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How do you like your rivers? Portraying public perception and preference for urban rivers in China via a combined visual and textual analysis

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Abstract

Urban rivers play a pivotal role in fostering human–nature interaction in cities. This study investigates the evolving relationship between humans and rivers by examining public perceptions of rivers' multifaceted roles—an aspect not yet explored through social science methods—within the context of China's river restoration trends. We conducted a public survey in three riverine cities in China—Chongqing, Wuhan and Hangzhou, and generated 114 photographs of respondents' 'favourite river sites', as well as detailed written explanations of why they liked those places. By combining visual content analysis and textual thematic analysis to their answers, we identified five specific perceived values of urban rivers: ecological, recreational, scenic, economic and sentimental. The findings reveal a widespread preference for the ecological and recreational benefits of urban rivers, particularly through direct, sensory interactions with water. Urban rivers are also found to evoke enduring emotional bonds with people—for example, being referred to as the 'mother river'—which is deeply rooted in Chinese culture. Water quality emerges as the most valued attribute, reflecting an urgent need to address the widespread pollution of rivers in Chinese cities. Biodiversity, however, remains underrepresented in public perception. People overwhelmingly prioritise water quality, often lacking awareness of the biological quality of rivers. The study also highlights potential conflicts between the high demand for recreational use of rivers and the need to conserve their ecosystems, suggesting future strategic mitigation plans to address this challenge. Rivers' cooling effects and mental health benefits can further contribute to the city's climate adaptation efforts. Given the substantial investments in river restoration in China, the study emphasises integrating social needs and involving public participation in urban river management. Ultimately, the results contribute to China's

sustainable transformation by aligning ecological restoration with cultural and societal goals, and promoting coexistence between humans and nature within urban river corridors.

KEYWORDS
human–nature interaction, human–river relationship, inland waters, perception analysis, river management, social-ecological system

1 | INTRODUCTION

Rivers are social-ecological integrated systems (Boelens et al., 2023; Wantzen et al., 2016). In cities, rivers provide local water supply, contribute to biodiversity conservation and support recreational activities as well as cultural traditions through ceremonies and daily life interactions (Murphy et al., 2022; Wantzen, 2024; Zingraff-Hamed et al., 2021). However, in industrial societies, urban rivers are facing unprecedented pressures—a phenomenon known as 'urban stream syndrome' (Walsh et al., 2005)—which include water pollution, degraded ecosystems, increased flooding frequency and severity, and the transformation of natural waterways into highly engineered channels disconnected from urban life (Brill et al., 2017; Wantzen et al., 2019). In addition, the decline in biodiversity has weakened urban residents' physical and psychological connections to nature—referred to as the 'extinction of experience' (Soga & Gaston, 2016).

To address these challenges, river restoration has been widely employed to revitalise valuable natural assets in cities. Today, it is often implemented as part of the development of nature-based solutions (NbS) to tackle complex climate change issues (Chen et al., 2019; Cohen-Shacham et al., 2016). In cities, river restoration aims to revitalise rivers' socio-environmental functionalities and foster people's interactions with nature to support their health and well-being (Cottet et al., 2018; Guimarães et al., 2021). In recent years, social dimensions of rivers are increasingly acknowledged in both the science and practice of river restoration (Anderson et al., 2019), particularly through efforts to restore their 'social connectivity' in cities (Kondolf & Pinto, 2017).

In China, unprecedented industrialisation and urbanisation over the past 40 years have resulted in severe pollution and ecological degradation of river ecosystems (Cao & Vazhayil, 2023). According to the Ministry of Housing and Urban-Rural Development (2016), the water quality of about 90% of urban watercourses was rated as Grade V/V− (the worst grade according to the Environmental Quality Standards for Surface Water) (Ministry of Ecology and Environment, 2002), rendering water in these rivers beyond any practical or functional use. A total of 2026 'heavily polluted urban rivers/stretches' (black in colour with a bad odour and water quality sitting at Grade V/V+) were identified in 220 out of 295 cities at the prefecture level or above (Ministry of Housing and Urban-Rural Development, 2016). The degradation of rivers has significantly disrupted the connection between citizens and rivers in modern Chinese cities.

Since 2012–13, China shifted its focus from economic growth to sustainable development, and the central government initiated large-scale river restoration efforts (Zhou et al., 2011). These include the treatment of urban malodorous black rivers since 2015 to combat water pollution (Yu et al., 2021), the launch of the Sponge City Program in 2013 (Chan et al., 2022) to transform urban rivers and lakes into NbS infrastructures (Cao & Wantzen, 2023a), and the establishment of the national River Chief System in 2018 to enhance coordination and effectiveness in river management (Cao & Wantzen, 2023b). Globally, increasing emphasis is being placed on incorporating social needs into the design and evaluation of river restoration projects (Deffner & Haase, 2018). Yet in China—a country with a profound river culture rooted in the Yellow and Yangtze River basins—the cultural significance of rivers, for example, the notion of the 'mother river', is often invoked to serve community interests and symbolise civil society in river restoration movements (Heikkila, 2011). Previous studies in China have primarily focused on public evaluations (Feng et al., 2015; Yu et al., 2021), preferences (Chen et al., 2018), or the extent of willingness to pay for specific river restoration projects (Khan et al., 2019). However, how these initiatives rekindle the bond between urban inhabitants and the restored 'mother river' remains largely unexplored (Cao & Wantzen, 2023a). Despite the daily interactions of communities with restored river sites, China's predominantly top-down river management structure often restricts opportunities for understanding public perspectives (Cao & Wantzen, 2023b).

