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The Usage and Constraints of Urban River Corridor from a Socio-ecological Perspective: a Systematic Review

Abstract

River corridors, acknowledged as "blue-green infrastructure," have gained increasing attention due to their potential benefits on individual quality of life and social well-being in urban areas. However, there remains a lack of a comprehensive synthesis of evidence through a systematic literature review on the usage and associated constraints of urban river corridors. The paper aims to systematically review those attributes that influence the usage of urban river corridors and to analyse their complex interactions from a socio-ecological perspective. Results comprise an overview of the reviewed literature, including authorship, journal, geographical distribution, sample characteristics, data collection and analysis methods, and critical findings. Fifty-nine peer-reviewed papers published between 2012 and 2023 met the authors' inclusion criteria. The findings highlight the significant influence of individual, social, and physical factors on the usage of urban river corridors. Additionally, time reason also impact users' decisions regarding the usage of urban river corridors. Finally, a conceptual framework was proposed to guide urban planners, designers, and policymakers in enhancing urban river corridors' design and management standards, ultimately creating a sustainable, resilient, and inclusive leisure space catering to diverse needs.

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1 Introduction

Due to rapid urbanization and climate change, rivers have undergone significant physical and spatial transformations, resulting in severe social and ecological issues (Best, 2019; Nguyen et al., 2019; Remondi et al.,2016; Zainal Abidin & Lee, 2011). In response to this growing concern, countries worldwide have recognized this phenomenon and actively striving to restore river ecosystems through ecological design approaches while enhancing their recreational and leisure value (Scott et al., 2016). Today, with the gradual improvement of water quality, urban river corridors have gained increasing prominence in urban ecology planning, green infrastructure development, green space management, and climate change adaptation strategies (Zhang et al., 2022a; Zheng et al., 2019).

River corridors refer to the vegetated areas along river channels and their adjacent zones, serving as transitional zones between the river and surrounding terrestrial ecosystems (Forman, 1995). Given the complexity and uniqueness of river corridor landscapes, experts from various disciplines adopt diverse terms to define river corridors (Zhang et al., 2022a). For instance, ecologists commonly use "riparian zone" or "riparian area," while hydrologists refer to the "floodplain." In the field of landscape, terms such as "waterfront green space" or "riverside" are frequently employed. Additionally, the terms "river corridor" and "stream corridor" are often used interchangeably. It is essential to acknowledge that certain concepts extend beyond the boundaries of river corridors, such as greenways, blue ways, and ecological corridors, which may encompass broader areas, including natural vegetation zones on both sides of rivers or roads (Zhang et al., 2022a). River ecological corridors, riparian zones and areas, riparian vegetation buffers, riparian buffer strips, and green river corridors are all elements of river corridors.

Research has demonstrated that urban river corridors, as blue-green infrastructure, perform a dual role as natural and social corridors, thereby contributing significantly to urban stability, comfort, and sustainability (Janiszek & Krzysztofik, 2023; Ji et al., 2012). On the one hand, urban river corridors act as ecological corridors, facilitating the migration of organisms, enhancing biodiversity, and providing habitats and migration routes for wildlife (Baschak & Brown, 1995; Bennett & Mulongoy, 2006). These corridors establish unique habitats within urban areas, creating energy and material flow pathways between urban green spaces, effectively mitigating landscape and habitat fragmentation (Beatley, 2000; Vermaat et al., 2016). On the other hand, urban river corridors hold the potential to serve as urban greenways, regulating the urban microclimate, mitigating urban heat island effects, preserving water and soil resources, purifying water bodies, and offering psychological benefits through attention restoration (Guimarães et al., 2021; Hathway & Sharples, 2012; Kenwick et al., 2009; Vaeztavakoli et al., 2018). Furthermore, natural riverbanks contribute to the scenic beauty of cities and play a vital role in shaping urban landscapes (Che, 2001). Urban river corridors serve as excellent public spaces to showcase vegetation and optimize the visual landscape of cities. Moreover, these corridors provide water-related spaces for urban residents, attracting them to connect with nature (Zainal Abidin, 2017). In this regard, understanding the public's usage of urban river corridors is of utmost importance, given their potential impact on individual quality of life and social well-being (Che, 2001; Garcia et al., 2017; Nguyen et al., 2021; Oertli & Parris, 2019).

Given the myriad benefits of river corridors, extensive research has been conducted to gain a deeper understanding of the factors influencing public usage and constraints in these areas. Researchers are increasingly focusing on comprehending the interplay between the physical characteristics of river corridors and the "human dimension," encompassing socio-cultural attributes of individuals and social groups that offer valuable insights for urban planning (Garcia et al., 2020; Pouya & Baskaya, 2018). Among individual attributes, gender, age, occupation, race, education level, socio-economic status, and modes of transportation play pivotal roles in determining the usage of urban river corridors (Xie et al., 2023). Studies have shown that natural elements like water features and green vegetation, well-maintained facilities, and the presence of wildlife are appealing features that entice regular visits to urban river corri-

dors (Garrett et al., 2019; Luo et al., 2022; Van Hecke et al., 2016). Conversely, uncivil behaviours such as graffiti, littering, and the presence of troublesome individuals can impede usage (Eid et al., 2021; Smith et al., 2022; Vert et al., 2019). A survey conducted in Hangzhou on the suitability of urban waterfront spaces revealed five common factors influencing the satisfaction of older adults with urban blue-green spaces: environment, functionality, transportation, socio-culture, and vision (Gong et al., 2019). On the other hand, children tend to prioritize natural elements and engage in physical activities involving water, such as swimming and water slides (Mansournia et al., 2021). Furthermore, the accessibility and distance to urban river corridors also play significant roles in influencing public usage (Othman et al., 2021; Wüstemann et al., 2017). Longer durations of access to blue-green spaces have been associated with higher levels of well-being (Garrett et al., 2019), while feelings of insecurity act as significant barriers to fully utilizing river corridors (Vierikko & Yli-Pelkonen, 2019). Therefore, a socio-ecological model that incorporates individual, physical, and social environmental factors provides a comprehensive theoretical framework to understand the complex dynamics of urban river corridor usage (Glanz et al., 2008). This holistic approach enables a deeper comprehension of the intricate interactions between various elements that influence public utilization of these spaces and provides valuable guidance for urban planners and policymakers aiming to create sustainable and people-oriented urban environments.

However, there remains a lack of comprehensive literature reviews investigating the relationship between urban river corridors and socio-ecological perspectives. Hence, the primary objective of this study is to systematically review the evidence of the factors influencing the usage, constraints, and satisfaction of urban river corridors, as well as the interconnections between these factors. Specifically, this paper will (a) comprehensively review the existing literature on the factors influencing the usage and constraints of urban river corridors, encompassing their authorship, journal, geographical distribution, sample characteristics, data collection, and analysis methods, as well as critical findings; (b) analyse the attributes that impact the public's usage and constraints of urban river corridors; and (c) propose a conceptual framework for the usage and associated constraints of urban river corridors based on the socio-ecological method. The contribution of this study will enhance the existing landscape design processes and provide up-to-date design and management strategies for the future development and enhancement of urban river corridors.

2 Research method

2.1 Search strategy

This study employed the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) as a standardized tool for screening and extracting literature, ensuring the traceability of the screening process (Moher et al., 2009). The author searched peer-reviewed English-language academic literature using three widely recognized electronic databases (Science Direct, Web of Science, and Scopus) to identify relevant papers on the usage and constraints of urban river corridors. In order to broaden the scope of literature search, we systematically employed an extensive set of keyword combinations. These terms encompass (1) river corridor, stream corridor, riverfront, riverside, riparian, riverscape, urban blue, and greenway; (2) usage, use, recreation, activity, and behaviour; and (3) barrier, disservice, constraint, and restriction. The search was conducted until November 5, 2023, and included the most current available literature.

2.2 Inclusion and exclusion criteria

The inclusion criteria are as follows: (i) the survey area was urban river corridors or waterfront spaces, (ii) the study is based on the usage and constraint of people, (iii) the article is an empirical study subject to peer review, and (iv) the language of the article is English.

The exclusion criteria are as follows: (i) articles that are unrelated to the topic, (ii) grey literature, including conference proceedings, book chapters, literature reviews, MSc and Ph.D. theses, course notes, and government reports, and (iii) duplicate articles.

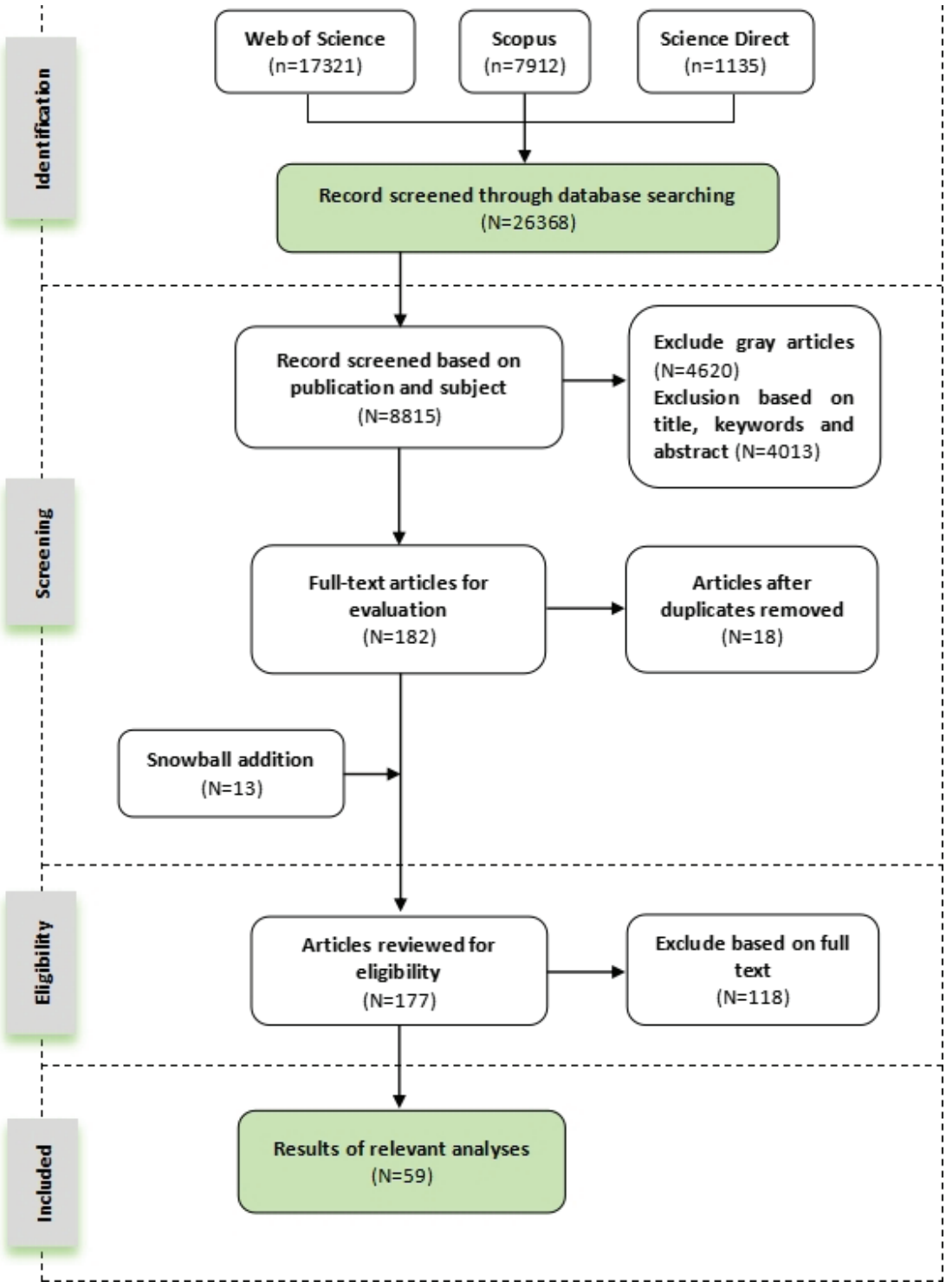

Figure 1. Steps involved in a systematic review.

2.3 Study selection

Initially, a total of 26,368 articles were retrieved. Subsequent to excluding 17,553 records based on considerations related to publication title and subject areas, 8,815 articles remained. From this pool, 4,620 gray literature sources were systematically eliminated. Rigorous scrutiny of titles, keywords, and abstracts, coupled with a meticulous evaluation based on predetermined inclusion and exclusion criteria, led to the exclusion of 4,013 articles deemed irrelevant to the research objectives. The remaining 182 articles underwent a secondary screening, during which 18 duplicate entries were identified and

subsequently removed. To ensure the thoroughness of the literature review, an additional 13 articles, overlooked in the search process, were identified through a systematic review of reference lists (snowballing). Following an exhaustive examination of the full text of the initially selected 177 peer-reviewed journal articles, 59 articles met the predetermined inclusion criteria (Figure 1).

2.4 Data extraction

Following a comprehensive review of the selected articles, the authors extracted pertinent information for analysis and organized the data and findings within a Microsoft Excel spreadsheet. The extracted information encompassed various aspects such as author names, publication dates, countries, journals, sample characteristics, data collection methods, sampling methods, sample sizes, data analysis techniques employed, and primary research findings.

2.5 Quality appraisal

Some studies have shown that documenting the steps taken by researchers to identify and recruit participants and providing details on how they collected and analysed outcome data contributes to assessing the study based on appropriate criteria (Garside, 2014). Therefore, it is necessary to conduct a quality assessment of the included studies. In this study, the authors employed the Crowe Critical Appraisal Tool (CCAT) for analysis and evaluation (Crowe et al., 2011). The CCAT has been widely applied in systematic reviews due to its validated effectiveness and reliability in research design (Crowe & Sheppard, 2011). The latest version of CCAT (Version 1.4) consisted of eight key categories, with scores ranging from 0 to 5, resulting in a total score of 40 for each study (Crowe, 2013). The overall manuscript score can be represented as a percentage, obtained by dividing the total score by 40, where 40 is the sum of the scores from the eight categories, each having a maximum score of five (Crowe, 2013). Two authors independently assessed and rated each study using the same quality rating scale. In cases of divergent opinions, resolution was achieved through discussion and deliberation. Although the CCAT does not include a descriptive or qualitative data analysis component, it is worth noting that alternative critical appraisal tools provide specific thresholds for evaluation. For instance, Gascon et al. (2017) established quality assessment criteria for studies in the field of green spaces and provided corresponding quality scores: excellent (≥81%), good (61-80%), fair (41-60%), poor (21-40%), and very poor (≤20%).

