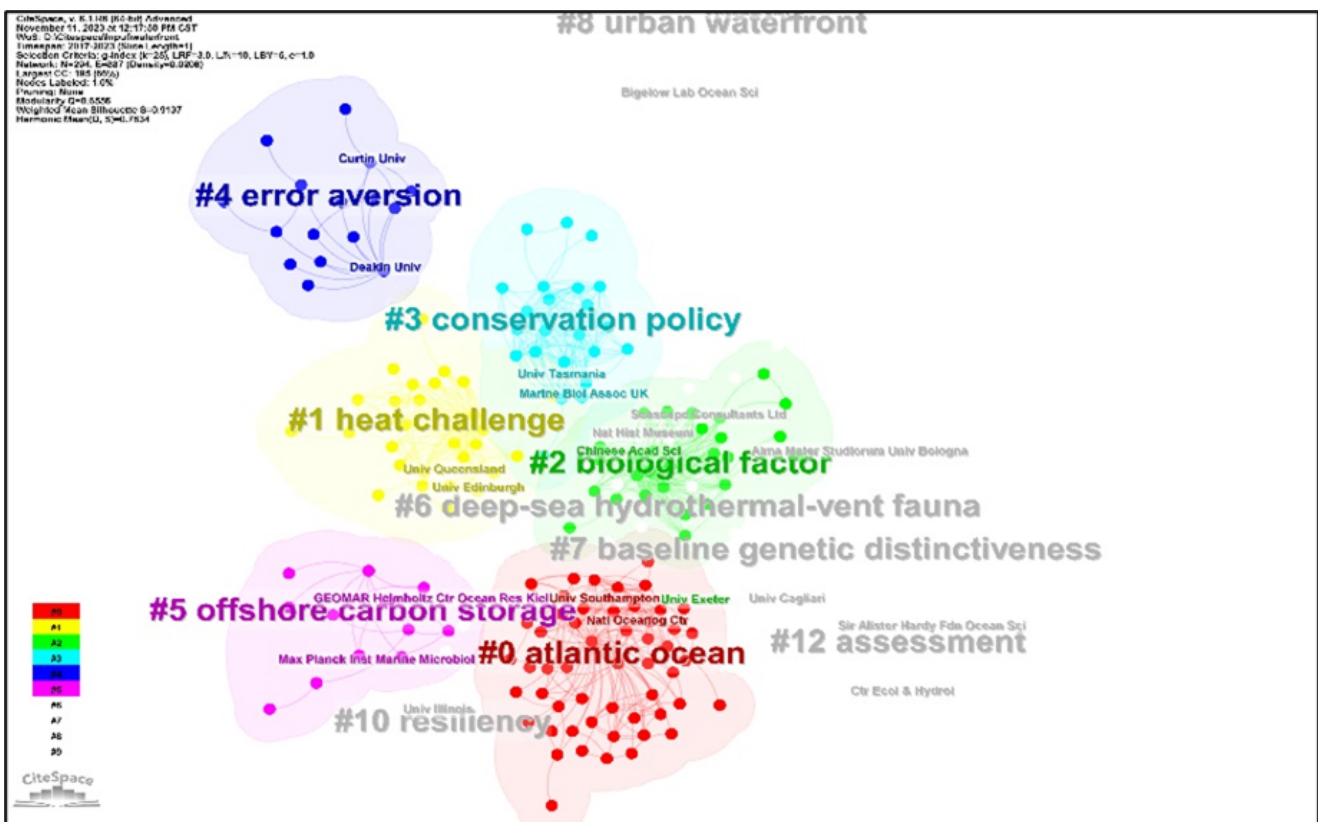
2. Literature feature analysis

CiteSpace is a quantitative analysis and visualization tool for literature information. It explores mutual citation and co-citation relationships among literature, publishing institutions, and authors in a specific field. It presents changes in research hotspots, conducts cluster analysis, and illustrates the development of research trends and characteristics in this field in a multidimensional manner.