How people perceive urban rivers is a key aspect of the complex interactions between society and nature (Soga & Gaston, 2020, 2022). Social science methods, including questionnaires, surveys, interviews and fieldwork, have been employed to investigate this topic in relation to rivers (Le Calvez et al., 2021; van den Born et al., 2021). Previous studies have reported heterogeneous public perceptions of urban rivers. While some view urban rivers negatively as a source

TABLE 1 Five values linking urban rivers with public perception.

Dimension	Definition	References
Ecological	Rivers' geomorphological, environmental and natural characteristics	Everard and Moggridge (2012), Fisher et al. (2021)
Scenic	Rivers' aesthetic appeal in urban areas that contributes to city attraction	Junker and Buchecker (2008), Prominski et al. (2023), Rodríguez-Lozano et al. (2020), Shuhan and Kongjian (2021)
Recreational	Recreational activities (physical activity, social interaction and relaxation) enabled by river spaces	Che et al. (2012), House and Sangster (1991), Vian et al. (2021), Zingraff-Hamed et al. (2018)
Sentimental	People's sentimental attachment to rivers (i.e., nature connectedness, sense of home, and sense of belongingness) that can be associated with personal experiences and childhood memories, cultural connections, and spiritual or religious significance	Amirbeiki and Ghasr (2020), Birch et al. (2020), Rosa et al. (2018), van den Born et al. (2021), Verbrugge and van den Born (2018), White et al. (2010)
Economic	Rivers' direct and indirect economic benefits, such as shipping, transportation, hydroelectric power generation, irrigation and less tangible economic benefits, such as increased property values	Bowker and Bergstrom (2017), Chen et al. (2019), Lee et al. (2021)

of discomfort or potential health hazards (Procopiuck & Rosa, 2015), others view them positively as a valuable natural amenity, particularly after restoration efforts that transform degraded or polluted rivers into appealing recreational venues (Che et al., 2012; Junker & Buchecker, 2008). The way the public perceives urban rivers is influenced by a range of factors, including the environmental characteristics of the rivers, people's experiences interacting with them (Di Baldassarre et al., 2013), their spiritual/cognitive connections (Birch et al., 2020), and the aesthetic appeal of the rivers (Prominski et al., 2023). Drawing on a literature review and guided by the multifunctionality framework of NbS, we identified and summarised five specific values of urban rivers (Table 1).

Through a public survey, our study explored how rivers have been integrated into citizens' lives by examining public perceptions of urban rivers in three representative riverine Chinese cities. Visual and textual framing of participants' favourite river sites were analysed qualitatively. The study addresses two key research questions: (1) How does the public perceive the various values associated with urban rivers? and (2) What factors influence public preferences for river values, and how might these values intersect or conflict? The findings of this study enrich our empirical understanding of the dynamic interactions between society and nature amid China's ongoing urban transformation. They also provide practical insights for promoting more inclusive river management practices that align with societal demands.

2 | METHODOLOGY

2.1 | Questionnaire design and survey execution

A questionnaire was designed for this study, informed by discussions with international river museum managers through the Global Network of Water Museums (https://www.watermuseums.net/) and the UNESCO Chair River Culture— Fleuves et Patrimoine, as well as the author team's previous research on public perceptions of urban riverfronts in France (Cao & Wantzen, 2023). The questionnaire consisted of two sections. The first section included two key questions: (1) Can you provide a photo of your favourite river site in the city you currently live in? and (2) Can you explain why you like this place? The second section gathered demographic information about respondents, including gender, age, education level, occupation and income level, which was used for descriptive analysis.

The survey was administered online (https://www.wjx.cn/) with the assistance of three water museums in China: the Changjiang Civilisation Museum (located in Wuhan city with the Yangtze River and its tributaries running through the city, central China), the National Water Museum of China (located in Hangzhou city with the Qiantang River traversing the city, east China), and the Baiheliang Underwater Museum (located in Chongqing city with the upper section of the Yangtze River flowing through the city, southwest China). The three museums were established in 2015, 2010 and 2009, respectively, to highlight the city's cultural history of living alongside the rivers and its local management efforts, including river restoration projects. Between July and October 2022, a poster was displayed in the entrance hall of each

museum, featuring a QR code linking to the questionnaire. The poster described the study and ensured participants' informed consent. Museum visitors were randomly invited to participate in the survey by voluntarily scanning the QR code using their smartphones or tablets. Museum staff provided technical assistance when needed. All collected information was translated from Chinese to English for data analysis.

2.2 | Combined content analysis and thematic analysis

This study combined two qualitative data analysis approaches commonly used in the social sciences: content analysis and thematic analysis. Content analysis (Bell, 2001) was adopted to extract key features from the photos of river sites provided by the respondents. Visual framing of such sites captures what is consciously included within the final frame (Hall, 2010), resulting from three interconnected elements: the ideas captured by sense, the realities perceived through mental operations, and the thoughts formed through memory and imagination (Schwartz & Ryan, 2003). Thus, content analysis of respondents' visual framing of river sites is able to elicit their perceptions of natural landscapes (Alam et al., 2018; Ferreira & Serpa, 2020; Zhang et al., 2022). Nevertheless, content analysis primarily focuses on the composition of the visual presentation, whereas the meanings underlying the creation of those photographs cannot be unveiled (Rose, 2016). To gain additional insights pertaining to the nexus between visible river-related features, the associated appreciated values of the river, and the participants' underlying experiences, thematic analysis was employed to interpret the respondents' textual elaboration about why they selected these sites, as a complementary source of data through triangulation (Philipps, 2012; Ting Cho et al., 2021).