3 Results

3.1 Synthesis of study findings

After review, a total of 59 original research articles that underwent peer review were identified. These articles were disseminated across 35 distinct journals, with the highest volume appearing in Sustainability (9 articles), succeeded by Land (5 articles). Four articles were published in Landscape and Urban Planning, Urban Forestry & Urban Greening, and the International Journal of Environmental Research and Public Health. Two articles were featured in Health & Place, International Journal of Geo-Information, and Frontiers of Architectural Research, while the remaining 27 journals each contributed a single article. Concerning regional distribution, except for one article lacking specified research location, the majority of studies (26 articles) were conducted in China, followed by Germany (5 articles) and the USA (3 articles). Hong Kong, Spain, Serbia, Poland, Egypt, and the UK each contributed two articles. At the same time, other regions (Cyprus, Taiwan, Finland, Barcelona, Bangladesh, Kurdistan, New Zealand, Chile, Iran, and the Czech Republic) were represented by a single article. Additionally, one article encompassed a research scope of 15 European countries, and another focused on the 14 EU Member States. From the time perspective, the 59 papers were published between 2012 and 2023. Over time, there has been a significant increase in research on usage and constraints related to urban river corridors or riverfront spaces, with 85% of the research output (50 articles) mainly concentrated after 2019. The overall publication trend is depicted in Figure 2.

Among the 59 studies reviewed, all provided detailed descriptions of their sample characteristics. Some studies recruited interviewees, such as residents (20%), users of river corridors (17%), and visitors

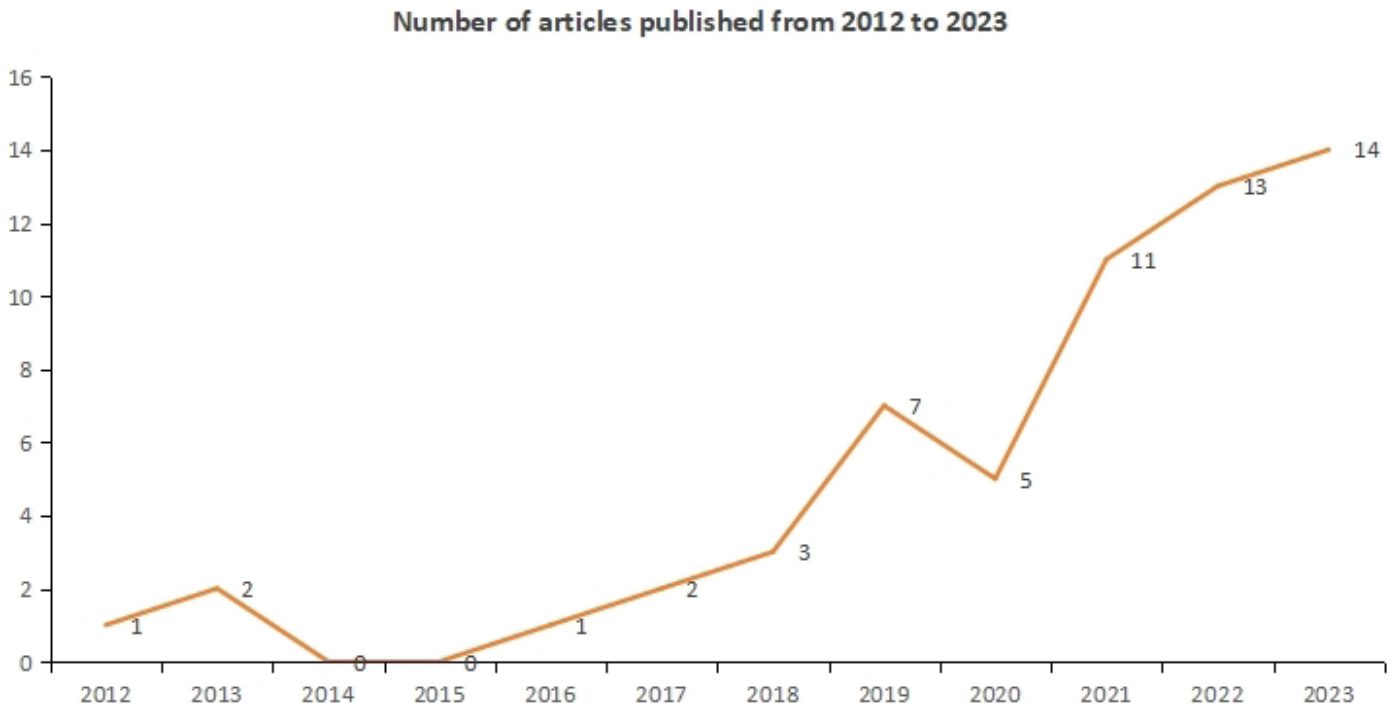

Figure 2. Number of publications on usage and constraints of urban river corridors from 2012 to 2023.

(15%). Additionally, three articles (5%) specifically included older adults as participants, while seven articles (12%) targeted online users from platforms like Tencent, Weibo, and Dianping. Other studies involved general citizens, tourists, passers-by, volunteers, students, experts, young people, children, pedestrians, mobile phone users, camping people, planning officials, and non-governmental organizations. Almost all studies investigated the usage of urban river corridors by gender, and no reports exclusively focused on a single gender.

In terms of data collection, a majority of the articles (56%) employed quantitative methods such as questionnaires, field surveys, observations, Baidu heat maps, GIS, GPS, and behavioral notation techniques. Meanwhile, four articles (7%) utilized qualitative methods such as interviews, while twelve (20%) adopted mixed methods combining quantitative and qualitative approaches. Furthermore, ten articles (17%) relied on secondary data sources. It is worth noting that several studies also tapped into online data sources like Baidu heat maps, POI data, NDVI data, Real-time Tencent user density data, morphological data, spatio-temporal cellular data, drone aerial photography, crowd distribution heat map, building vector data, and road network data.

In addition, a substantial number of studies (51%) provided explicit descriptions, employing either probability sampling techniques (such as random sampling and stratified sampling) or non-probability sampling methods (including convenience sampling, quota sampling, snowball sampling, and voluntary sampling). However, a notable proportion (49%) did not provide detailed explanations of the sampling methods employed. Meanwhile, 20 articles did not specify the sample size used in their studies.

Furthermore, all articles comprehensively described the data analysis methods employed. These methods encompassed qualitative approaches such as content analysis, semantic differential methods, and quantitative techniques, including descriptive analysis, regression analysis, ANOVA, kernel density estimation, analytic hierarchy process, t-tests, F-test, Fuzzy set qualitative comparative analysis (fsQCA), chi-square tests, and more.

3.2 Quality review

In accordance with the CCAT criteria, the authors conducted quality assessments for the eight key categories and calculated total scores and percentages. The result showed that all included studies (59) achieved scores of ≥60%. Referring to the research

quality assessment criteria established by Gascon et al. (2017) in the field of green spaces, five studies (8%) were rated as excellent, the majority (n=50) of the included studies demonstrated good methodological quality, and the remaining four studies (7%) received a fair overall quality rating. None of the studies were classified as poor or very poor. Specifically, 36 studies obtained scores of four or five out of five in the preliminaries category (i.e., title, abstract, and text), while 23 received a score of three. In the introduction section, most studies provided background information; however, six studies did not summarize the primary objective, aims, or secondary questions. Concerning the study design (including intervention, treatment, exposure, outcome, output, predictor, measure, bias, etc.), 16 articles received moderate scores in this category. Moreover, 29 studies achieved high scores (four or five out of five) in the sampling procedures, 28 studies scored medium (three out of five), and the remaining two studies received low scores (two out of five). In data collection, most studies obtained high scores (four or five out of five), while only 15 attained a medium score (three out of five). Only seven studies reported ethical considerations. It is worth noting that all results obtained scores of medium (three out of five) or above (four or five out of five). Finally, in the discussion section (including interpretation, generalization, and concluding remarks), most studies (44) received high scores (four or five out of five), 13 studies scored medium (three out of five), and two studies received low scores (two out of five) due to the lack of detailed discussions or limitations.

3.3 Factors of urban river corridor usage

According to Mcleroy et al. (1988), factors affecting the usage were structured employing a socio-ecological framework model. This model recognize that individual behaviour is influenced by multiple factors, including personal, social, and physical attributes.

3.3.1 Personal attributes

This study examined the usage of urban river corridors by scrutinizing individual attributes, encompassing demographic characteristics, activity motivations, modes of transportation, frequency of visit / familiarity, duration of stay, time of the day, and dog ownership. However, within the pool of 59 included studies, 12 articles failed to furnish demographic data regarding the respondents.

The findings from 29 studies (49%) revealed that age is the most frequently observed variable. Research has found that adults constitute the primary user group of urban river corridors (Djukić et al., 2020; Giannakis et al., 2016; Vert et al., 2019), followed by seniors and children (Vert et al., 2019). This predilection may stem from the ability of younger individuals to rely on vehicular transport to access distant urban riverside (Wu et al., 2019b). Conversely, due to declining health conditions, seniors tend to engage in less physically demanding activities, such as walking in nearby outdoor natural spaces (Garrett et al., 2019; Gong et al., 2019; Rantanen et al., 2012). However, a study focusing on using the Donghu Greenway in China highlighted that seniors use urban river corridors more due to their ample and flexible leisure time (Börger et al., 2021; Xie et al., 2023). Children and adolescents exhibit lower usage of these areas as societal norms increasingly deem children's unsupervised use of the riverfront unacceptable, reducing their utilization of such spaces (Freeman & Tranter, 2012; Vert et al., 2019). Djukić et al. (2020) discovered no discernible correlation between specific age groups and their riverside usage frequencies.

Similarly, motivation stands out as the most frequently discussed variable among individual factors. An equal number of studies examine personal motivation as a variable (n=29, 49%). Individuals visit urban riversides primarily for physical exercise, recreation and leisure, including activities such as walking or jogging, cycling, swimming, dancing, skateboarding, rowing, dragon boat racing, water marathons, dog walking, picnicking, dining, photography, social gatherings, commuting, chess, and camping (e.g., Chen & Ma, 2023; Gargiulo et al., 2020; Guo et al., 2022; Gong et al., 2019; Liu et al., 2023; Meng et al. 2020; Vierikko & Yli-Pelkonen, 2019; wade et al., 2023; Wu et al., 2019a; Yu et al., 2022; Zhang et al., 2022b; Zingraff-Hamed et al., 2022). Furthermore, two studies also discussed the motivation for restoration (Gargiulo et al., 2020; Jakstis et al., 2023). River proximity is a significant attraction for many individuals, as they prefer to be as close to the wa-

ter as possible (Eid et al., 2021), particularly during hot summers, eliciting feelings of relaxation or tranquillity upon encountering water (Ćwik et al., 2021). People's purposes for visiting urban riversides often vary by gender and age. One study revealed that middle-aged individuals exhibit the highest demand for sports and leisure spaces, while seniors express a heightened preference for social gatherings (Ouyang & Wu, 2023). Children enjoy direct physical contact with water (Mansournia et al., 2021). Conversely, due to declining health conditions, seniors tend to engage in less physically demanding activities, such as walking in nearby outdoor natural spaces (Garrett et al., 2019; Gong et al., 2019; Rantanen et al., 2012). A study conducted in Wuhan, China, found that women prefer to come to the riverside squares in the morning to participate in square dancing for physical exercise (Wu et al., 2019b).

Gender is another prominent factor that has received considerable attention, with 25 studies (46%) exploring it as an independent variable. The findings revealed substantial variations in preferences between male and female users regarding different river corridors in terms of temporal and spatial aspects (Wu et al., 2019b). Female users tended to spend less time engaging with urban river corridors (Xie et al., 2023). Two studies from China demonstrated that the proportion of females in the spatial distribution of users is slightly higher than males (Wu et al., 2019b; Zhang et al., 2022b). However, another study conducted in the Riverside area of Barcelona, Spain, came to the opposite conclusion, suggesting that men outnumbered women.

The frequency of visitation/familiarity (n=26, 44%) also influences people's willingness to visit. Djukić et al. (2020) revealed that nearly one-sixth of individuals partake in daily walks along the river, with the majority (44%) indicating a regular monthly stroll. This phenomenon signifies active engagement with the urban riverfront. Visitation frequency significantly correlates with the perceived walking distance (Völker et al., 2018) and water quality (Börger et al., 2021). Frequent physical access to riverfront green spaces is only feasible when the vertical distance is appropriate and the riverbank is not steep (Vian et al., 2021). Moreover, Xie et al. (2023) reported a positive correlation between greenway visitation frequency and social cohesion. Participants' satisfaction with riverfront green spaces primarily stems from their familiarity with these areas and their level of engagement in social interactions within them (Vert et al., 2019). Additionally, the frequency of urban riverfront use is related to time and season. For instance, Vierikko and Yli-Pelkonen (2019) observed differences in visitation frequency between tourists in summer and non-summer seasons. The frequency of nighttime use of open riverfront spaces significantly decreases (Rakonjac et al., 2022).

In addition, 34% of the studies (n=20) investigated the impact of residence on the utilization of urban river corridors, yielding mixed findings. In Finland, it was observed that during the summer season, most visitors resided in rental apartments rather than vacation homes, while non-summer visitors predominantly stayed in their own detached houses (Vierikko & Yli-Pelkonen, 2019). A study encompassing fifteen European countries conducted separate examinations for the Nordic, Central European, and Southern European regions and found variations in the frequency of urban river green space visits before and during the pandemic across the three different regions (Jakstis et al., 2023). Xie et al. (2023) indicated a negative correlation between homeownership rate and riverside utilization frequency. Additionally, the length of residency demonstrated a significant positive association with familiarity, usage patterns, and positive interactions with urban river corridors (Haeffner et al., 2017). Due to their long-term residency in the local area, most individuals exhibit familiarity and a preference for the community, engaging in numerous social interactions (Vert et al., 2019).

Moreover, 19 studies (32%) specifically examined the duration of visitor stays. The majority of these studies indicated that visitors spend approximately one hour on urban river corridors (Garrett et al., 2019; Liu et al., 2023; Luo et al., 2022; Mansournia et al., 2021; Rakonjac et al., 2022; Vierikko & Yli-Pelkonen, 2019; Wang et al., 2020; Zhang et al., 2022b). Some individuals seeking proximity to the water may invest several hours sitting along the riverbank, observing the water flow (Völker & Kistemann, 2013). In contrast, Ćwik et al. (2021) argued that fountains with multi-media shows may attract visitors more

than the mere presence of water. The availability of leisure time plays a role in the duration of recreational sports activities along the urban riverfront (Gargiulo et al., 2020). Two other studies concluded that visitors extend their stays slightly on weekends compared to weekdays (Chen et al., 2022; Fan et al., 2023). Higher socioeconomic status households may allocate more leisure time to riverside activities, while renters and temporary residents, engrossed in their livelihoods, may have limited time by the riverside (Haeffner et al., 2017). Additionally, the presence of recreational facilities and the quality of the natural environment also impact the duration of stays (Chen & Ma, 2023). Higher environmental quality tends to correlate with extended stay durations.