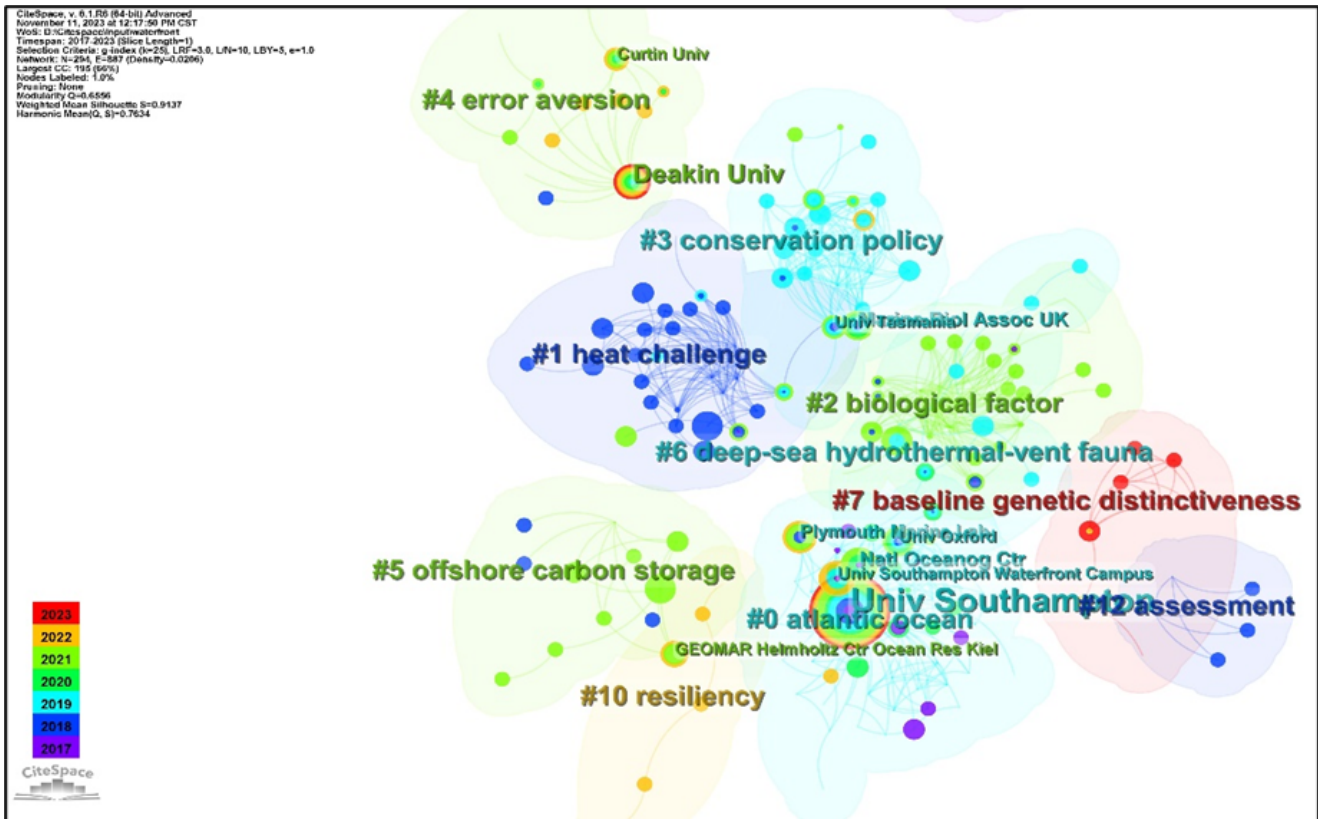
2.1. Analysis of issuing institutions and authors

CiteSpace was used to analyze the authors and the top 63 research institutions with the largest number of publications from 2017 to 2023. **Figure 1** illustrates that the overall research on urban waterfront human settlements is relatively limited, with several notable research teams. Notably, Daniel OB Jones from the University of Southampton, as well as Bates and Amanda from the University of Victoria, hold a significant presence in the research network, having initiated research earliest. In terms of research content, the focus predominantly revolves around urban waterfront industrial facilities such as docks and shipyards.