Table 2 presents a set of codes and sub-codes developed for visual content analysis, which captures the key landscape features of the photograph corpus, such as composition, colour and symbolism (Patton, 2014; Saldaña, 2013). Each photo was coded by assigning one or multiple codes to relevant sections in the photo, recognising the different (either contrasting or reinforcing) meanings that might be denoted by various landscape features (O'Neill et al., 2023). The data analysis was conducted using NVivo® 12 (Jackson & Bazeley, 2019); the percentage coverage of each feature (i.e., code/sub-code) was quantitatively calculated and a cluster analysis (based on Pearson correlation) was performed to derive the preferred river values (Parry, 2020).

To explore why the public prefers certain river sites, in a similar vein, a thematic coding was developed (Krippendorff, 2019) and aligned with the five river values presented in Table 1. Five common themes (corresponding to the five values in Table 1) and an additional 18 sub-themes (Table 3) were identified (Gibbs, 2007). The researchers rigorously examined and assigned each textual response to one or more themes (Bryman, 2016). And slight overlap between themes was allowed as long as it did not substantially intersect with other codes (King, 2004). To reinforce the distinctiveness of each theme, examples of every sub-theme and direct quotes from the responses—for example, 'mother river'—were extracted as separate categories (Table 3). Ultimately, each theme fitted into the overarching story regarding the entire dataset and its connection to the research questions (Braun & Clarke, 2006). Many responses were also assigned multiple codes, as narratives often appeared in multiple themes. The frequency and distribution of codes were then computed to delve into why certain features were preferred and interpret which river values were prioritised. The thematic analysis was conducted using XLSTAT (2022), a Microsoft Excel data analysis add-on.

Finally, word clouds were generated (Creswell & Creswell, 2017) to highlight the frequency of key terms, allowing for a comparison of visual and textual emphases on different river values. Although ecological and recreational values are generally appreciated by urban residents, incorporating them into river restoration can require balancing competing priorities. Thus, we systematically examined how the two perceived values coexist or come into conflict within urban river corridors. To do so, we created two matrices of code co-occurrence: one derived from the visual content analysis (using the 'Matrix Coding Query' function in NVivo® 12), and the other from the textual thematic analysis (using 'Matrix Operations' in XLSTAT). These matrices captured how often the two themes appeared together or separately across the data sources, offering a nuanced perspective on the interplay between ecological and recreational values in urban rivers. This analysis further aims to inform recommendations for urban river restoration practices.

3 | RESULTS

From a total of 657 participants who took part in the survey, 120 photographs were successfully collected. Of these, 114 were deemed valid for this study. We defined a photograph as valid if it was accompanied by sufficiently detailed textual

TABLE 2 Codes for content analysis, used in NVivo® 12.

Codes	Sub-codes	Description
Architectural Heritage	Ancient Chinese Architecture	Photographs containing architectural features and styles of ancient canal towns in China, including a moat, pavilions, kiosks and grid-patterned streets with brick, stone and wooden buildings merging with nature
Fauna and Flora	Bird	Photographs containing any floral/faunal species
	Bushes, Shrubs	
	Duck	
	Fish	
	Flower	
	Grassland	
	Sand	
	Tree	
	Water plants	
Human Figures	Group	Photographs containing an identifiable person or group of people
	Solo	
Infrastructure	Bridge	Photographs depicting buildings or structures, including a range of physical and technical systems, reflecting practical, utilitarian purposes
	Concrete Revetment	
	Dam	
	Dock	
	Earth Embankment	
	Riprap	
	Roadway	
	Vegetative Riverbank	
Landscapes	Urban Landscape	Photographs depicting a wide view of the natural or built environment
	Natural Landscape	
Physical Activities	Biking	Photographs depicting physical activities that people engage in for enjoyment, relaxation or recreation and take place along or near rivers
	Boating	
	Cruising	
	Fishing	
	Running	
	Swimming	
	Walking	
Recreational Facilities	Bench	Photographs depicting facilities that are designed to provide recreational opportunities along a river
	Fountains	
	Pedestrian Path	
	Shops, Catering	
	Street/City Lights	
	Trash Bins	

elaboration, in which participants explained the context and significance of the image. A few photographs were deemed invalid if they were unrelated to the study objectives (e.g., selfies). The relatively low return rate of photos is probably attributed to respondents' concern over privacy issues. Table 4 presents a description of the respondents. A gender balance was achieved. The most common age group among the participants was 18–25 years (30.0%), followed by 31–40 (27.5%), 26–30 (14.0%), 41–50 (12.8%) and 51–60 years (10.5%). Most participants had a high degree of education (university or higher, 93.2%) and were either full-time employed (56.2%) or studying (27.9%). The most common income class among the participants was 5000–10,000 yuan (≈682–1363 euros; 30.1%) and 1000–5000 yuan (≈136–682 euros; 30.0%). Overall, the respondents represent a relatively young and well-educated cohort. Caution should be exercised when extrapolating the findings of this study to the whole population of China.