Other factors, such as time (n=19, 32%), also influence the utilization of urban river corridors. Time-related variables encompass temporal points, day or night, and weekdays or weekends. Multiple studies reveal that urban river corridors exhibit higher vibrancy during weekends than on weekdays (Ding et al., 2023; Grzyb & Kulczyk, 2023; Liu et al., 2021; Wu et al., 2019b). However, Chen et al. (2022) present contrasting findings, indicating lower spatial density during weekends. Significant differences in visitor numbers during daytime and nighttime were noted (Chen & Ma, 2023; Giannakis et al., 2016; Rakonjac et al., 2022). Individuals often prefer camping during pleasantly comfortable times, such as evenings in summer (Wu et al., 2023). Nevertheless, conclusions from different studies are inconsistent, as articulated by an adult white individual who feels secure during the daytime along rivers but rarely ventures there at night due to inadequate lighting (Vert et al., 2019).

Although 18 studies (31%) investigated the participants' educational level, only one study demonstrated significant findings for this variable, indicating no systematic linear relationship between participants' formal education level and their proximity to riversides or familiarity with them (Haeffner et al., 2017). However, individuals with higher levels of education, such as those with university and graduate degrees, are more likely to spend time on local riversides and thus benefit from various forms of interactive experiences (Haeffner et al., 2017).

Furthermore, 12 studies (20%) examined the transportation modalities associated with the utilization of urban river corridors. The majority of these studies consistently reported that walking is the predominant mode of transportation for individuals accessing urban river corridors (Gong et al., 2019; Ouyang & Wu,2023; Xie et al., 2023; Zhang et al., 2022; Zhao et al., 2021; Zhou et al., 2022). Other modes of transportation were found, including public transportation, private vehicles, sightseeing buses, and multi-bikes (Liu et al., 2023; Othman et al., 2021; Völker & Kistemann,2013; Zhang et al., 2022b). A study investigating the preferences and attitudes of citizens towards urban riversides revealed that individuals residing farther from the river corridors primarily relied on private vehicles, which may raise concerns regarding traffic connectivity and parking availability (Wang et al., 2020).

The review also identified some less-studied variables, including socioeconomic status (n=10, 17%), employment status or occupation (n=10, 17%), family structure (n=9, 15%), health status (n=5, 8%), race or ethnicity (n=4, 7%) and marital status (n=3, 5%). One study conducted in Utah, USA, revealed that compared to non-white Hispanic backgrounds, people with higher socioeconomic status and white ethnicity were more familiar with urban waterways and likelier to spend time there (Haeffner et al., 2017). Additionally, a study conducted in Germany indicated that individuals with an immigrant background tended to reside closer to urban blue spaces compared to those without an immigrant background (Wüstemann et al., 2017). Although ten studies described employment status or occupation in their research, none conducted a correlation analysis to investigate their association with the use or constraints of urban river corridors. Another less-examined factor is family structure, with nine studies describing this variable. Xie et al. (2023) asserted that the frequency of lakeside visits was negatively associated with single-person households. Haeffner et al. (2017) found that, compared to families without young individuals, families with children appear less familiar with local riversides. A survey conducted in Finland reported that families with children were more common during the summer season compared to the off-peak season, and approximate-

ly one-fourth of the respondents visited urban river corridors alone during the off-peak season (Vierikko &Yli-Pelkonen, 2019). In addition, only five research focused on health status. It seems that health status positively influences the utilization of urban river corridors, particularly among the elderly population (Garrett et al., 2019; Gong et al., 2019). A study conducted in Hong Kong revealed that older adults who frequently visited riversides were more likely to have better psychological well-being, and individuals who had a view of blue spaces from their residences were more likely to report overall good health (Gong et al., 2019). However, a study in Egypt reported that residents' walking ability and health status did not demonstrate statistically significant associations (Othman et al., 2021). While three studies provided descriptive information on marital status as a demographic variable, no correlation analysis was conducted (Börger et al., 2021; Zhao et al., 2021; Xie et al., 2023).

The least observed factors encompass dog ownership (n=1), proficiency in swimming (n=1), and childhood nature experiences (n=1). A study investigating the recreational value of blue spaces across Europe revealed that individuals who own dogs and those proficient in swimming tend to visit blue spaces more frequently than those without canine companions or swimming skills (Börger et al., 2021). Additionally, a dedicated inquiry into the relationship between childhood nature experiences and riverside utilization concluded that the duration of childhood exposure to nature does not exhibit a significant correlation with adults' involvement in natural environments (Van Heezik et al., 2021). This suggests that irrespective of limited childhood experiences, and adults can actively engage with nature in urban river corridors.

3.3.2 Social attributes

In the social-ecological model, individuals' thoughts, feelings, and behaviours are largely influenced by their social environment and the resulting psychological processes known as social attributes (Paneerchelvam et al., 2020). Social attributes encompass elements contingent upon the cultural significance of activities and the social interactions among individuals (Gargiulo et al., 2020). The literature identified that social factors comprise five factors: sociability, safety, and social incivilities.

Sociability significantly influences the public use of urban river corridors, with 18 (30%) studies discussed this variable. Riversides often serve as popular venues for diverse social interactions (Völker & Kistemann, 2013). Individuals enjoy socializing, dining, and recreational activities with family, partners, or friends during weekends or leisure time in culturally themed river front areas or amidst beautiful natural landscapes (Djukić et al., 2020; Wu et al., 2019a). This attests to the crucial social role that urban riverbanks play for users. For instance, some parents or grandparents frequently relax on the riverside during the summer while caring for their children (Vierikko & Yli-Pelkonen, 2019). However, some homemakers may lack the time to stroll by the riverside due to family responsibilities (Gargiulo, 2020). Furthermore, specific riverside spaces frequently host public events such as rowing competitions and botanical exhibitions, attracting urban residents (Shangi et al., 2020). Strong neighbourhood social cohesion may foster increased social interactions among neighbours (Xie et al., 2023). However, there are also individuals expressing discontent with crowded environments, as highlighted by a middle-aged male athlete who sometimes perceives it as resembling a bustling street (Gargiulo, 2020).

Another frequently described social attribute is safety (n=17, 29%). Inadequate facilities contribute to potential safety risks, including a lack of nighttime illumination (Che et al., 2012; Gong et al., 2009; Rakonjac et al., 2022), limited road width, malfunctioning traffic signals, and restricted availability of underground passages (Othman et al., 2021), as well as armoured or concrete steep slopes (Eid et al., 2021). In addition, disorderly individuals at specific locations displaying antisocial behaviours (such as pickpockets, vendors, and intoxicated individuals) and interference from wildlife can evoke fears of accidents and crime (Gargiulo et al., 2020; Hale & Taylor, 1986; Vierikko & Yli-Pelkonen, 2019; Völker & Kistemann, 2013). For example, simultaneous conflicting activities on the same pathway increase awareness of overcrowding and the risk of accidental injuries (Godbey et al., 2005). In contrast, Vert et al. (2019) concluded that most participants per-

ceived riverbank areas as safe, at least during daylight hours. Similarly, older users from Hong Kong did not consider safety a significant concern (Garrett et al., 2019). This may be attributed to the generally good public safety and lower crime rates in Hong Kong. Parents are less likely to allow their children to engage in perceived risky water-related activities such as feeding fish, wading in the water, and climbing (Mansournia et al., 2021).

Only nine studies (15%) described social incivilities, the least studied social variable in the literature. Five studies indicated that many tourists complain about antisocial behaviours exhibited by residents, such as offensive language and disrespectful conduct (Eid et al., 2021; Gargiulo et al., 2020; Vert et al., 2019; Vierikko & Yli-Pelkonen, 2019; Völker & Kistemann, 2013). Specifically, visitors expressed fear of harassment from street vendors (Eid et al., 2021; Völker & Kistemann, 2013), comments and whistling from truck drivers that may cause fear of harassment among female users (Gargiulo et al., 2020). Visitors also conveyed discomfort when sharing the area with dogs, particularly off-leash dogs, as it infringes upon their sense of comfort (Vert et al., 2019). Moreover, other observed uncivil behaviours, including noise, illegal parking, and lack of cleanliness (e.g., littering or dog excrement), have the potential to evoke anger and dissatisfaction, thereby disrupting the overall user experience (Shangi et al., 2020; Smith et al., 2022; Völker & Kistemann, 2013).

3.3.3 Physical attributes

Physical attributes primarily pertain to objects' tangible characteristics and spatial elements (Wang et al., 2019). In this study, the physical factors encompass distance, accessibility, landscape setting, facilities, natural elements (such as vegetation, water, and animals), maintenance/management, weather, and season.

Among the articles included in the review, facilities emerge as the most frequently assessed physical attribute (n=42, 71%). Multiple studies underscore the impact of outdated building facilities, insufficient commercial and entertainment services around the river, lack of continuous and appropriate pathways and lighting, monotonous and uninspiring sightseeing boats, the absence of barrier-free open spaces, and steep banks frequently restrict people's exploration and experiences along river corridors (Chen et al., 2018; Chen et al., 2022; Cheng et al., 2022; Eid et al., 2021; Smith et al., 2022; Vian et al., 2021; Völker & Kistemann, 2013; Wu et al., 2019c). Consequently, individuals tend to gravitate towards areas with well-developed recreational and leisure facilities (Chen & Ma, 2023). Certain studies focus on particular groups, highlighting the lack of facilities for disabled individuals and children along river front roads (Che et al., 2012). In contrast to the built environment, children are more concerned about natural elements (Mansournia et al., 2021). The satisfaction of older adults with urban riverside landscapes is greatly influenced by functional factors such as night time lighting, seating facilities, fitness amenities, and spatial dimensions (Garrett et al., 2019; Gong et al., 2019). Conversely, a survey in Wuhan, China, suggests that people may be more drawn to beautiful natural landscapes rather than prioritizing facilities (Wu et al., 2019a). The reported associations also unveil evident gender differences, with female users exhibiting a higher preference and willingness for riverside areas with a dense distribution of recreational and public service facilities (Wu et al., 2019b).

More than half of the studies (n=40, 68%) described the importance of natural elements such as vegetation, water, and animals. The literature review revealed that people enjoy visiting river corridors to experience natural environments. A woman from Spain said, "The reason I went to the riverside area is that I like rivers, birds, etc." (Vert et al., 2019). This conclusion finds recognition in Asian contexts as well. For instance, a study conducted in Taiwan demonstrated that riverside green belts and lush vegetation can enhance the tourism appeal of urban riverbanks (Chen et al., 2018). Chen and Ma (2023) supported this viewpoint and highlighted a positive correlation between vegetation richness and user activities, such as resting, dog walking, and gardening. However, conflicting results arise from a study in Finland, where natural rivers and riverside vegetation scored lowest among respondents (Vierikko & Yli-Pelkonen, 2019). In Egypt, the imperative for ground vegetation along the Nile waterfront in central Cairo also restricts user access (Eid et al., 2021). Most Europeans prefer diverse, natural, or unmanaged green elements (Jakstis et al., 2023). In Kurd-

istan, children showed considerable enthusiasm for water-related activities and natural elements in urban riversides (Mansournia et al., 2021). Elderly individuals particularly appreciate the natural environmental elements in riversides, especially greenery and river landscapes (Gong et al., 2019). The perception of wildlife's presence contributes to older adults' health and well-being (Garrett et al., 2019).

Research indicated that accessibility (n=28, 46%) and distance (n=17, 29%) significantly impact the utilization and constraints of urban river corridors. Detailed street patterns and travel times may influence the accessibility of rivers (Andersen Cirera, 2022; Luo & Lin, 2023; Othman et al., 2021). Gong et al. (2019) asserted that spatial continuity enhances accessibility. Conversely, a lack of vertical and horizontal social connections with neighbouring communities can diminish the potential utilization of river corridors (Eid et al., 2021). For instance, older adults, engaging more in linear and leisurely walking activities, exhibit a higher demand for spatial continuity (Gong et al., 2019). On the other hand, private ownership or restricted land use along rivers can affect spatial accessibility, as these areas are not open to the public (Andersen Cirera, 2022; Eid et al., 2021; Scott Shafer et al., 2013; Shangi et al., 2020). In addition to spatial accessibility, accessibility includes visual accessibility (Che et al., 2012). The crowded presence of high-rise residential buildings along riverbanks may negatively impact visual accessibility (Che et al., 2012). Notably, higher visual accessibility to water bodies is associated with enhanced vitality (Ding et al., 2023). Lower visual accessibility implies larger spatial enclosure and increased privacy, making it a preferred outdoor activity area. Three studies concluded that convenient public transportation could bring more vibrancy to urban riverside areas (Chen & Ma, 2023; Fan et al., 2021; Niu et al., 2021). However, Liu et al. (2021) presented opposing findings, suggesting that high levels of transportation accessibility may impede riverside vibrancy. Perceived walking distance and actual residential distance are crucial in determining public usage frequency (Völker et al., 2018). For example, river corridors accessible within a 10 to 15-minute walk appear to attract regular visits from older adults (Garrett et al., 2019; Liu et al., 2022), while those farther from the river are less likely to be aware of or utilize such spaces (Haeffner et al., 2017).

Furthermore, 15 studies (25%) identified inadequate maintenance and management as a significant factor limiting the use of urban river corridors. Multiple studies from various regions, such as China, Bangladesh, and Egypt, have indicated that inadequate maintenance and poor management are crucial factors leading to the degradation of river environments and subsequently reducing visitors' usage. These issues encompass water pollution, waste, animal excrement, noise, and harassment from street vendors, among others (Eid et al., 2021; Khairabadi et al., 2023; Shangi et al., 2020; Smith et al., 2022; Vian et al., 2021; Wu et al., 2019c; Zhang et al., 2022b). Regarding management, Zhang et al. (2022b) discovered that visitor centres responsible for guiding functions have low utilization rates and must effectively communicate information about waterfront facilities.

In fact, seasonal landscape variations attract people to explore riversides during different seasons (n=13, 22%), influencing their frequency of use and preferences (Wu et al., 2019a). In Finland, significant differences in socio-demographic characteristics and preferences exist between summer and non-summer visitors (Vierikko & Yli-Pelkonen, 2019). Related to this factor is the weather (n=8, 14%).Spring and summer are typically more suitable for visiting river corridors, possibly due to favourable weather conditions conducive to various outdoor activities (Grzyb & Kulczyk, 2023; Vert et al., 2019). However, challenges may arise in winter due to weather and road conditions (Chen & Ma, 2023; Smith et al., 2022). Some complaints about summer are voiced, citing intense daytime sunlight and a lack of shade along the riverbanks, leading to peak pedestrian flow around 19:00 (Chen & Ma, 2023). Clear weather generally attracts more people to recreational activities and social interactions along urban riverbanks (Grzyb & Kulczyk, 2023). As expressed by a Spanish white woman, "When the weather is not cold, I enjoy picnicking downstream along the river with my children" (Vert et al., 2019).