The second notable research direction involves Lichtschlag, Anna and James, Rachael H, among others, from the University of Southampton in the UK. Their research primarily centers on carbon collection technology in urban waterfront areas. Moiron and Maria from the University of Bielefeld in Germany, and Le Coeur and Christle from the University of Oslo in Norway, have focused more on the study of biodiversity in water areas. Lastly, Ben Roche along with others from the University of Southampton in the UK, have concentrated on investigating the influence of water flow structure in urban waterfront areas.



(a)



(b)

Figure 1. Analysis of (a) issuing institutions and (b) authors.

2.2. Keyword cluster analysis

The keyword co-occurrence visualization function of CiteSpace aims to identify the prevalent research directions by analyzing high-frequency words in the database. In contrast, we utilized CiteSpace’s keyword timeline clustering function in conjunction with recent governmental and organizational policies and events to analyze the fluctuation characteristics of cluster nodes each year. This approach helps in determining the research trend in the target field.

Figure 2 presents the thematic timeline clustering diagram of urban waterfront human settlements spanning from 2017 to 2023. The diagram reveals approximately eight clusters, including thermal comfort, indicators, water bodies, carbon capture and storage, sea level rise, and water quality, among others.

The clustering description categorizes clusters into three types: climate change-related hot spots, environmental science-related hot spots, and scientific measurement and reference hot spots. Key terms such as thermal comfort, water body, sea level rise, water quality, and carbon sequestration technology are highlighted within these clusters. Thermal comfort addresses individuals’ comfort levels concerning temperature and humidity, while water body encompasses all water on Earth, including oceans, rivers, lakes, and glaciers. Sea level rise, resulting from global warming, poses substantial impacts on both the environment and society. Water quality describes the purity and pollution levels of water. The terms carbon sequestration technology and sea level rise are both related to climate change. Additionally, carbon sequestration technology plays a pivotal role in climate change mitigation efforts, involving methods to reduce carbon dioxide emissions and store carbon.