TABLE 3 Themes and sub-themes for thematic analysis, used in XLSTAT.

Themes	Sub-themes	Examples (direct quotation from participants' textual answers)
Sentimental	Tangible cultural heritage	The river passes through the city and divides the city into two parts; it is the representation of our town
	Mother river	It is the mother river of my city
	Sense of home	My favourite river is the one easily reachable from my house
	Childhood memory	Growing up by the river, it is probably engraved in my blood
	Psychological restoration	My mood becomes very peaceful when I go to the river site
Ecological	Nature connectedness	It provides a touch of nature
	Presence of fauna and flora	That river has lots of waterfowl
	Presence of water	I like the place because there is lots of water
	Sound of water	What I like most is the sound of the water flowing
	Cooling effect	It is a very good place to cool off
	Urban quietness	The riverside in the city is very quiet when you are alone
	River water quality	The river water is cleaner
Recreational	Leisure activities	It has beautiful and excellent public facilities, a very good place for fitness, recreation, leisure and entertainment
	Summer escape	It's cool to walk along the river in the summer heat in the evening
	Relaxation and fun	I'm able to go there regularly for relaxation
Scenic	Appreciation of the landscape	Because it is a scenic area with open and good views
	Good management	I like this place because it has been renovated by the government to look more beautiful
Economic	Economic benefits	Houses by the river tend to rise in value

3.1 | People's preferred river features revealed by visual content analysis

Among the seven main codes, 'Fauna and Flora' was the most frequently occurring code, accounting for 30.3%, followed by 'Infrastructure' (23.6%), 'Landscapes' (14.8%), 'Recreational Facilities' (11.8%), 'Physical Activities' (11.3%) and 'Human Figures' (6.7%). The least common code was 'Architectural Heritage' (1.6%), with only nine photos featuring elements such as Chinese pavilions, ancient gardens and bridges. In the sub-codes, the most prevalent feature was 'Trees' (15.1%), indicating that the combination of green elements and water/river was most preferred by those taking the photographs. In the 'Fauna and Flora' category, green vegetation was prominent, with 'Bushes and Shrubs' accounting for 6.9%, 'Grassland' for 3.0%, 'Water Plants' for 2.3% and 'Flowers' for 1.9%. Only one photo contained 'Ducks' and another one included 'Fish', revealing the fact that little faunal species can be supported in the commonly very polluted rivers in Chinese cities. Interestingly, the second most frequent sub-code was 'Urban Landscape', accounting for 10.4%. In comparison, 'Natural Landscape' accounted for only 4.4%. This suggests that urban rivers have been integrated into urbanised landscapes, and citizens favour river sites that display socioeconomic prosperity.

A diversity of infrastructural elements was detected, including 'Bridges' (7.7%), 'Concrete Revetments' (7.0%), 'Docks' (2.6%), 'Earth Embankments' (1.9%), 'Vegetative Riverbanks' (1.9%) and 'Roadways' (1.6%). Despite the emphasis on 'Physical Activities' enabled by the provision of recreational facilities in many river restoration/revitalisation projects (Bernhardt & Palmer, 2007), these features were less likely presented in the respondents' favourite river sites. The most common physical activity shown in the photographs was 'Boating' (3.2%), followed by 'Cruising' (2.8%), 'Walking' (2.8%), 'Fishing' (1.2%), 'Swimming' (0.5%), 'Biking' (0.5%) and 'Running' (0.2%). Regarding 'Recreational Facilities', the most common feature was 'Pedestrian Path' (4.6%), followed by 'Street and City Lights' (3.0%), 'Benches' (1.6%), 'Trash Bins' (1.2%), 'Fountains' (0.7%) and 'Shops and Catering' (0.7%). Additionally, 'Human Figures', albeit a common feature in urbanised sites, were seldom shown in the respondents' favourite river sites, with 'Groups' and 'Solo' person(s) appearing in 3.9% and 2.8% of the photos, respectively.

TABLE 4 Descriptive statistics of participants.

Categories	%
Gender	
Female	47.50
Male	51.30
Non-specific	1.20
Age	
Under 18 years	0.80
18–25 years	30.00
26–30 years	14.00
31–40 years	27.50
41–50 years	12.80
51–60 years	10.50
Over 60 years	44
Education	
Primary school	5
Secondary school	6.40
University or higher	93.20
Occupation	
Full-time student	27.90
Full-time employment	56.20
Part-time employment	1.20
Retired	8.20
Unemployed	0.60
Self-employed	3.20
Homemaker	0.60
Others	2.10
Monthly income	
Under 1000 CNY	21.90
1000–5000 CNY	30.00
5000–10,000 CNY	30.10
Over 10,000 CNY	18.00

3.2 | Preferred river features and relevant values

A cluster analysis regrouped the sub-codes into four clusters based on their coding similarity, as measured by the Pearson coefficient. For each cluster, a specific river value (as listed in Table 1) was assigned to delve into the respondents' perception of river values as presented by their favourite river sites in visual content. Figure 1 illustrates the relevant results with a cluster diagram.

The first cluster, accounting for 25.2% of the total coding references, captured the economic value of urban rivers in areas such as navigation, transportation and tourism. This cluster was composed of built infrastructures, for example, bridges, roads, docks and roadways, as well as cruising.