Moreover, despite limited research attention to this aspect, the impact of landscape settings (n=7, 12%)

on the public's perception and willingness to engage with riverside zones has been underscored. In particular, Liu et al. (2021) posited a positive correlation between site design and the vibrancy of urban riversides. Similarly, Luo et al. (2022) highlighted the importance of integrating and diversifying natural elements to attract a more extensive audience to visit and utilize waterfront spaces. Therefore, for the elderly, thoughtful consideration of the design of stairways and ramps becomes paramount, recognizing that an excessive or monotonous arrangement of these elements could diminish their satisfaction and sense of closeness to the riversides (Garrett et al., 2019; Gong et al., 2019).

4 Discussion

This systematic literature review comprehensively analyses and quantifies the evidence pertaining to the utilization and constraints of urban river corridors on a global scale. A total of 59 eligible studies were identified for analysis. The discussion section, grounded in the social-ecological model, introduces a conceptual framework (Figure 3), comprehensively examining factors influencing the utilization and constraints of urban river corridors from three dimensions: personal attributes, social attributes, and physical attributes. The primary objective of the discussion is to enhance a more comprehensive understanding of how these attributes interact. The study seeks to present a comprehensive overview of the current research status on using urban river corridors and identify existing research gaps, thus offering valuable recommendations for future research endeavours.

4.1 Summary of the current state of research on urban river corridor utilization

The research on urban river corridors is characterized by its multifaceted and interdisciplinary approach, resulting in notable discrepancies in terminology. Among the 59 articles in this study, apart from 23 papers published in journals related to landscape, the rest were disseminated in interdisciplinary journals spanning ecology, city, environment, architecture, geography, health, and engineering. Publishing in cross-disciplinary journals facilitates valuable dialogues and extensions of knowledge related to urban river corridors across diverse disciplines, ultimately promoting terminological standardization. Geographically, the urban river corridor usage research is predominantly concentrated in China. While developing countries show lower utilization rates of urban river corridors, developed countries need more participation in this research. Although English accounts for over 75% of published social science and humanities articles worldwide (Hamel, 2007), it is essential to acknowledge that this study's search was limited to more than three English databases. Exploring non-English journals could broaden the scope of the search and offer additional insights from non-English-speaking countries.

In the collated literature, few articles specifically addressed vulnerable groups' utilization of urban river corridors. Yung et al. (2016) proposed that with declining health conditions, the elderly's activities increasingly rely on their immediate living environment, community amenities, and social engagements, deemed their most critical needs. Children possess unique perspectives and desires regarding urban spaces, and their views should be considered rather than solely relying on parental opinions (Corsaro, 2012). Therefore, to achieve inclusivity, it is crucial to cater to the diverse needs of different age groups and populations (Aram et al., 2019).

Purely quantitative research often faces challenges capturing participants' life experiences (Diriwächter & Valsiner, 2006), whereas purely qualitative research can only reflect participants' experiences (Tenny et al., 2017). In contrast, mixed research methods incorporate both quantitative and qualitative data, which enhance the validity and credibility of findings and avoid the limitations and biases of relying solely on a single research technique (George, 2022). However, only approximately one-fifth of the studies embraced this comprehensive methodology. Beyond conventional data collection approaches, recent advancements in mobile technology have facilitated the analysis of urban residents' spatial behaviours and the exploration of interactions between individuals and urban public spaces through social media data (Eagle & Pentland, 2005; Wu et al., 2018; Wu et al., 2019b). Regarding sampling methods,

over two-fifths of the articles did not describe their sampling methods. Sampling is a crucial research component, as the study outcomes largely depend on the chosen sampling technique. Therefore, it is essential to select appropriate and well-described sampling techniques to obtain accurate results or make reliable estimations of the overall population.

4.2 Personal attributes

Individuals are at the core of the social-ecological model (Dai et al., 2022). Examining personal attributes (Box 1, Figure. 3) in the utilization of urban river corridors has provided valuable insights into the diverse factors influencing individuals' engagement with these spaces. Despite the multifaceted nature of the findings, several key themes emerge, including age, motivation, gender, frequency of visitation/familiarity, residence, educational level, duration of stay, time of the day, transportation modalities, and less-studied variables such as socioeconomic status, employment or occupation, family structure, health status, ethnicity or race, marital status, and unique factors like dog ownership, and swimming proficiency. The complexity of individual attributes underscores the need for comprehensive, context-specific strategies to accommodate diverse preferences and needs within urban populations. Applying these findings to research or spatial planning further informs the development of more inclusive and targeted urban green spaces.

Most studies indicated that age and gender play a significant role in determining the utilization of urban river corridors, closely linked to their motivations for visiting. Adults consistently constitute the primary user group, primarily engaging in physical exercise and leisure activities along urban river corridors. In contrast, due to health considerations, older individuals tend to participate in lighter physical and social activities such as walking or social gatherings, benefitting from flexible and frequent visitation post-retirement. Conversely, children and adolescents prefer more stimulating and exploratory activities, often requiring parental supervision for safety reasons. The inherent attraction to riverfronts is universal, providing a natural environment that induces tranquility and relaxation (Shi et al., 2023; Wang, 2011). Frequent exposure to outdoor blue-green spaces improves mental health and happiness and increases physical activity levels (Gascon et al., 2017). While some studies suggest a slightly higher number of female users, overall, women tend to spend less time in these spaces than men when considering the overall usage patterns of urban river corridors day and night. This pattern aligns with prior research indicating that women exhibit a lower frequency of use in open public spaces (Navarrete-Hernandez et al., 2021). Reasons for this phenomenon may be associated with women's concerns about personal safety and the lack of leisure time due to household responsibilities. Women's fear, often rooted in a widespread fear of male aggression, limits their outdoor activities (Pain, 1997). Additionally, societal pressure on women to be exemplary mothers and wives may hinder their leisure participation (Day, 2000; Gargiulo et al., 2020). The impact of residence on usage is complex, with a negative correlation between homeownership and usage frequency. Previous studies confirmed that in urban green spaces, more frequent visits to specific areas foster increased familiarity with the surrounding environment and fellow users (Sreetheran & Van Den Bosch, 2014). Longitudinal residency is positively associated with familiarity and positive interactions, emphasizing the importance of community connections. While walking is the primary mode of accessing urban river corridors, concerns about traffic connectivity may arise for those residing farther from the river (Dai et al., 2022). It is well known that the frequency of use of these spaces decreases with increasing distance from the urban riverfront (Völker & Kistemann, 2013). Utilizing urban river corridors implies direct and purposeful contact with water, and optimal water quality contributes to a more pleasurable psychological experience (Völker & Kistemann, 2013). In addition, the correlation between extended stay durations and higher environmental quality indicates potential focal points for creating attractive urban river corridors. The influence of education on river corridor utilization remains inconclusive, with only one study showing significant findings. However, individuals with higher education levels often enjoy higher socioeconomic status and better employment conditions, making them more likely to spend time along local riversides, benefiting from various interactive experiences. Apart from the attributes

mentioned above, time factors, such as time points, daytime or nighttime, weekdays or weekends have significantly shaped public behaviour and experiences. Variations in usage patterns between weekends and weekdays have been identified regarding time. Studies suggested that river corridor vitality is higher during weekends, potentially associated with individuals having more leisure time and interest in visiting riverfront areas on rest days (Ding et al., 2023; Liu et al., 2021; Wu et al., 2019b). However, research remains controversial regarding daytime and nighttime visits, which may result in the safety issues they are concerned about at night, especially for women. Furthermore, less-studied variables like family structure, health status, race or ethnicity, marital status, dog ownership, and swimming proficiency offer nuanced insights. For instance, single elderly individuals may require more attention from researchers as they might encounter more physical limitations and experience higher loneliness when using urban river corridors. Awareness of adverse marital conditions may lead to psychological distress (Dai et al., 2022). These aspects may necessitate more inclusive universal design elements to enhance the accessibility, safety, comfort, and social engagement of urban river corridor environments (Magrinyà et al., 2023).

4.3 Social attributes

Social attributes (Box 2, Figure. 3) refer to individuals' social-psychological processes when interacting with others, society, and nature during social practice activities (Dai et al., 2022; Sreetheran & Van Den Bosch, 2014). The literature indicated that the social factors affecting the usage of urban river corridors include sociability, safety, and social incivilities. High levels of neighbourhood social cohesion foster positive interactions and provide experiential enhancements in cognition, emotion, socialization, and spirituality (Haeffner et al., 2017; Vert et al., 2019; Völker & Kistemann, 2013; Xie et al., 2023). Recognizing the importance of family, partners, and friends interacting during leisure time contributes to underscoring these spaces' multifunctional role. For instance, interpersonal communication among frequent park visitors may reduce susceptibility to crime and uncivil behaviours in such environments (Westover, 1985). Safety concerns are crucial in shaping users' perceptions of urban river corridors. Factors ranging from inadequate facilities to antisocial behaviours influence overall safety perceptions. However, some researchers argue that crime is not a prominent safety issue, which may be attributed to the overall improvement in societal security and the decline in crime rates over time (Garrett et al., 2019). Although research on social incivilities is limited, their impact on the user experience is noteworthy. Concerns about littering, noise, offensive language, disrespectful behaviour, and dog interactions contribute to a nuanced understanding of potential stressors. Integrating safety measures, fostering social interactions, and addressing social incivilities are integral to developing inclusive and vibrant urban river corridors. These synthesized insights offer feasible strategies to enhance the user experience and promote the overall well-being of urban communities.

4.4 Physical attributes

This paper defines physical attributes (Box 3, Figure. 3) as the objective and perceived characteristics of the physical environment, including artificial facilities and natural elements, landscape setting, maintenance and management conditions, distance, accessibility, season, and weather that impact the usage of urban river corridors. Among these attributes, facilities emerge as the most extensively discussed aspect, whether positive or negative. Most research findings indicate that people tend to be drawn to well-equipped facilities and pleasant natural surroundings, while chaotic environments may lead to aversion (Chen & Ma, 2023; Eid et al., 2021; Shangi et al., 2020; Shi et al., 2023; Wu et al., 2019c). For example, poor service facilities (such as building facilities around rivers or commercial areas, insufficient recreational services, lack of continuity of access, insufficient lighting, etc.) may not meet the needs of the public. Additionally, there is a strong interest in natural elements. Residents frequently visit riverbanks to interact with flora and fauna, and these activities promote physical activity and social cohesion and help enhance mental health (Vert et al., 2019). Furthermore, landscape setting plays a crucial role in the utilization and attractiveness of urban river corridors despite limited research at-

tention. It is generally accepted that implementing less intensive semi-natural management strategies, such as reducing mowing frequency, can lead to positive outcomes for vegetation and overall biodiversity (Chollet et al., 2018; Negrini & Walford, 2022). Nonetheless, urban river corridors should prioritize cleanliness, safety, and well-maintained facilities to provide visitors with charming scenery and pleasant experiences. Because inadequate maintenance and poor management may reduce usability and thus reduce visits (Sreetheran & Van Den Bosch, 2014; Zelinka & Brennan, 2001). These issues encompass water pollution, waste, animal excrement, noise, and harassment from street vendors, among others (Eid et al., 2021; Shangi et al., 2020; Wu et al., 2019c; Zhang et al., 2022b). Therefore, management personnel should engage in practical and thoughtful maintenance and management practices in urban river corridors to enhance their appeal and encourage public usage (Smith et al., 2022).

The literature extensively deliberates on the distance and accessibility of urban river corridors. Accessibility concerns encompass issues of distance, traffic conditions, and spatial continuity. Research indicates that river corridors within walking distance within a range of 10 to 15 minutes appear more conducive to regular visits by seniors; however, beyond this distance, their usage diminishes rapidly (Garrett et al., 2019). On the other hand, transportation also influences the frequency and likelihood of residents visiting. Enhancements in transportation convenience contribute to increased accessibility of river corridors, attracting more residents for utilization and interaction (Chen & Ma, 2023; Fan et al., 2021; Niu et al., 2021; Othman et al., 2021). Moreover, studies suggest that high-rise residential structures along riverbanks may compress the space visually, potentially leading to poorer visual accessibility and impacting residents' perception and attraction toward river corridors (Che et al., 2012). Considering the social connections of surrounding communities and designing integrated riverfront spaces with expansive water vistas can offer residents an enhanced outdoor experience, elevating the allure and utilization potential of such areas (Eid et al., 2021).

While this review does reveal associations between weather, seasons, and the usage of urban river corridors, only a few studies have explicitly examined this relationship. People's preferences for outdoor activities in pleasant weather underscore the potential negative impact of unfavourable weather conditions on public behaviour. Riverfront activities peak during spring and summer in temperate regions due to favourable weather and organized events. Overcoming seasonal disparities requires increased emphasis on promoting tourism during the off-peak periods. Overall, understanding the influence of these factors on public habits and preferences facilitates urban planners and managers in better organizing activities and optimizing facilities and services to meet diverse user needs across different season and weather conditions.

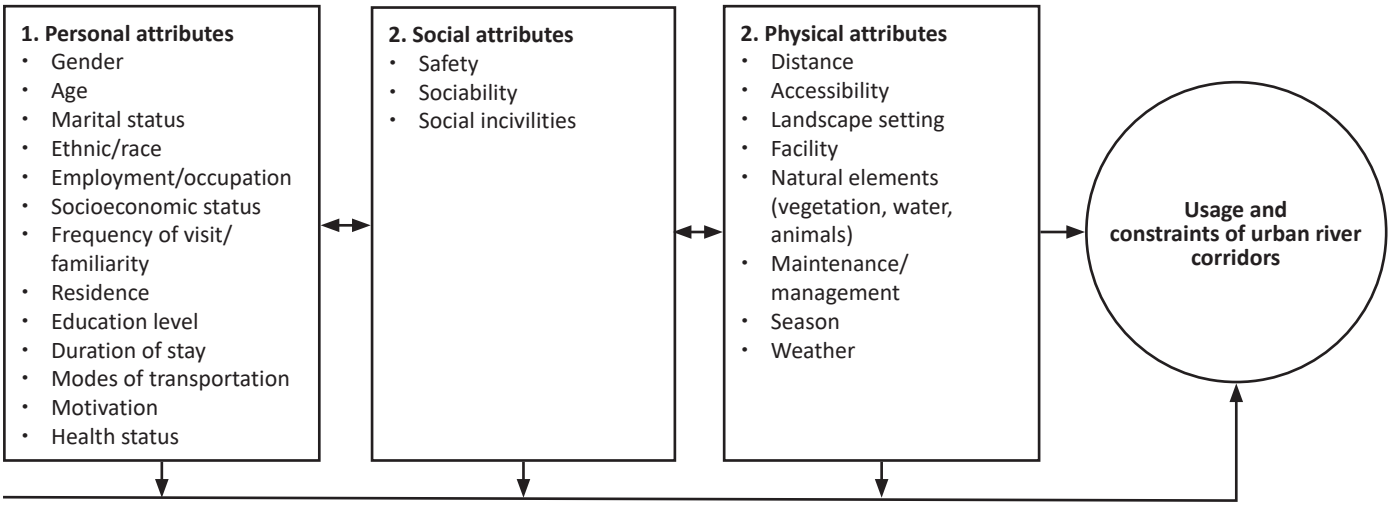

Figure 3. A conceptual framework for analysing the usage and constraints of urban river corridors based on social ecology approach.