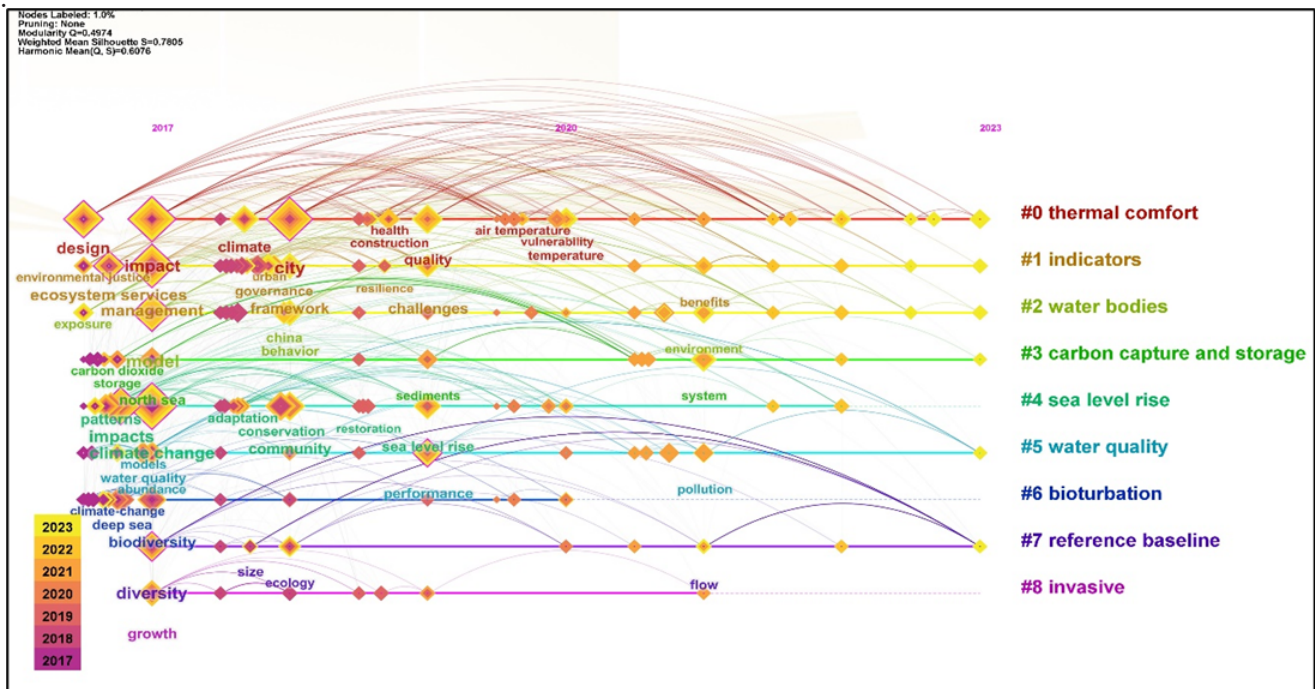


Figure 2. 2017–2023 research topic timeline cluster graph

3. Research hotspot analysis

An analysis could be conducted based on the evolution trend of keywords in urban waterfront human settlements in recent years and the keyword timeline clustering diagram generated by CiteSpace (Figure 3). Seven distinct cluster clusters are proposed based on the network structure and the clarity of the cluster map. CiteSpace provides two key indexes, modularity (Q value) and silhouette (S value), which serve as criteria for evaluating the quality of the map's depiction. The value of Q ranges from 0 to 1, when $Q > 0.3$, it means that the divided cluster structure is significant; if it is above 0.5, the clustering is generally considered reasonable; when the S value is close to 0.7, the clustering reliability is the highest; if S value is infinite, the number of clusters is usually 1, so the selected network may be too small to represent only one research topic.

In this paper, the Q value was found to be 0.42, and the S value was 0.77, indicating that the clustering effect of the map was good, the results were reasonable, and the homogeneity was high. Based on the literature corresponding to cluster words such as “functional traits,” “invasive,” “waterfronts,” “blue space,” “rework,” and “community,” the research on urban waterfront human settlements was divided into two dimensions: the evaluation method of thermal comfort in urban waterfront settlements and the functional characteristics of water in urban waterfront settlements.