The second cluster, which represented the recreational value (36.3%) of urban rivers, was primarily characterised by varied physical activities, such as boating and running, and recreational facilities, for example, benches and pedestrian paths, that support these activities.

The third cluster represents rivers' ecological value and natural scenery (22.2%), was defined by the presence of floral and faunal species, as well as the overall natural landscape setting. The inclusion of 'dams' in this cluster reveals the three cities' historical adaptation to their flood-prone environments through hydro-agricultural practices (Gao, 2022). Consequently, locals continue to regard dams as an ecological feature that blend with the river's natural landscape.
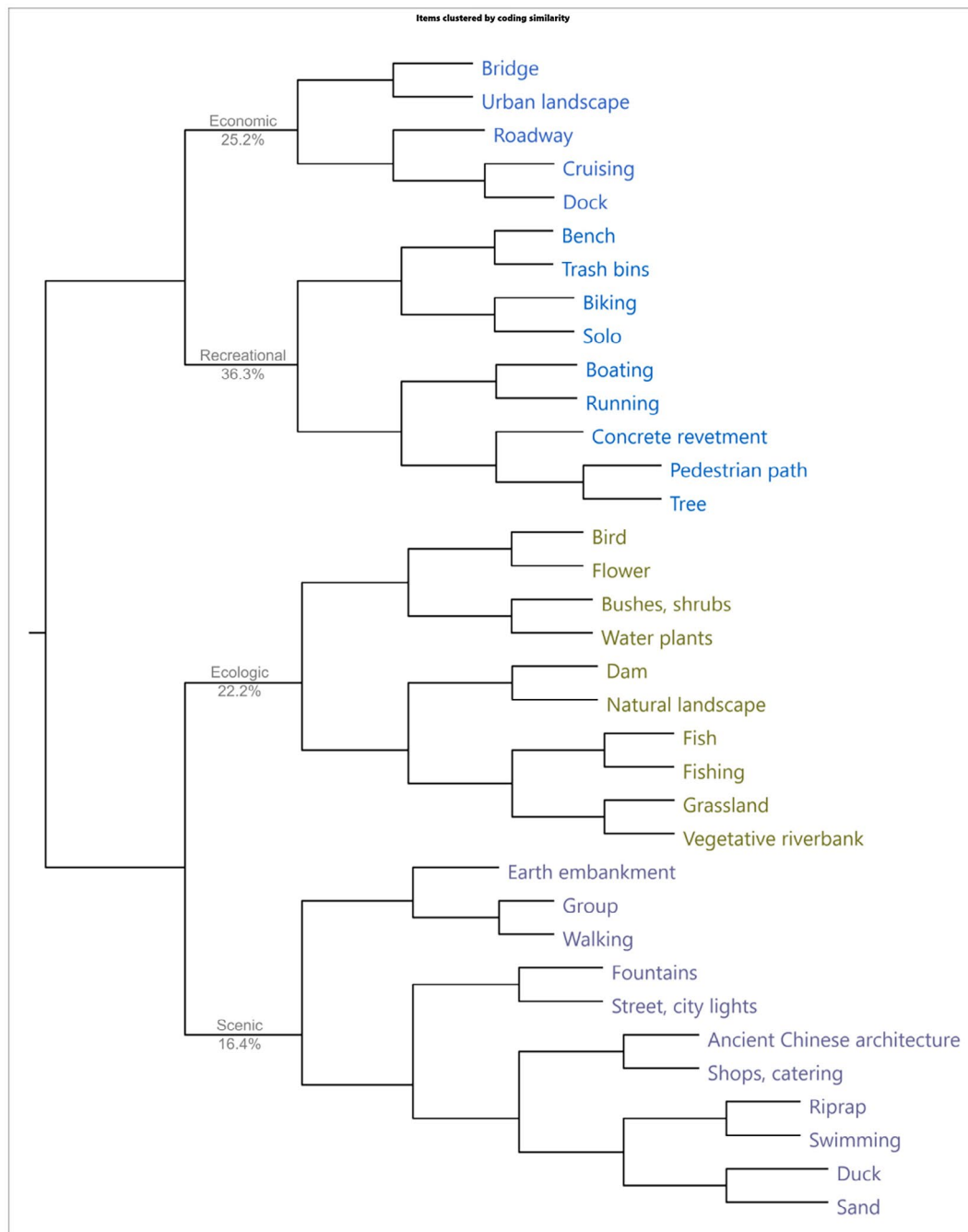
FIGURE 1 Cluster diagram of all 35 sub-codes used in visual content analysis, result in NVivo® 12.

The final cluster, representing rivers' scenic value (16.4%), primarily included man-made structures along the rivers. This cluster was tied to the commercialisation of river spaces in Chinese cities and their influence on the shift to a modern lifestyle (Ting Cho et al., 2021), for example, the presence of 'fountains', 'city lights', 'shops', 'catering'.

The latent sentimental value was not readily apparent in the photographs submitted by the respondents; however, it was widely expressed in the accompanying textual responses.

3.3 | Results of thematic analysis of respondents' textual framing

Among all sub-themes present in the respondents' textual framing of their preferred river sites, three distinctive themes were identified: appreciation of the landscape (15.8% of all codes), leisure activities (15.6%) and a sense of home (13.0%).