The theoretical framework of social ecology directs attention to individuals and highlights the multi-level interaction between people and their environment (Walmsley & Lewis, 2014). The social and physical environment influence individual behaviour; conversely, the actions of individuals, groups, and organizations can also impact the social and physical environment (Dunlap & Catton, 1983). Environmental conditions can shape or constrain human behaviour, and environmental modifications can change specific behaviours. As a result, achieving more effective outcomes necessitates interventions tailored to the distinct contexts of human-environment interactions.

5 Limitation of the review

This study presents a preliminary review of current research on the usage and constraints of urban river corridors, representing the first attempt to synthesize the literature using a socio-ecological framework. However, there are still some limitations when analysing these articles. Firstly, the literature retrieval methods and database selection have inherent limitations, which may result in potential omissions in literature coverage. The search was confined to publications in English, potentially excluding relevant studies in other languages. Despite employing comprehensive inclusion criteria during the search, it remains possible to overlook essential articles due to the omission of relevant keywords or the unavailability of complete texts for specific previous papers. Notably, no peer-reviewed articles on the usage of urban river corridors were published before 2012. Secondly, most studies infrequently addressed ethical considerations, and some articles lacked comprehensive information regarding study limitations or recommendations for future research. Finally, the reliance on students or experts as respondents in some studies, supported by Stamps (1999), may introduce biases based on age, profession, and education level. In conclusion, despite the constraints related to literature sources, quality evaluation, and sample representativeness, this study is a valuable reference for exploring information concerning the public utilization of urban river corridors.

6 Conclusion

River corridors are essential components of most cities. Exploring how users engage with these urban river corridors and understanding the associated constraints hold significant implications for the planning and management of such spaces. This endeavour contributes to creating sustainable urban waterfront areas that cater to the diverse needs of residents. This paper contributes to the existing knowledge base of urban river landscapes by systematically reviewing how users engage with urban river corridors and the constraints associated with these experiential interactions. It demonstrates that scholarly attention to the usage of urban river corridors has predominantly emerged in the past five years, highlighting it as an emerging research topic. Furthermore, the results show that individual, social, and physical attributes, play crucial and multidimensional roles in shaping the utilization of urban river corridors. These findings align with the proposed socio-ecological framework, emphasizing the intricate interplay of these attributes. While specific attributes may not universally apply across diverse cultures, additional research in different global regions is essential. Understanding usage patterns driven by socio-ecological embeddedness can aid in balancing user experiences with river resilience, minimizing conflicts among diverse user groups. Therefore, future research should delve deeper into the intricate interdependencies among attributes that influence the use of urban river corridors and formulate targeted construction plans to enhance human health and well-being in the urban environment.

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Declaration of Competing Interest

The authors declare no conflict of interest.

References

Andersen Cirera, K. (2022). Spatial Equity in River Access. Measuring the Public Space Potential of Urban Riverbanks in Valdivia, Chile. International Journal of Sustainable Development & Planning, 17(1). https://doi.org/10.18280/ijsdp.170101

Aram, F., Solgi, E., & Holden, G. (2019). The role of green spaces in increasing social interactions in neighborhoods with periodic markets. Habitat International, 84, 24-32. https://doi.org/10.1016/j.habitatint.2018.12.004

Baschak, L. A., & Brown, R. D. (1995). An ecological framework for the planning, design and management of urban river greenways. Landscape and urban planning, 33(1-3), 211-225. https://doi.org/10.1016/0169-2046(94)02019-C

Beatley, T. (2000). Preserving biodiversity: Challenges for planners. Journal of the American Planning Association, 66(1), 5-20. https://doi.org/10.1080/01944360008976080

Bennett, G., & Mulongoy, K. J. (2006). Review of experience with ecological networks, corridors and buffer zones. In Secretariat of the convention on biological diversity, Montreal, Technical Series (Vol. 23, p. 100).

Best, J. (2019). Anthropogenic stresses on the world's big rivers. Nature Geoscience, 12(1), 7-21. https://doi.org/10.1038/s41561-018-0262-x

Börger, T., Campbell, D., White, M. P., Elliott, L. R., Fleming, L. E., Garrett, J. K., ... & Taylor, T. (2021). The value of blue-space recreation and perceived water quality across Europe: A contingent behaviour study. Science of the Total Environment, 771, 145597. https://doi.org/10.1016/j.scitotenv.2021.145597

Che, S.Q. (2001). Study on the Green Corridors in Urbanized Areas. Urban Ecological Study, 25(11), 44-48.

Che, Y., Yang, K., Chen, T., & Xu, Q. (2012). Assessing a riverfront rehabilitation project using the comprehensive index of public accessibility. Ecological Engineering, 40, 80-87. https://doi.org/10.1016/j.ecoleng.2011.12.008

Chen, L., & Ma, Y. (2023). How do ecological and recreational features of waterfront space affect its vitality? developing coupling coordination and enhancing waterfront vitality. International Journal of Environmental Research and Public Health, 20(2), 1196. https://doi.org/10.3390/ijerph20021196

Chen, M. S., Ko, Y. T., & Lee, L. H. (2018). The relation between urban riverbank reconstruction and tourism attractiveness shaping-A case study of love river in kaohsiung, taiwan. Journal of Asian Architecture and Building Engineering, 17(2), 353-360. https://doi.org/10.3130/jaabe.17.353

Chen, Y., Jia, B., Wu, J., Liu, X., & Luo, T. (2022). Temporal and Spatial Attractiveness Characteristics of Wuhan Urban Riverside from the Perspective of Traveling. Land, 11(9), 1434. https://doi.org/10.3390/land11091434

Cheng, S., Zhai, Z., Sun, W., Wang, Y., Yu, R., & Ge, X. (2022). Research on the Satisfaction of Beijing Waterfront Green Space Landscape Based on Social Media Data. Land, 11(10), 1849. https://doi.org/10.3390/land11101849

Chollet, S., Brabant, C., Tessier, S., & Jung, V. (2018). From urban lawns to urban meadows: Reduction of mowing frequency increases plant taxonomic, functional and phylogenetic diversity. Landscape and Urban Planning, 180, 121-124. https://doi.org/10.1016/j.landurbplan.2018.08.009

Corsaro, W. A. (2012). Interpretive Reproduction in Children's Play. American Journal of Play, 4(4), 488-504.

Crowe, M. (2013). Crowe Critical Appraisal Tool (CCAT) User Guide Version 1.4. Creative Commons Attribution, Townsville.

Crowe, M., & Sheppard, L. (2011). A general critical appraisal tool: an evaluation of construct validity. International journal of nursing studies, 48(12), 1505-1516. https://doi.org/10.1016/j.ijnurstu.2011.06.004

Crowe, M., Sheppard, L., & Campbell, A. (2011). Comparison of the effects of using the Crowe Critical Appraisal Tool versus informal appraisal in assessing health research: a randomised trial. International Journal of Evidence-Based Healthcare, 9(4), 444-449. https://doi.org/10.1111/j.1744-1609.2011.00237.x

Ćwik, A., Wójcik, T., Ziaja, M., Wójcik, M., Kluska, K., & Kasprzyk, I. (2021). Ecosystem services and disservices of vegetation in recreational urban blue-green spaces—Some recommendations for greenery shaping. Forests, 12(8), 1077. https://doi.org/10.3390/f12081077

Dai C.Y., Maruthaveeran, S., & Shahidan, M. F. (2022). The usage, constraints and preferences of green space at disadvantage neighborhood: A review of empirical evidence. Urban Forestry & Urban Greening, 75, 127696. https://doi.org/10.1016/j.ufug.2022.127696

Day, K. (2000). The ethic of care and women's experiences of public space. Journal of environmental psychology, 20(2), 103-124. https://doi.org/10.1006/jevp.1999.0152

Ding, J., Luo, L., Shen, X., & Xu, Y. (2023). Influence of built environment and user experience on the waterfront vitality of historical urban areas: A case study of the Qinhuai River in Nanjing, China. Frontiers of Architectural Research, 12(5), 820-836. https://doi.org/10.1016/j.foar.2023.05.004

Diriwächter, R., & Valsiner, J. (2006). Qualitative developmental research methods in their historical and epistemological contexts. In Forum Qualitative Sozialforschung/Forum: Qualitative Social Research (Vol. 7, No. 1). https://doi.org/10.17169/fqs-7.1.72

Djukić, A., Marić, J., Antonić, B., Kovač, V., Joković, J., & Dinkić, N. (2020). The evaluation of urban renewal waterfront development: The case of the Sava riverfront in Belgrade, Serbia. Sustainability, 12(16), 6620. https://doi.org/10.3390/su12166620

Dunlap, R. E., & Catton Jr, W. R. (1983). What environmental sociologists have in common (whether concerned with "built" or "natural" environments). Sociological inquiry, 53(2-3), 113-135. https://doi.org/10.1111/j.1475-682X.1983.tb00030.x

Eagle, N., & Pentland, A. (2005). Social serendipity: Mobilizing social software. IEEE Pervasive computing, 4(2), 28-34. https://doi.org/10.1109/MPRV.2005.37

Eid, S., Khalifa, M., & Abd Elrahman, A. S. (2021). Biophilic perceptions in the urban waterfront: analytical study of the Nile waterfront in central cairo. HBRC Journal, 17(1), 19-39. https://doi.org/10.1080/16874048.2021.1872052

Fan, Y., Kuang, D., Tu, W., & Ye, Y. (2023). Which Spatial Elements Influence Waterfront Space Vitality the Most?—A Comparative Tracking Study of the Maozhou River Renewal Project in Shenzhen, China. Land, 12(6), 1260. https://doi.org/10.3390/land12061260

Fan, Z., Duan, J., Luo, M., Zhan, H., Liu, M., & Peng, W. (2021). How did built environment affect urban vitality in urban waterfronts? A case study in Nanjing Reach of Yangtze River. ISPRS International Journal of Geo-Information, 10(9), 611. https://doi.org/10.3390/ijgi10090611

Forman, R. T. (1995). Land mosaics: the ecology of landscapes and regions. Cambridge university press.

Freeman, C., & Tranter, P. (2012). Children and their urban environment: Changing worlds. Routledge.

Garcia, X., Benages-Albert, M., Pavón, D., Ribas, A., Garcia-Aymerich, J., & Vall-Casas, P. (2017). Public participation GIS for assessing landscape values and improvement preferences in urban stream corridors. Applied Geography, 87, 184-196. https://doi.org/10.1016/j.apgeog.2017.08.009

Garcia, X., Gottwald, S., Benages-Albert, M., Pavón, D., Ribas, A., & Vall-Casas, P. (2020). Evaluating a web-based PPGIS for the rehabilitation of urban riparian corridors. Applied geography, 125, 102341. https://doi.org/10.1016/j.apgeog.2020.102341

Gargiulo, I., Benages-Albert, M., Garcia, X., & Vall-Casas, P. (2020). Perception assessment of environmental factors related to leisure-time physical activity in an urban stream corridor. Leisure Studies, 39(5), 688-705. https://doi.org/10.1080/02614367.2020.1743742

Garrett, J. K., White, M. P., Huang, J., Ng, S., Hui, Z., Leung, C., ... & Wong, M. C. (2019). Urban blue space and health and wellbeing in Hong Kong: Results from a survey of older adults. Health and place, 55, 100-110. https://doi.org/10.1016/j.healthplace.2018.11.003

Garside, R. (2014). Should we appraise the quality of qualitative research reports for systematic reviews, and how? Innovation: The European Journal of Social Science Research, 27(1), 67-79. https://doi.org/10.1080/13511610.2013.777270

Gascon, M., Zijlema, W., Vert, C., White, M. P., & Nieuwenhuijsen, M. J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. International journal of hygiene and environmental health, 220(8), 1207-1221. https://doi.org/10.1016/j.ijheh.2017.08.004

George, T. (2022). Mixed Methods Research | Definition, Guide and Examples. Scribbr. https://www.scribbr.com/methodology/mixed-methods-research/

Giannakis, E., Bruggeman, A., Poulou, D., Zoumides, C., & Eliades, M. (2016). Linear parks along urban rivers: Perceptions of thermal comfort and climate change adaptation in Cyprus. Sustainability, 8(10), 1023. https://doi.org/10.3390/su8101023

Glanz, K., Rimer, B. K., & Viswanath, K. (eds.). (2008). Health behavior and health education: theory, research, and practice. John Wiley and Sons.

Godbey, G. C., Caldwell, L. L., Floyd, M., & Payne, L. L. (2005). Contributions of leisure studies and recreation and park management research to the active living agenda. American journal of preventive medicine, 28(2), 150-158. https://doi.org/10.1016/j.amepre.2004.10.027

Gong, M., Ren, M., Dai, Q., & Luo, X. (2019). Aging-suitability of urban waterfront open spaces in gongchen bridge section of the grand canal. Sustainability, 11(21), 6095. https://doi.org/10.3390/su11216095

Grzyb, T., & Kulczyk, S. (2023). How do ephemeral factors shape recreation along the urban river? A social media perspective. Landscape and Urban Planning, 230, 104638. https://doi.org/10.1016/j.landurbplan.2022.104638

Guimarães, L. F., Teixeira, F. C., Pereira, J. N., Becker, B. R., Oliveira, A. K. B., Lima, A. F., ... & Miguez, M. G. (2021). The challenges of urban river restoration and the proposition of a framework towards river restoration goals. Journal of Cleaner Production, 316, 128330. https://doi.org/10.1016/j.jclepro.2021.128330

Guo, Y., Fu, B., Wang, Y., Xu, P., & Liu, Q. (2022). Identifying spatial mismatches between the supply and demand of recreation services for sustainable urban river management: a case study of Jinjiang River in Chengdu, China. Sustainable Cities and Society, 77, 103547. https://doi.org/10.1016/j.scs.2021.103547

Haeffner, M., Jackson-Smith, D., Buchert, M., & Risley, J. (2017). Blue" space accessibility and interactions: Socio-economic status, race, and urban waterways in Northern Utah. Landsc. Urban Plan, 167, 136-146.