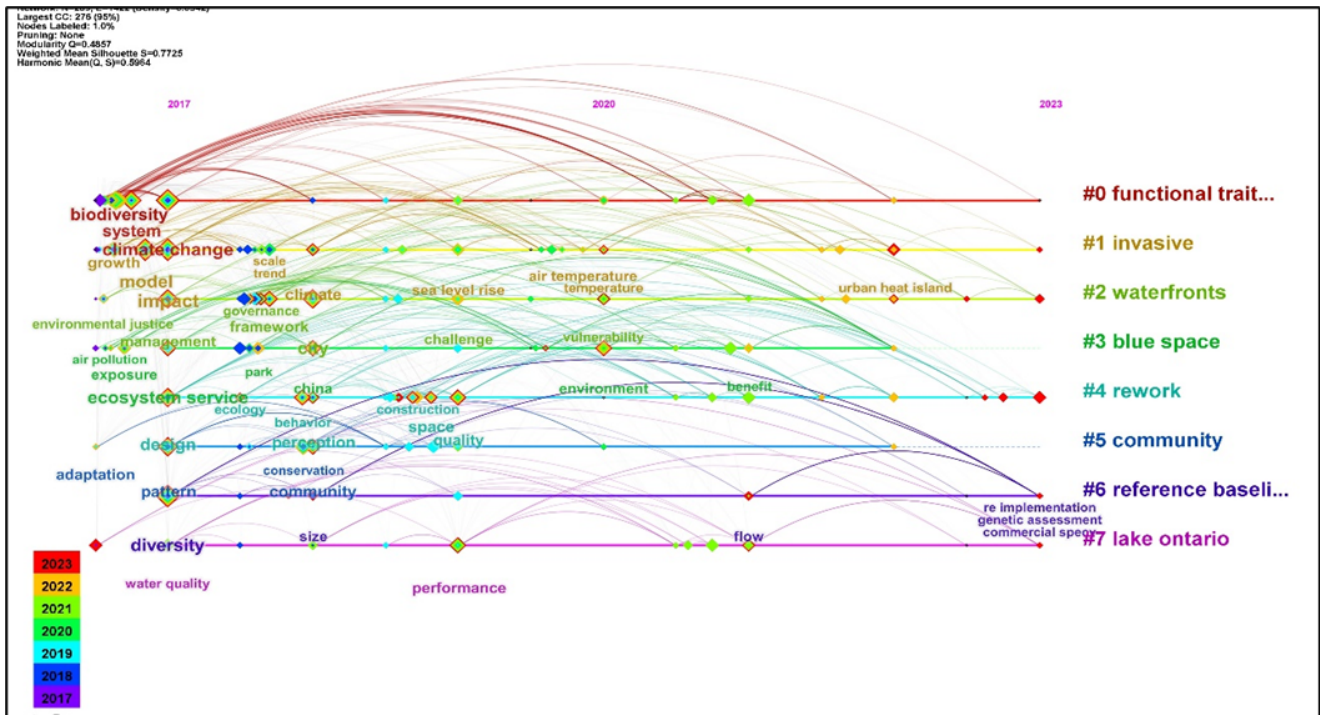


Figure 3. 2017–2023 research keywords timeline cluster graph

3.1. Thermal comfort evaluation method of urban waterfront human settlements

Combining the cluster words “functional traits,” “waterfronts,” “blue space,” and “thermal comfort” extracted in Figure 3, it becomes evident that the thermal comfort evaluation method serves as a pivotal basis for various studies, offering substantial theoretical and practical foundations for accurately measuring the characteristics of waterfront human settlements on multiple scales. Through analysis and summarization of the literature corresponding to relatively concentrated cluster nodes, several common evaluation methods for assessing the thermal comfort of waterfront human settlements emerge.

(1) Thermal environment evaluation model

This approach involves conducting numerical simulations using thermal environment models like computational fluid dynamics (CFD) models. Such simulations aim to replicate parameters such as temperature, humidity, and wind speed in waterfront areas to evaluate thermal comfort. Typically, these methods require long-term and short-term meteorological data for evaluation and analysis and employ various simulation software for calculations.

(2) Survey method

This method relies on field investigations and user feedback to gauge residents’ perceptions of the waterfront human settlement environment. By observing residents’ behaviors in the area (such as outdoor stay time and transportation usage), comprehensive surveys were conducted to analyze residents’ choices and adaptation strategies during extreme weather conditions.

(3) Remote sensing data measurement

This technique primarily utilizes multi-source remote sensing data to extract information about the human settlement environment surrounding water bodies. Through repeated calculations, average temperature and other relevant data of the target area were obtained, aiding in the evaluation of thermal comfort.

3.2. Functional characteristics of water bodies in urban waterfront human settlements

In the study of urban waterfront human settlement environments, the functional characteristics of water bodies encompass various aspects, intertwining with both the natural environment and urban planning, as well as ecosystem services and other factors. Through the literature analysis, several typical functional characteristics of water bodies in urban waterfront human settlements emerged

(1) Urban heat island slow-release effect

Water bodies play a crucial role in spatial comfort, with their characteristics such as area, shape, and distribution pattern under different climate or water conditions being extracted to inform the construction of urban climate comfort. This effect is essential for mitigating the urban heat island phenomenon.