Additional factors contributing to the preference for urban rivers included relaxation and fun (9.0%), the cooling effect (7.6%), good water quality (6.9%), nature connectedness (6.6%) and childhood memories (6.1%).

Good water quality (6.9%), often resulting from river restoration efforts, has become a key factor in shaping public perceptions of urban rivers. Additionally, 6.1% of respondents expressed fondness for their hometown rivers due to the childhood memories they evoke, while 6.6% appreciated the sense of connection to nature that these rivers provide. The natural aesthetics of rivers contribute to mental relaxation (9.0%) and offer a cooling effect (7.6%) during the summer, further enhancing their appeal.

Three themes received the least attention: the sound of water (0.5%), economic benefits (0.3%) and good management of riverine landscapes (0.6%). In highly urbanised cities, anthropogenic noise is nearly ubiquitous, which would mask possible sonic aesthetics associated with rivers. The sound of bubbling and rushing water cannot be easily noticed by citizens, making this theme unlikely a common factor shaping people's preferences for river sites. The infrequent mention of economic value and good management as reasons for favouring river sites may stem from respondents perceiving these factors as tools for enhancing the ecological and recreational value of urban rivers, which are closely tied to sensory experiences. For example, travelling on a riverboat—an economic activity associated with the river—allows individuals to appreciate its natural beauty and enjoy its recreational offerings.

Grouping the respondents' textual framing of urban rivers by relevant values (Figure 2) shows that the ecological value of urban rivers was the most appreciated, with 29.3% of total codes. Other values that received more attention include sentimental (28.2%), recreational (25.8%) and scenic (16.4%) values. People's cultural relation with rivers was manifested in childhood memories and the perception of the river as a 'mother river'. Only two respondents mentioned that specific river sites were preferred because 'the housing price near the river is higher' (0.3% of total codes), corroborating that the economic value of urban rivers is the least preferred.

3.4 | Discrepancy between respondents' visual and textual preferences of river values

A comparison between the values portrayed in photographs and those presented in textual elaborations was conducted using word clouds (Figure 3). The results revealed a clear discrepancy: in respondents' visual framing, the recreational value of urban rivers was the most favoured, followed by economic, ecological and scenic values. Few sentimental relationships were established in the visual framing. In contrast, in respondents' textual framing, the ecological value was the most distinguished one, followed by sentimental, recreational and scenic values, while the economic value was rarely acknowledged.

This comparison suggests that the combination of visual and textual elaboration provides more comprehensive insights into people's understanding of urban rivers. Recreational value supports people's use of rivers and is predominantly represented visually, as infrastructure tends to be the most eye-catching element. Some infrastructures also exhibit economic value and are often captured in photos but appear to garner less attention from the public—as people increasingly prioritise ecological features, which are scarce in today's Chinese cities. The strong preference for the ecological value of rivers further confirms this trend. Although sentimental values are not easily conveyed through visual representations, they were expressed in respondents' textual descriptions, linked to 'mother' and 'childhood'. This suggests that individuals understand the significance of a place through their place experiences and personal attachment (Tuan, 1975).

3.5 | Co-occurrence of rivers' recreational and ecological values in respondents' visual and textual framing

To gain insights into how people perceive the coexistence of natural elements and recreational activities within urban river corridors, we performed matrix co-occurrence analyses on both the visual data (in NVivo® 12, Figure 4) and the textual data (in XLSTAT, Figure 5).