Hale, M. A. R. G. A. R. E. T., & Taylor, R. (1986). Testing Alternatives models of fear of crime'. The Journal of Criminal Law and criminology, 151-189.

Hamel, R. E. (2007). The dominance of English in the international scientific periodical literature and the future of language use in science. Aila Review, 20(1), 53-71. https://doi.org/10.1075/aila.20.06ham

Hathway, E. A., & Sharples, S. (2012). The interaction of rivers and urban form in mitigating the Urban Heat Island effect: A UK case study. Building and environment, 58, 14-22. https://doi.org/10.1016/j.buildenv.2012.06.013

Jakstis, K., Dubovik, M., Laikari, A., Mustajärvi, K., Wendling, L., & Fischer, L. K. (2023). Informing the design of urban green and blue spaces through understanding Europeans' usage and preferences. People and Nature, 5(1), 162-182. https://doi.org/10.1002/pan3.10419

Janiszek, M., & Krzysztofik, R. (2023). Green Infrastructure as an Effective Tool for Urban Adaptation—Solutions from a Big City in a Postindustrial Region. Sustainability, 15(11), 8928. https://doi.org/10.3390/su15118928

Ji, P., Zhu, C.Y., & Li, S.H. (2012). Effects of the different structures of green belts on the temperature and humidity in river corridors. Scientia Silvae Sinicae, 48(3), 58-65.

Kenwick, R. A., Shammin, M. R., & Sullivan, W. C. (2009). Preferences for riparian buffers. Landscape and Urban Planning, 91(2), 88-96. https://doi.org/10.1016/j.landurbplan.2008.12.005

Khairabadi, O., Shirmohamadi, V., & Sajadzadeh, H. (2023). Understanding the mechanism of regenerating urban rivers through exploring the lived experiences of residents: A case study of Abbas Abad river in Hamadan. Environmental Development, 45, 100801. https://doi.org/10.1016/j.envdev.2023.100801

Liu, D., Kwan, M. P., Kan, Z., & Wang, J. (2022). Toward a healthy urban living environment: Assessing 15-minute green-blue space accessibility. Sustainability, 14(24), 16914. https://doi.org/10.3390/su142416914

Liu, S., Lai, S. Q., Liu, C., & Jiang, L. (2021). What influenced the vitality of the waterfront open space? A case study of Huangpu River in Shanghai, China. Cities, 114, 103197. https://doi.org/10.1016/j.cities.2021.103197

Liu, X., Chen, X., Huang, Y., Wang, W., Zhang, M., & Jin, Y. (2023). Landscape Aesthetic Value of Waterfront Green Space Based on Space–Psychology–Behavior Dimension: A Case Study along Qiantang River (Hangzhou Section). International Journal of Environmental Research and Public Health, 20(4), 3115. https://doi.org/10.3390/ijerph20043115

Luo, H., Deng, L., Song, C., Jiang, S., Huang, Y., Wang, W., ... & Li, X. (2022). Which characteristics and integrations between characteristics in blue–green spaces influence the nature experience? Journal of Environmental Planning and Management, 66(6), 1253-1279. https://doi.org/10.1080/09640568.2022.2026307

Luo, Y., & Lin, Z. (2023). Spatial Accessibility Analysis and Optimization Simulation of Urban Riverfront Space Based on Space Syntax and POIs: A Case Study of Songxi County, China. Sustainability, 15(20), 14929. https://doi.org/10.3390/su152014929

Magrinyà, F., Mercadé-Aloy, J., & Ruiz-Apilánez, B. (2023). Merging Green and Active Transportation Infrastructure towards an Equitable Accessibility to Green Areas: Barcelona Green Axes. Land, 12(4), 919. https://doi.org/10.3390/land12040919

Mansournia, S., Bahrami, B., Farahani, L. M., & Aram, F. (2021). Understanding children's perceptions and activities in urban public spaces: The case study of Zrêbar Lake Waterfront in Kurdistan. Urban Studies, 58(2), 372-388. https://doi.org/10.1177/0042098020903008

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. Health education quarterly, 15(4), 351-377. https://doi.org/10.1177/109019818801500401

Meng, S., Huang, Q., Zhang, L., He, C., Inostroza, L., Bai, Y., & Yin, D. (2020). Matches and mismatches between the supply and demand for cultural ecosystem services in rapidly urbanizing watersheds: A case study in the Guanting Reservoir basin, China. Ecosystem Services, 45, 101156. https://doi.org/10.1016/j.ecoser.2020.101156

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Altman, D., Antes, G., ... & Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement (Chinese edition). Journal of Chinese Integrative Medicine, 7(9), 889-896. https://doi.org/10.3736/jcim20090918

Navarrete-Hernandez, P., Vetro, A., & Concha, P. (2021). Building safer public spaces: Exploring gender difference in the perception of safety in public space through urban design interventions. Landscape and Urban Planning, 214, 104180. https://doi.org/10.1016/j.landurbplan.2021.104180

Negrini, C., & Walford, N. (2022). A stroll in the park, a view of water: Quantifying older people's interaction with 'green'and 'blue'spaces in urban areas. Applied Geography, 149, 102808. https://doi.org/10.1016/j.apgeog.2022.102808

Nguyen, T. T., Ngo, H. H., Guo, W., Wang, X. C., Ren, N., Li, G., ... & Liang, H. (2019). Implementation of a specific urban water management-Sponge City. Science of the Total Environment, 652, 147-162. https://doi.org/10.1016/j.scitotenv.2018.10.168

Nguyen, T. T., Meurk, C., Benavidez, R., Jackson, B., & Pahlow, M. (2021). The effect of blue-green infrastructure on habitat connectivity and biodiversity: a case study in the Ōtākaro/Avon River catchment in Christchurch, New Zealand. Sustainability, 13(12), 6732. https://doi.org/10.3390/su13126732

Niu, Y., Mi, X., & Wang, Z. (2021). Vitality evaluation of the waterfront space in the ancient city of Suzhou. Frontiers of Architectural Research, 10(4), 729-740. https://doi.org/10.1016/j.foar.2021.07.001

Oertli, B., & Parris, K. M. (2019). Toward management of urban ponds for freshwater biodiversity. Ecosphere, 10(7), e02810. https://doi.org/10.1002/ecs2.2810

Othman, A., Al-Hagla, K., & Hasan, A. E. (2021). The impact of attributes of waterfront accessibility on human well-being: Alexandria Governorate as a case study. Ain Shams Engineering Journal, 12(1), 1033-1047. https://doi.org/10.1016/j.asej.2020.08.018

Ouyang, P., & Wu, X. (2023). Analysis and Evaluation of the Service Capacity of a Waterfront Public Space Using Point-of-Interest Data Combined with Questionnaire Surveys. Land, 12(7), 1446. https://doi.org/10.3390/land12071446

Pain, R. (1997). Whither women's fear? Perceptions of sexual violence in public and private space. International Review of Victimology, 4(4), 297-312. https://doi.org/10.1177/026975809700400404

Paneerchelvam, P. T., Maruthaveeran, S., Maulan, S., & Shukor, S. F. A. (2020). The use and associated constraints of urban greenway from a socioecological perspective: A systematic review. Urban forestry & urban greening, 47, 126508. https://doi.org/10.1016/j.ufug.2019.126508

Pouya, S., & Baskaya, F. A. T. (2018). Residents' Perceptions of Riverine Landscape Changes; Case Study of Beykoz Stream/Istanbul. Anadolu University Journal of Science and Technology A-Applied Sciences and Engineering, 19(2), 253-266. https://doi.org/10.18038/aubtda.336959

Rakonjac, I., Zorić, A., Rakonjac, I., Milošević, J., Marić, J., & Furundžić, D. (2022). Increasing the livability of open public spaces during nighttime: The importance of lighting in waterfront areas. Sustainability, 14(10), 6058. https://doi.org/10.3390/su14106058

Rantanen, T., Portegijs, E., Viljanen, A., Eronen, J., Saajanaho, M., Tsai, L. T., ... & Rantakokko, M. (2012). Individual and environmental factors underlying life space of older people–study protocol and design of a cohort study on life-space mobility in old age (LISPE). BMC public health, 12, 1-17. https://doi.org/10.1186/1471-2458-12-1018

Remondi, F., Burlando, P., & Vollmer, D. (2016). Exploring the hydrological impact of increasing urbanisation on a tropical river catchment of the metropolitan Jakarta, Indonesia. Sustainable Cities and Society, 20, 210-221. https://doi.org/10.1016/j.scs.2015.10.001

Scott, M., Lennon, M., Haase, D., Kazmierczak, A., Clabby, G., & Beatley, T. (2016). Nature-based solutions for the contemporary city/Re-naturing the city/Reflections on urban landscapes, ecosystems services and nature-based solutions in cities/Multifunctional green infrastructure and climate change adaptation: Brownfield greening as an adaptation strategy for vulnerable communities?/ Delivering green infrastructure through planning: Insights from practice in Fingal, Ireland/Planning for biophilic cities: From theory to practice. Planning Theory & Practice, 17(2), 267-300. https://doi.org/10.1080/14649357.2016.1158907

Scott Shafer, C., Scott, D., Baker, J., & Winemiller, K. (2013). Recreation and amenity values of urban stream corridors: Implications for green infrastructure. Journal of urban design, 18(4), 478-493. https://doi.org/10.1080/13574809.2013.800450

Shangi, Z. A. D., Hasan, M. T., & Ahmad, M. I. (2020). Rethinking Urban Waterfront as a Potential Public Open Space: Interpretative Framework of Surma Waterfront. Architecture Research, 10(3), 69-74. ttps://doi.org/10.5923/j.arch.20201003.01

Shi, J., Dai, X., Sun, Z., Liu, M., & Tang, D. (2023). Exploring the Determinants and Consequences of Public Satisfaction with Urban Waterfronts: A Case Study of the Xuhui Waterfront in Shanghai, China. Journal of Urban Planning and Development, 149(2), 04023005. https://doi.org/10.1061/JUPDDM.UPENG-4139

Smith, N., Georgiou, M., King, A. C., Tieges, Z., & Chastin, S. (2022). Factors influencing usage of urban blue spaces: A systems-based approach to identify leverage points. Health & Place, 73, 102735. https://doi.org/10.1016/j.healthplace.2021.102735

Sreetheran, M., & Van Den Bosch, C. C. K. (2014). A socio-ecological exploration of fear of crime in urban green spaces–A systematic review. Urban Forestry & Urban Greening, 13(1), 1-18. https://doi.org/10.1016/j.ufug.2013.11.006

Tenny, S., Brannan, J. M., & Brannan, G. D. (2017). Qualitative study.

Vaeztavakoli, A., Lak, A., & Yigitcanlar, T. (2018). Blue and green spaces as therapeutic landscapes: health effects of urban water canal areas of Isfahan. Sustainability, 10(11), 4010. https://doi.org/10.3390/su10114010

Van Hecke, L., Deforche, B., Van Dyck, D., De Bourdeaudhuij, I., Veitch, J., & Van Cauwenberg, J. (2016). Social and physical environmental factors influencing adolescents' physical activity in urban public open spaces: A qualitative study using walk-along interviews. PloS one, 11(5), e0155686. https://doi.org/10.1371/journal.pone.0155686

van Heezik, Y., Freeman, C., Falloon, A., Buttery, Y., & Heyzer, A. (2021). Relationships between childhood experience of nature and green/blue space use, landscape preferences, connection with nature and pro-environmental behavior. Landscape and Urban Planning, 213, 104135. https://doi.org/10.1016/j.landurbplan.2021.104135

Vermaat, J. E., Wagtendonk, A. J., Brouwer, R., Sheremet, O., Ansink, E., Brockhoff, T., ... & Hering, D. (2016). Assessing the societal benefits of river restoration using the ecosystem services approach. Hydrobiologia, 769, 121-135. https://doi.org/10.1007/s10750-015-2482-z

Vert, C., Carrasco-Turigas, G., Zijlema, W., Espinosa, A., Cano-Riu, L., Elliott, L. R., ... & Gascon, M. (2019). Impact of a riverside accessibility intervention on use, physical activity, and wellbeing: A mixed methods pre-post evaluation. Landscape and urban planning, 190, 103611. https://doi.org/10.1016/j.landurbplan.2019.103611

Vian, F. D., Izquierdo, J. J. P., & Martínez, M. S. (2021). River-city recreational interaction: A classification of urban riverfront parks and walks. Urban Forestry & Urban Greening, 59, 127042. https://doi.org/10.1016/j.ufug.2021.127042

Vierikko, K., & Yli-Pelkonen, V. (2019). Seasonality in recreation supply and demand in an urban lake ecosystem in Finland. Urban Ecosystems, 22, 769-783. https://doi.org/10.1007/s11252-019-00849-7

Völker, S., Heiler, A., Pollmann, T., Claßen, T., Hornberg, C., & Kistemann, T. (2018). Do perceived walking distance to and use of urban blue spaces affect self-reported physical and mental health?. Urban forestry & urban greening, 29, 1-9. https://doi.org/10.1016/j.ufug.2017.10.014

Völker, S., & Kistemann, T. (2013). Reprint of:"I'm always entirely happy when I'm here!" Urban blue enhancing human health and well-being in Cologne and Düsseldorf,

Germany. Social science & medicine, 91, 141-152. https://doi.org/10.1016/j.socscimed.2013.04.016

Wade, M. T., Julian, J. P., Jeffery, K. S., & Davidson, S. M. (2023). A Participatory Approach to Assess Social Demand and Value of Urban Waterscapes: A Case Study in San Marcos, Texas, USA. Land, 12(6), 1137. https://doi.org/10.3390/land12061137

Walmsley, D. J., & Lewis, G. J. (2014). People and environment: Behavioural approaches in human geography. Routledge. https://doi.org/10.4324/9781315845258

Wang, R., Zhao, J., Meitner, M. J., Hu, Y., & Xu, X. (2019). Characteristics of urban green spaces in relation to aesthetic preference and stress recovery. Urban Forestry & Urban Greening, 41, 6-13. https://doi.org/10.1016/j.ufug.2019.03.005

Wang, Y., Dewancker, B. J., & Qi, Q. (2020). Citizens' preferences and attitudes towards urban waterfront spaces: A case study of Qiantang riverside development. Environmental Science and Pollution Research, 27(36), 45787-45801. https://doi.org/10.1007/s11356-020-10419-6

Westover, T. N. (1985). Perceptions of crime and safety in three Midwestern parks. The Professional Geographer, 37(4), 410-420. https://doi.org/10.1111/j.0033-0124.1985.00410.x

Wu, D., Liu, L., & Li, L. (2023). Study on Camping Behavior Patterns for Thermal Comfort at Riverside Parks. Buildings, 13(5), 1295. https://doi.org/10.3390/buildings13051295

Wu, H., Liu, L., Yu, Y., & Peng, Z. (2018). Evaluation and planning of urban green space distribution based on mobile phone data and two-step floating catchment area method. Sustainability, 10(1), 214. https://doi.org/10.3390/su10010214

Wu, J., Chen, X., & Chen, S. (2019a). Temporal characteristics of waterfronts in Wuhan City and people's behavioral preferences based on social media data. Sustainability, 11(22), 6308. https://doi.org/10.3390/su11226308

Wu, J., Li, J., & Ma, Y. (2019b). A comparative study of spatial and temporal preferences for waterfronts in Wuhan based on gender differences in check-in behavior. ISPRS international journal of geo-information, 8(9), 413. https://doi.org/10.3390/ijgi8090413

Wu, J., Li, J., & Ma, Y. (2019c). Exploring the relationship between potential and actual of urban waterfront spaces in Wuhan based on social networks. Sustainability, 11(12), 3298. https://doi.org/10.3390/su11123298

Wüstemann, H., Kalisch, D., & Kolbe, J. (2017). Accessibility of urban blue in German major cities. Ecological indicators, 78, 125-130. https://doi.org/10.1016/j.ecolind.2017.02.035

Xie, B., Pang, Z., He, D., Lu, Y., & Chen, Y. (2023). Effects of neighborhood environment on different aspects of greenway use: Evidence from East Lake Greenway, China. Journal of Transport Geography, 106, 103488. https://doi.org/10.1016/j.jtrangeo.2022.103488

Yung, E. H., Conejos, S., & Chan, E. H. (2016). Social needs of the elderly and active aging in public open spaces in urban renewal. Cities, 52, 114-122. https://doi.org/10.1016/j.cities.2015.11.022

Abidin, Z., Arbina, N., & Lee, G. (2011). Methodology for evaluating the landscape character of Malaysian heritage urban river corridors. EddBE2011, 27-29.