(2) Waterfront ecosystem optimization

Water bodies constitute integral parts of the natural ecosystem, offering various ecological attributes such as water supply, purification, and biodiversity enhancement. Exploring ways to highlight the importance of ecosystems in urban waterfront human settlement environments and optimizing them represents a significant research direction. Additionally, water bodies serve functions in disaster prevention and reduction, contributing to the regulation of urban microclimates.

(3) Increased transportation options

In urban waterfront living environments, convenient water transportation provides people with more diverse travel and material transportation choices. Water transportation tends to be more cost-effective and capable of carrying larger loads than road transportation, thus effectively alleviating pressure on urban transportation systems.

4. Research trend analysis

Currently, although research on urban waterfront settlements remains limited, significant strides have been made throughout the years. Drawing from the research context, present status, policy developments, and recent research emphases on waterfront human settlements, future trends are anticipated to center around three aspects.

(1) Exploration of refined and integrated thermal comfort evaluation methods for urban waterfront settlements

As research on urban waterfront human settlement environments evolved, there has been a growing emphasis on cross-disciplinary collaboration. Integration of knowledge and methods from multiple disciplines such as ecology, urban planning, architectural design, sociology, and economics has become essential for more comprehensive research. Establishing interdisciplinary research teams that combine fieldwork, numerical simulation, and experimental studies can facilitate a thorough understanding and evaluation of the thermal comfort of urban waterfront settlements.

(2) Research on smart cities and innovative construction methods based on urban waterfront settlements

Scholars are increasingly focused on achieving sustainable environmental, social, and economic balance in urban waterfront areas. This includes safeguarding ecosystem services, judiciously utilizing water resources, and fostering community participation. The advancement of smart city technology significantly influences the management and planning of urban waterfront living environments. Leveraging sensors, big data, artificial intelligence, and other technologies to monitor, analyze, and manage waterfront areas can enhance the efficiency and quality of urban governance.

(3) Emphasis on the ecological and cultural values in urban waterfront human settlements and exploration of their added value

With climate change intensifying, urban waterfront areas face mounting challenges. Therefore, studying how to adapt to and mitigate the impacts of climate change on urban waterfront human settlements is paramount. Additionally, researchers are increasingly recognizing the cultural and historical significance of waterfront areas. Protecting these values while undertaking urban renewal and development has become a focal point of concern.

5. Conclusion

This paper examines the literature pertaining to urban waterfront human settlements, analyzing it by disciplines, institutions, and publication volume. Utilizing CiteSpace, it delves into both domestic and foreign research hotspots and trends, yielding the following conclusions: In the study period spanning from 2017 to 2023, scholars forming the core research teams exhibited distinct regional characteristics, yet a broad consensus remained elusive. Notably, the University of Southampton in the United Kingdom emerged with the highest publication count and considerable influence, closely followed by institutions in Australia, China, and the United States. Regarding research content and hotspots, several key characteristics were observed: (1) Research hotspots displayed discernible policy orientations and temporal dynamics. Initially centered on basic thermal comfort evaluation, the focus gradually shifted towards understanding the functional mechanisms of water bodies and subsequently expanded to encompass their ecological impacts and influence on residents' behaviors. (2) The integration of multiple disciplines fostered a diversified perspective on urban waterfront human settlements, leading to a concentration of research in interdisciplinary fields. Concurrently, technological advancements and methodological innovations have enhanced the scope and depth of experiments in urban waterfront human settlement research. (3) Research on urban waterfront human settlement environments from an ecological perspective has undergone significant deepening. There is a heightened emphasis on achieving harmonious coexistence between ecological and cultural values and human inhabitants.

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The authors declare no conflict of interest.

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