Among the 114 photographs analysed, walking was found to co-exist most frequently with natural elements (including trees, flowers and grasses), followed by activities of fishing, boating, cruising, biking, swimming and running (Figure 4). Specifically, fishing was accompanied by the greatest variety of flora and fauna, including riverine and aquatic vegetation as well as fish. Trees were the only natural element found to co-exist with all types of recreational activities, while birds
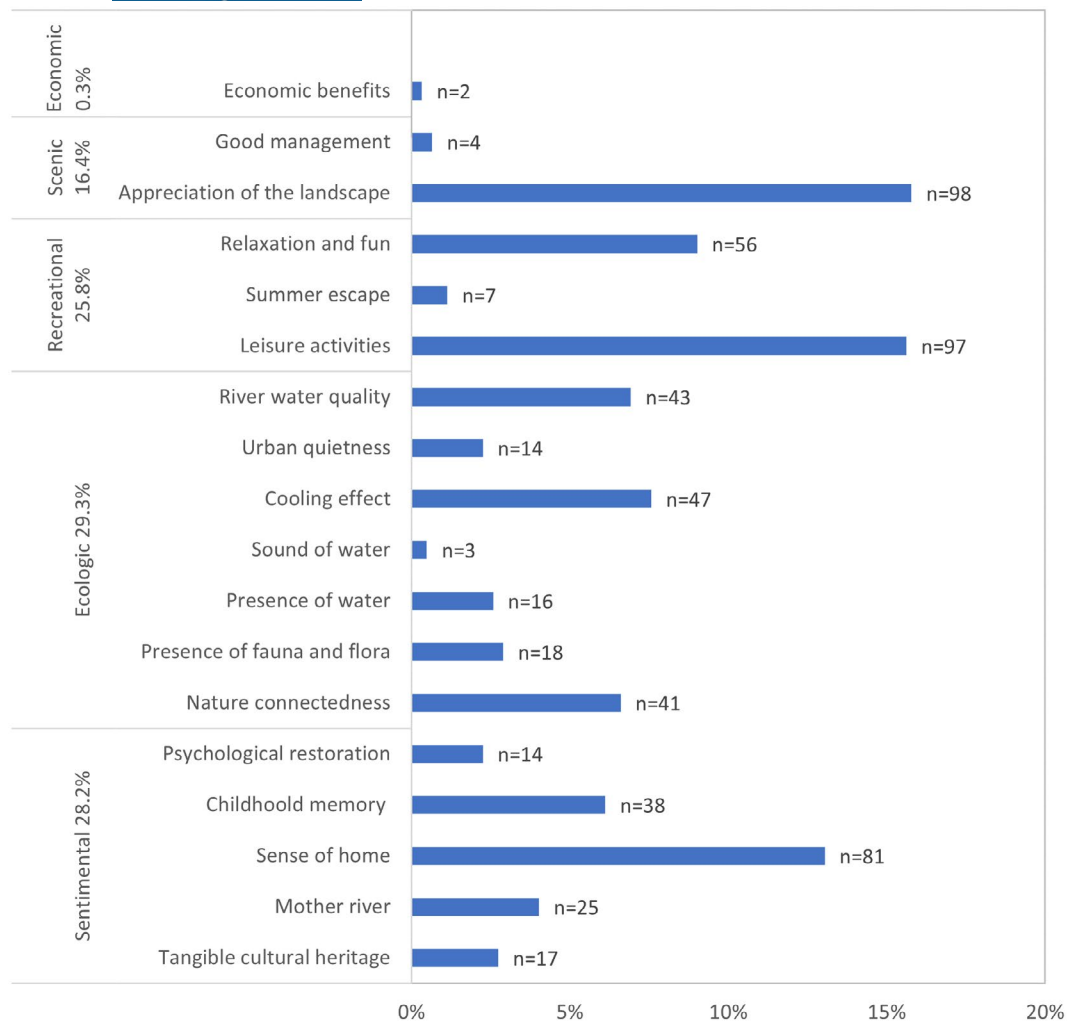
FIGURE 2 Frequency of themes of respondents' textual framing of preferred river sites, result in XLSTAT.

FIGURE 3 A comparison of urban rivers' values reflected by respondents' visual framing (left, analysed in NVivo® 12) and textual framing (right, analysed in XLSTAT).

and ducks were not observed to be presented together with any recreational activities. These findings highlight the role natural elements play in enhancing the quality of recreational experiences, with trees emerging as particularly valuable contributors. On the other hand, the absence of birds and ducks may indicate a gap in river restoration design, for example, lacking creation of their habitats.

The textual analysis confirms the importance of urban rivers' cooling effects in supporting leisure activities, relaxation and fun, especially during the summer (Figure 5). The presence and sound of water were found to enhance relaxation and enjoyment, demonstrating how sensory contact shapes people's perceptions. This also aligns with findings on the therapeutic effects of river sounds in promoting mental restoration (Guo et al., 2022).
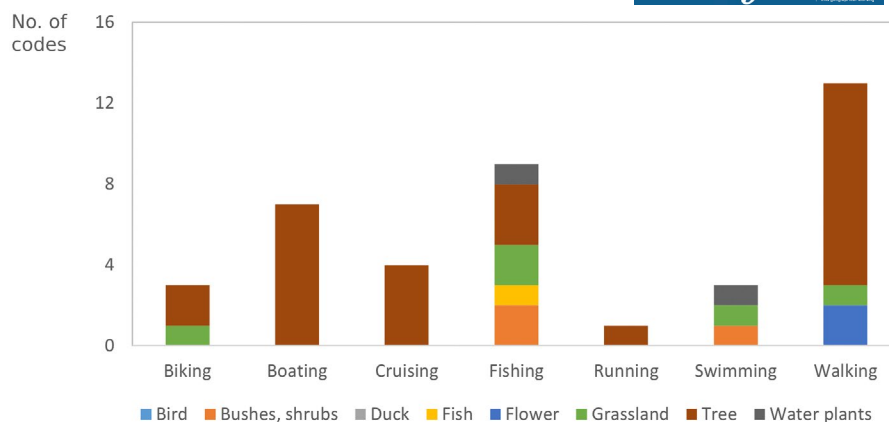
FIGURE 4 Co-existence between fauna and flora (*y*-axis) and leisure activities (*x*-axis) by coding references count in respondents' visual framing (analysed with 'Matrix Coding Query' function in NVivo® 12).
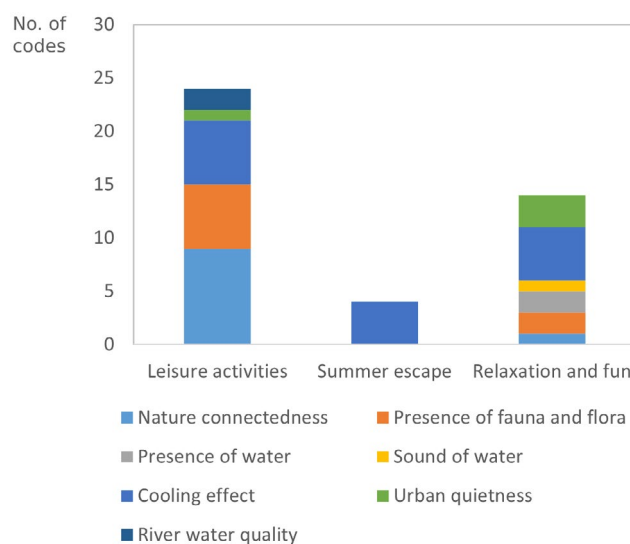

FIGURE 5 Co-existence between the ecological (*y*-axis) and recreational themes (*x*-axis) by coding references count in respondents' textual framing (analysed with 'Matrix Operations' in XLSTAT).