Zainal Abidin, N. A. (2017). Assessing the landscape character of Malaysia's heritage urban river corridors (Doctoral dissertation, Queensland University of Technology). https://doi.org/10.5204/thesis.eprints.110347

Zelinka, A., & Brennan, D. (2001). SafeScape. Creating safer, more livable Communities through planning and design. http://worldcat.org/isbn/1884829376

Zhang, P., Ding, Y., Cai, Y., Zhang, G., Wu, Y., Fu, C., & Wang, H. (2022a). Research progress on methods of river ecological corridor extraction and their application. Acta Ecol. Sin, 42, 2010-2021.

Zhang, Q., Lee, J., Jiang, B., & Kim, G. (2022b). Revitalization of the waterfront park based on industrial heritage using post-occupancy evaluation—a case study of Shanghai (China). International Journal of Environmental Research and Public Health, 19(15), 9107. https://doi.org/10.3390/ijerph19159107

Zhao, Z., Gan, H., Qian, X., Leng, J., Wang, Y., & Wu, P. (2021). Riverside greenway in urban environment: Residents' perception and use of greenways along the Huangpu River in Shanghai, China. International journal of environmental research and public health, 18(3), 1120. https://doi.org/10.3390/ijerph18031120

Zheng, H., Gao, J., Xie, G., Zou, C., & Jin, Y. (2019). Ecological corridor. Journal of Ecology and Rural Environment, 35(2), 137-144.

Zhou, S., Chen, F., & Xu, Z. (2022). Evaluating the accessibility of urban parks and waterfronts through online map services: A case study of Shaoxing, China. Urban Forestry & Urban Greening, 77, 127731. https://doi.org/10.1016/j.ufug.2022.127731

Zingraff-Hamed, A., George, F. N., Lupp, G., & Pauleit, S. (2022). Effects of recreational use on restored urban floodplain vegetation in urban areas. Urban Forestry & Urban Greening, 67, 127444. https://doi.org/10.1016/j.ufug.2021.127444

Supplementary material A

Table A1. Database search strategy.

Electronic database	Search terms
Science Direct	Title, abstract or author-specified keywords: ("river corridor" OR riparian OR greenway OR riverfront) AND (usage OR behaviour OR restriction OR constraint)
Web of Science	TS= (("RIVER CORRIDOR" OR "STREAM CORRIDOR" OR RIVERFRONT* OR RIVERSCAPE* OR RIPARIAN* OR "URBAN BLUE" OR GREENNWAY* OR RIVERSIDE*) AND (USE* OR BEHAVOR* OR RECREATION* OR ACTIVITY* OR BARRIER* OR DISSERVICE* OR RESTRICTION* OR CONSTRAINT))
Scopus	TITLE-ABS-KEY: ("river corridor" OR “stream corridor” OR riverfront OR riverscape OR riparian OR "urban blue" OR greenway OR riverside) AND (usage OR behaviour OR recreation OR activity OR barrier OR disservice OR restriction OR constraint)

Supplementary material B

Table B1. Summary of findings from reviewed articles (n =59).

Author	Region	Sample characteristics	Data collection	Sampling		Data analysis approach	Findings
		Respondent	**Data collection methods**	**Sampling method(s) described**	**Sample size (N)**		
Che et al. (2012)	China	Investigation groups	Quantitative (questionnaire)	Quota sampling	48	Comprehensive Index of Public Accessibility of Riverfront (CIPAR) method	The Public Accessibility of Riverfront of most sections of the Suzhou Creek is still in poor condition, and the visual accessibility is low.
Scott Shafer et al. (2013)	USA	Residents	Secondary data	Quota sampling	85	Hierarchical logistic regression, Descriptive statistics analysis	The proximity of stream corridors to local residents, the level of pedestrian access available and tree cover are the best predictors of recreational use.
Völker & Kistemann (2013)	Germany	Visitors	Quantitative (geographical approach, observation, questionnaire)	Random sampling	42	Spatial analysis, Grounded theory	Promenades are favourite place for people to spend leisure time and engage in recreational activities.
Giannakis et al. (2016)	Cyprus	Visitors	Quantitative (questionnaire)	Random sampling	305	Descriptive analysis, Variance analysis, Ordered logit model	People’s main reasons to visit linear parks along urban rivers are physical activity and exercise, nature and cooling.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Haeffner et al. (2017)	USA	Adults in urban neighbourhoods	Quantitative (questionnaire + GIS), Secondary data	Random sampling + Non-random sampling	1179 households	Descriptive analysis, Pearson's chi-square tests, t-test, ANOVA, Tukey's post hoc comparison tests, Multivariate models	Urban waterways contribute to enhancing the quality of community life. The further a household is from blue space, the less likely they are to be aware of or utilize these amenities.
Wüstemann et al. (2017)	Germany	Households	Secondary data	No	No	Descriptive statistics analysis, Welch's, F-test	Non-Germans live closer to water on average, while Germans and childless households are surrounded by higher urban blue coverage.
Chen et al. (2018)	Taiwan	Planning officials, non-governmental organizations, tourists, industries and local residents	Qualitative (focus groups) + Quantitative (Kano survey)	No	No	Kano Model and C-S Coefficient	A more diverse range of activities can be offered to the public, accumulating experiences and practices that shape the attractiveness of tourism.
Völker et al. (2018)	Germany	Adults	Quantitative (questionnaire)	Random sampling	1041	Descriptive analysis, Bivariate analysis, Three-step linear multiple regression model	There was a significant association between frequency of use and perceived walking distance of blue spaces.
Zingraff-Hamed et al. (2018)	Germany	Users	Quantitative (observation)	No	No	Descriptive analysis	Recreational users may contribute to the reduction of highly suitable habitat for sensitive life cycle stages of *C. nasus* during summer when recreational user densities are high.
Garrett et al. (2019)	Hong Kong	The elderly	Quantitative (survey)	Convenience sampling	1000	Logistic regression	Regular visits to blue spaces were more prevalent among the elderly residing within a 10-15-minute walking distance and those perceiving the presence of adequate facilities and wildlife at the visitation sites.
Gong et al. (2019).	China	The elderly	Quantitative (observation + questionnaire) + Qualitative (semi-structured interview)	Random sampling	Observation = 9768 Interviews = 178 Survey = 89	Mean analysis, Pearson correlation analysis, KMO and Bartlett's test	Several factors impact the elderly's satisfaction with waterfront spaces, encompassing environment, function, transportation, social culture, and vision.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Vert et al. (2019)	Spain	Users	Quantitative (SOPARC observation) + Qualitative (semi-structured interview)	No	17	Intraclass Correlation Coefficient (ICC), Content analysis, Chi-square tests, T-test, Multinomial logistic regression models, Likelihood ratio test (LRT)	Users in the river improvement area increased after the intervention, with user growth driven primarily by women, adults, children, and non-white populations.
Vierikko & Yli-Pelkonen (2019)	Finland	Visitors	Qualitative (semi-structured interviews)	Random sampling	153	Descriptive analysis	The socio-demographic characteristics and needs of summer and non-summer tourists differ significantly.
Wu et al. (2019a)	China	Weibo users	Quantitative (GIS), Secondary data	No	Check in times number = 997,832	Kernel density estimation (KDE), ArcGIS 10.3, Geographic Field Model (GFM), Geographically and Temporally Weighted Regression (GTWR)	On weekdays, people prefer walking to nearby waterfront areas after 18:00 for leisure activities focused on consumption and exercise. On weekends, people favour well-equipped and culturally rich coastal areas.
Wu et al. (2019b)	China	Weibo users	Quantitative (GIS), Secondary data	No	Check in times number = 652,870	Cluster analysis, Nuclear density estimation (KDE), ArcGIS 10.5	Male and female users exhibit significant differences in their preferences for different lakes in terms of both time and space. However, their usage frequency is noticeably higher on weekends compared to weekdays.
Wu et al. (2019c)	China	Weibo users	Quantitative (GIS), Secondary data	No	No	Multiple linear regression analysis□Kernel density estimation (KDE), ArcGIS 10.5	There is a notable user presence along the existing waterfronts; however, the provided infrastructure falls short of adequately catering to their requirements.
Djukić et al. (2020)	Serbia	Residents	Qualitative (e-questionnaire), Secondary data	Random sampling	n=281	Descriptive analysis, Information and communications technologies analysis	Accessibility, pavement and road quality, and greening quality are critical to individual preferences in deciding to visit urban river fronts.
Gargiulo et al. (2020)	Barcelona	Users	Quantitative (observation), Qualitative (in-depth interviews)	Purposive sampling + Snowball sampling	30	Content analysis	Safety is the main reason for differing perceptions among river corridor users.
Meng et al. (2020)	China	Passers-by, Dianping users	Quantitative (survey) + Qualitative (interviews), Secondary data	Random sampling	Survey = 298 passers-by, Comments = 22677	Survey driven model (SolVES), Content analysis, Kernel density estimation (KDE),	A spatial mismatch between the supply and demand of CES was observed in 80% of the basin's total area.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Shangi et al. (2020)	Bangladesh	Inhabitants, passers-by	Quantitative (observation) + Qualitative (interviews)	No	No	Descriptive analysis	Strategic goal-oriented planning and proper management help restore the waterfront as a major public recreational space and tourist attraction for city dwellers.
Wang et al. (2020)	China	Citizens	Quantitative (field observation + questionnaire survey)	Random sampling	102	Descriptive analysis, One-sample t test, Independent t test	Activity patterns on the Qiantang River waterfront promenade varied widely, with peak usage at night.
Börger et al. (2021)	14 EU Member States	Adults	Quantitative (online questionnaire)	Random sampling	n=11,443	TC-CB analysis, Regression analysis, Multivariate Poisson lognormal models, Descriptive analysis	Across the 14 EU member states surveyed, respondents visited blue spaces an average of 47 times per year.
Ćwik et al. (2021)	Poland	Visitors	Quantitative (observations)	No	No	Descriptive analysis	During non-holiday seasons, residents exhibit a heightened demand for bathing facilities and the multi-media fountain on hot, non-working days. Conversely, the riverside boulevards experience incredible popularity throughout the holiday and fine weather conditions.
Eid et al. (2021)	Egypt	Users	Quantitative (on-site observations)	No	No	Descriptive analysis	Users of the Nile waterfront are rarely allowed to physically touch the water. Lack of vertical and horizontal social links to the waterfront, continuous proper walkways and green spaces and facilities.
Fan et al. (2021)	China	Users	Baidu heat map, POI data, NDVI data	No	No	OLS regression analysis, Geographically weighted regression (GWR) analysis, Global and local regression models, ArcGIS 10.5	Urban waterfront building density has the strongest positive correlation with urban vitality

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Liu et al. (2021)	China	Tencent users	Real-time Tencent user density data (RTUD), POIs data, Building vector data and road network data	No	No	Bayesian estimation, Amos 26.0	The site design, population in the vicinity, and availability of service facilities demonstrated a significantly positive influence, whereas traffic accessibility had a negative impact on the vitality of river front public spaces.
Mansournia et al. (2021)	Kurdistan	Children, primary school aged children	Quantitative (observation + behaviour mapping + mental mapping + GIS) + Qualitative (focus-group interviews)	Quota sampling + Voluntary sampling	Observation = 82 children Focus-group interviews = 60 primary school aged children	Descriptive analysis	Physical environmental tolerance and safety-conscious parenting practices have a significant impact on children's freedom of movement and activities in public places.
Niu et al. (2021)	China	Experts	Quantitative (questionnaire + GIS), POI data	Purposive sampling	28	ArcGIS, Analytic hierarchy process (AHP) Hash algorithm, Kernel density analysis (KDE)	The vitality of waterfront spaces was primarily influenced by river attributes, followed by transportation accessibility, degree of functional mixing, and land spatial type.
Othman et al. (2021)	Egypt	Residents	Quantitative (questionnaire)	Random sampling	202	Descriptive analysis, Chi-square test, Regression analysis, Multiple stepwise regression model	The detailed configuration of the street pattern and travel time are the attributes that have the greatest impact on waterfront accessibility.
Van Heezik et al. (2021)	New Zealand	Urban residents, students	Qualitative (one-on-one interview)	Voluntary sampling + Snowball sampling	Survey 1 = 230 Survey 2 = 285	General linear models, Pearson's correlation analysis, Chi-squared tests, Logistic regression	Time spent in nature during childhood was not a good predictor of the likelihood of time spent in green and blue spaces as adults.
Vian et al. (2021)	Spain	Residents	Quantitative (field observations)	No	No	ArcGIS, Descriptive analysis	Although the spatial character, design, and use of public recreational river fronts can be almost unlimited, there are patterns associated with each category.
Zhao et al. (2021)	China	Residents	Quantitative (field survey + questionnaire) + Qualitative (interviews)	Stratified random sampling	Survey = 588	Semantic differential methods, Importance–performance analysis, IPA model	Most residents prefer mixed green ways.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Andersen Cirera (2022)	Chile	Users	Quantitative (observation, ArcGIS)	No	No	Public Space Index, Lateral Connectivity Index, Public Piers/Beach Index, Land Use Diversity Index	The absence of comprehensive shoreline planning in waterfront neighbourhoods, coupled with a lack of diverse public spaces, hinders proper utilization of public riverside areas and neglects the consideration of ecological degradation processes and social vulnerability.
Chen et al. (2022)	China	China Unicom users	Mobile Phone Signaling Data, POI data	No	No	TOPSIS, OLS regression model, Collinearity test, Significance test	The attractiveness of river fronts displayed regional clustering, with economically developed areas exhibiting high attractiveness.
Cheng et al. (2022)	China	Visitors	Secondary data	No	Comment data = 352837	Text analysis, IPA analysis, One-way ANOVA, Multiple comparison analysis	Tourists prefer spring landscapes, favour unique flora and fauna landscapes and recreational activities, and prioritize the quality-of-service facilities.
Guo et al. (2022)	China	Residential communities	Quantitative (field survey) + Google Earth images + Ovi map	Quota sampling	Residential communities = 4,640	Supply estimation, Hot spot analysis, Kernel density estimation (KDE), Geo detector method, Interactive detector method	The main factors affecting urban river recreation services are city centre distance, river recreation space supply, and river front proximity.
Liu et al. (2022)	Hong Kong	Disadvantaged neighbourhoods	Secondary data	No	No	2SFCA method	Neighbourhoods in Kowloon's districts are the most disadvantaged in accessing green-blue spaces within 15 min. of active travel.
Luo et al. (2022)	/	College students	Quantitative (online questionnaire)	Purposive convenience sampling + snowball sampling	658	Descriptive analysis, Hierarchical Bayesian (HB) algorithm, Conjoint analysis	Water features were most important, followed by bushes, upkeep, and trees. Integrating wildlife, companions, flowers, and paths with vegetation and water features improves their attractiveness for nature experiences.
Negrini & Walford (2022)	UK	The elderly	Quantitative (GIS, GPS)	Quota sampling + snowball sampling	50	Descriptive analysis	There's a difference between what people do when they travel and what they think is interesting enough to photograph.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Rakonjac et al. (2022)	Serbia	Users	Quantitative (field survey)	No	No	Descriptive analysis, Content analysis	Lighting design can influence the spatial distribution of users and their sense of security and comfort, as well as when, how often and how they are used.
Smith et al. (2022)	UK	Residents	Qualitative (intercept interviews)	Random sampling	203	Descriptive analysis, Content analysis, Built-in network analysis algorithms	The most influential factors for the use of the Glasgow Canal were sport and health, urban nature, and cleaning and maintenance.
Yu et al. (2022)	China	Tourists	Quantitative (questionnaire + observation)	No	372	Fuzzy set qualitative comparative analysis (fsQCA)	Night architecture, night lights, night cruises, urban development and image, urban atmosphere, functions and emotions influence night cruise tourist loyalty.
Zhang et al. (2022)	China	Users	Mixed methods: Quantitative (questionnaire) + Qualitative (interviews)	Random sampling	Survey = 195	Descriptive analysis, Frequency analysis, Technical statistical analysis, IPA analysis, T-test, ANOVA, Multiple regression analysis	The users are predominantly in their twenties and forties, with the highest utilization rate observed for the trail, while the visitor centre has the lowest utilization rate.
Zhou et al. (2022)	China	Residents	Quantitative (Baidu Map API)	No	Waterfront access points = 1612 Residential buildings = 4938 Communities = 580	ArcGIS, Cross-validation, Pearson correlation analysis	Only 22% of Shaoxing residents live within a 500-meter walking distance of a park. If the canal is well utilized, almost all residents would have access to natural environments within a 15-minute walk.
Zingraff-Hamed et al. (2022)	Germany	Users	Aerial photography	No	No	Descriptive analysis, Kruskal-Wallis and Mann-Whitney test, Bonferroni correction, Buhl's method, Spearman test	Users prefer urban riparian greenery and gravel bar elements to natural vegetation.
Chen & Ma (2023)	China	Visitors	Quantitative (field survey + behavioural notation method)	No	No	Coupled coordination calculation, ArcGIS, Pearson correlation analysis, Descriptive analysis, Multiple linear regression analysis, Redundancy analysis	The quantity of public facilities and the quality of natural environment are the dominant factors for the vitality of waterfront space.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Ding et al. (2023)	China	Dianping users	Quantitative (Baidu heat map), Secondary data	No	No	Global and local regression models, ArcGIS10.5	The urban vitality aggregation characteristics along the Qinhuai River are similar on weekdays and weekends, with the core vitality zones distributed in densely populated tourist, commercial, and residential areas along the river.
Fan et al. (2023)	China	Mobile phone users	Morphological data, spatio-temporal cellular data, POI data	No	cellular data = 829,539 (2018), cellular data = 766,388 (2020), POI data = 10,772 (2018), POI data = 10,244 (2020)	Multiple linear regression models, Multicollinearity and Durbin–Watson tests	Functional diversity and design quality are two of the most influential factors influencing the vitality of renewed river front spaces.
Grzyb & Kulczyk (2023)	Poland	Instagram users	POI data	No	Instagram posts = 40,062	OLS regression models, Pearson's correlation coefficient	Fine weather attracts Instagram users more than unfavourable conditions discourage them. Additionally, the demand for 'pure' riverine nature appears to be unaffected by various proposed factors.
Jakstis et al. (2023)	Europe (15 countries)	European residents	Quantitative (online questionnaire)	Voluntary sampling	584	Descriptive statistics analysis, Chi-squared analyses	Most Europeans have a positive view of green and blue spaces, preferring structurally diverse, natural or unmanaged green elements.
Khairabadi et al. (2023)	Iran	Residents	Quantitative (observation) + Qualitative (in-depth interviews)	Purposive sampling, + Snowball sampling	22	Descriptive analysis	Due to the lack of green and open spaces, the Abbas Abad River is not fully utilized despite its capacity.
Liu et al. (2023)	China	Users	Quantitative (Baidu heat map + nuclear density method + behaviour observation + GIS) Secondary data	No	No	Text sentiment analysis, Linear regression analysis, Word frequency analysis	The overall popularity of waterfront green spaces is concentrated at low levels. The main purpose of users was for recreation, with an average duration of 1.5 hours.
Luo & Lin (2023)	China	No	Quantitative (GIS), POI data, Depthmap data	No	No	Kernel density analysis	The accessibility of areas with high value of riverside space in the central city of Songxi County is concentrated in the central area, and areas with high accessibility value have obvious breaks at the river bank.

Table B1. Summary of findings from reviewed articles (n =59) *(continuation)*.

Mácová & Kozáková (2023)	Czech	Visitors	Quantitative (on-site survey)	Stratified random sampling	460	Multiple linear regression models	The average consumer surplus per person per trip to a large reservoir is €55.7, with a total recreation value of €34 billion per year (range between €22 and €57).
Ouyang & Wu (2023)	China	Visitors	Quantitative (questionnaire) + POI data	No	145	Descriptive analysis	Waterfront spaces accessible by foot provide the greatest satisfaction in terms of accessibility, followed by spaces accessible by bicycle. Visitors are more concerned with the scenery around the facility, and service facilities with beverage shops, fitness and small gatherings are more attractive.
Shi et al. (2023)	China	Visitors	Quantitative (questionnaire)	Random sampling	240	Model Fit Test	The service facilities and public expectations are the most important factors determining public satisfaction, followed by spatial design and perceived value.
Wade et al. (2023)	USA	Volunteers	Quantitative (questionnaire) + Qualitative (text mining analysis)	Voluntary sampling	565	R Studio, Kruskal–Wallis, Pairwise Wilcoxon ranked sum, Spearman's rho, Nonparametric statistical tests	Higher positive emotions were significantly associated with biophysical perceptions of flow, cleanliness, and nature.
Wu et al. (2023)	China	Camping people	Drone aerial photography, Python, Crowd distribution heat map	No	No	OpenCVYOLOv3 target detection algorithm	Air temperature has a moderate correlation with camping behaviour.
Xie et al. (2023)	China	Residents	Quantitative (follow-up survey) + Qualitative (face to face and structured interviews) Street network analysis	Stratified random sampling	970	Descriptive statistics analysis, Multi-level linear models, Logistic regression models	Self-rated health, walking and cycling to green ways, proximity, and social cohesion are positively associated with green way usage frequency, while home ownership and single-person households are negatively associated with green way usage frequency.

Supplementary material C

Table C1. Quality ratings.

Author	Journal	Pre-amble	Introduction	Design	Sampling	Data Collection	Ethical matters	Results	Discussion	Total score	Corre-sponding (%)
Che et al. (2012)	Ecological Engineering	4	3	4	4	3	0	4	4	26	65%
Scott Shafer et al. (2013)	Journal of Urban Design	4	4	3	3	4	0	4	5	27	68%
Völker & Kistemann (2013)	Social Science & Medicine	4	4	4	4	3	0	4	4	27	68%
Giannakis et al. (2016)	Sustainability	4	4	4	3	4	0	4	3	26	65%
Haeffner et al. (2017)	Landscape and Urban Planning	4	4	4	5	5	0	5	4	31	78%
Wüstemann et al. (2017)	Ecological Indicators	3	4	4	4	4	0	4	5	28	70%
Chen et al. (2018)	Journal of Asian Architecture and Building Engineering	3	4	3	3	3	0	5	3	24	60%
Völker et al. (2018)	Urban Forestry & Urban Greening	4	5	4	4	4	3	5	5	34	85%
Zingraff-Hamed et al. (2018)	Sustainability	3	4	4	3	4	0	4	4	26	65%
Garrett et al. (2019)	Health & Place	3	4	4	3	5	4	5	5	33	83%
Gong et al. (2019)	Sustainability	4	4	3	4	4	0	3	3	25	63%
Vert et al. (2019)	Landscape and Urban Planning	5	4	4	3	5	3	5	4	33	83%
Vierikko & Yli-Pelkonen (2019)	Urban Ecosystems	3	4	3	4	5	0	4	5	28	70%
Wu et al. (2019a)	Sustainability	4	5	4	3	4	0	4	4	28	70%
Wu et al. (2019b)	International Journal of Geo-Information	3	4	4	4	4	0	5	4	28	70%
Wu et al. (2019c)	Sustainability	3	5	3	4	4	0	4	3	26	65%
Djukić et al. (2020)	Sustainability	3	4	4	4	3	0	4	4	26	65%
Gargiulo et al. (2020)	Leisure Studies	4	5	4	4	3	0	4	5	29	73%
Meng et al. (2020)	Ecosystem Services	4	4	4	4	4	0	4	5	29	73%
Shangi et al. (2020)	Architecture Research	4	5	3	2	3	0	5	2	24	60%
Wang et al. (2020)	Environmental Science and Pollution Research	4	5	4	3	4	0	4	4	28	70%
Börger et al. (2021)	Science of the Total Environment	4	4	4	3	5	0	5	5	30	75%
Ćwik et al. (2021)	Forests	4	3	4	3	4	0	4	4	26	65%
Eid et al. (2021)	HBRC Journal	4	5	4	2	3	0	4	3	25	63%

Table C1. Quality ratings *(continuation)*.

Fan et al. (2021)	International Journal of Geo-Information	4	4	5	4	4	0	4	3	28	70%
Liu et al. (2021)	Cities	3	5	4	5	4	0	3	4	28	70%
Mansournia et al. (2021)	Urban studies	3	5	3	5	3	0	3	4	26	65%
Niu et al. (2021)	Frontiers of Architectural Research	3	4	4	4	5	0	5	2	27	68%
Othman et al. (2021)	Ain Shams Engineering Journal	3	5	4	4	4	0	5	4	29	73%
Van Heezik et al. (2021)	Landscape and Urban Planning	4	4	4	3	4	4	4	5	32	80%
Vian et al. (2021)	Urban Forestry & Urban Greening	4	4	4	4	4	0	4	4	28	70%
Zhao et al. (2021)	International Journal of Environmental Research and Public Health	3	4	5	3	3	0	5	4	27	68%
Andersen Cirera (2022)	International Journal of Sustainable Development and Planning	3	5	4	4	4	0	4	4	28	70%
Chen et al. (2022)	Land	4	4	3	4	4	0	5	3	27	68%
Cheng et al. (2022)	Land	5	4	4	4	4	0	5	4	30	75%
Guo et al. (2022)	Sustainable Cities and Society	3	4	3	4	4	0	5	4	27	68%
Liu et al. (2022)	Sustainability	4	5	4	3	3	0	4	3	26	65%
Luo et al.(2022)	Journal of Environmental Planning and Management	3	5	3	4	4	0	5	5	29	73%
Negrini & Walford (2022)	Applied Geography	3	5	3	3	4	0	3	3	24	60%
Rakonjac et al. (2022)	Sustainability	4	4	4	3	3	0	3	4	25	63%
Smith et al. (2022)	Health & Place	3	5	4	4	5	4	5	3	33	83%
Yu et al. (2022)	SAGE Open	3	5	4	3	3	0	4	4	26	65%
Zhang et al. (2022)	International Journal of Environmental Research and Public Health	4	3	4	3	4	0	5	3	26	65%
Zhou et al. (2022)	Urban Forestry & Urban Greening	3	3	4	4	4	0	3	5	26	65%
Zingraff-Hamed et al. (2022)	Urban Forestry & Urban Greening	4	4	4	3	4	0	3	5	27	68%
Chen & Ma (2023)	International Journal of Environmental Research and Public Health	5	3	3	3	4	0	4	5	27	68%
Ding et al. (2023)	Frontiers of Architectural Research	4	4	4	3	4	0	4	5	28	70%

Table C1. Quality ratings *(continuation)*.

Fan et al. (2023)	Land	4	4	3	3	4	0	4	5	27	68%
Grzyb & Kulczyk (2023)	Landscape and Urban Planning	4	4	4	3	4	0	4	4	27	68%
Jakstis et al. (2023)	People and Nature	5	5	5	4	4	3	4	5	35	88%
Khairabadi et al. (2023)	Environmental Development	3	4	4	4	3	0	4	5	27	68%
Liu et al. (2023)	International Journal of Environmental Research and Public Health	5	4	3	3	4	0	4	4	27	68%
Luo & Lin (2023)	Sustainability	4	4	3	3	4	0	4	4	26	65%
Mácová & Kozáková (2023)	Water	4	4	4	3	3	2	4	4	28	70%
Ouyang & Wu (2023)	Land	4	4	4	3	4	0	4	4	27	68%
Shi et al. (2023)	Journal of Urban Planning and Development	3	4	4	4	5	0	4	3	27	68%
Wade et al. (2023)	Land	4	4	4	3	3	0	4	4	26	65%
Wu et al. (2023)	Buildings	4	3	3	3	4	0	4	3	24	60%
Xie et al. (2023)	Journal of Transport Geography		5	5	4	5	0	5	4	31	78%