4 | DISCUSSION

A comprehensive analysis of respondents' visual and textual descriptions of their favourite river sites confirmed the multifunctionality of urban rivers through five key values: ecological, scenic, recreational, sentimental and economic. In China, urban rivers act as mirrors of societal dynamics, reflecting historical hydro-agricultural systems (Gao, 2022), the evolving lifestyles of modern urban dwellers (Ting Cho et al., 2021), and the enduring 'mother river' culture. Despite the degradation or disappearance of many rivers, they remain deeply embedded in collective memory and nostalgia (Chen et al., 2020). China's ongoing large-scale river restoration efforts are re-establishing these connections.

Under the influence of this trend, a growing emphasis was found on the socio-environmental functions of rivers—their ecological and recreational values—over economic aspects, with direct, sensory interactions with water being appreciated by the public. Furthermore, urban rivers are increasingly recognised for their cooling effects (Wang et al., 2022) and healing benefits (Roviello et al., 2022). These attributes deserve further exploration for leveraging rivers to mitigate and adapt to climate change, particularly in addressing urban heat islands (Park et al., 2019).

River water quality is among the most highly valued attributes, as it underpins essential functions such as recreation, ecosystem services and biodiversity (Chen & Li, 2018). It also reveals the widespread pollution in urban rivers across

China (Cao & Vazhayil, 2023; Zhou et al., 2011) as well as the urgent public demand for improving water quality (Chen et al., 2019). Public preferences for riverside service facilities, reflected in both visual and textual content, confirm that rivers in Chinese cities are being restored as NbS to provide wider social benefits (Cao & Wantzen, 2023). However, fauna, flora and natural habitats were rarely specified, and no respondent explicitly referred to biodiversity or river ecosystems in describing their favourite urban rivers. This result is consistent with previous studies that the public may lack knowledge about the biological aspects of high-quality rivers (Cockerill, 2016) and tends to overwhelmingly view water quality as the primary factor in shaping riverine ecosystems and biodiversity (Kochalski et al., 2019). This narrow perception mirrors a broader oversight in international freshwater biodiversity conservation, which has prioritised freshwater as a resource over its role as a vital habitat supporting rich organisms—an oversight that undermines efforts to achieve sustainable development goals (Lynch et al., 2023).

The emotional connections that respondents expressed toward urban rivers suggest that rivers in Chinese riverine cities exhibit enduring social connectivity (Kondolf & Pinto, 2017) and community bonding (Verbrugge & van den Born, 2018), which are rooted in Chinese cultural views of human–nature relationships. In this context, successful urban river restoration should focus on re-establishing the relationship between urban residents and river ecosystems (Kondolf & Yang, 2008) as a way to strengthen the city's social-ecological resilience in the long term (Berkes et al., 2008). This is particularly important for river management in China, where public participation has not yet been fully integrated into the process (Cao & Wantzen, 2023b). A previous study demonstrated that understanding how citizens perceive urban rivers can enhance their engagement in managing these ecosystems (Yu et al., 2021). Building on this finding, we recommend that public participation be explicitly included when designing, implementing and evaluating urban river restoration (Cottet et al., 2021) in the context of such an ongoing trend in China.

Although co-occurrence analysis suggests that recreational activities can coexist with urban nature, conflicts may arise between the growing demand for recreation and the need to preserve the fragile ecological functions of urban rivers (Kondolf, 2011). For example, intensive recreational use of riverfronts can hinder the re-establishment of sensitive species (Zingraff-Hamed et al., 2018, 2022). To address these challenges, river restoration projects should focus on careful planning and strategic mitigation to balance the provision of opportunities for direct interaction with nature, for example, through tree planting, while minimising negative ecological impacts, for example, establishing buffer zones that restrict human activities as habitats for specific species (Soga & Gaston, 2020). Ultimately, the goal is to achieve coexistence—a harmonious balance between human recreational use and the ecological health of urban river environments (Zingraff-Hamed et al., 2022).

5 | LIMITATIONS

While visual framing and textual framing are able to capture respondents' norms of perception of the world (Özgüner & Kendle, 2006), this study did not include respondents' demographic and visit-related variables (which might affect people's perception of urban landscapes) (Priego et al., 2008) in the statistical analysis. This was due to a significant amount of missing data pertaining to respondents' socioeconomic characteristics, which precluded a robust causality analysis to explore the relationships among these variables. Moreover, given the sensitivity of such information (e.g., gender, age, income, personal stories), we prioritised strict ethical standards to protect participants' privacy during data collection, also minimising the risk of misreporting on sensitive topics (Tourangeau & Yan, 2007). Finally, the study only included respondents who visited water museums, who might have a greater interest in and familiarity with urban rivers compared with the general population. As a result, the potential bias brought by respondents' self-selection (Chen et al., 2018) cannot be eliminated. Future studies should incorporate explanatory variables to ensure the generalisability of the analytical results.

6 | CONCLUSION

Urban rivers provide opportunities for human–nature interactions, and the social dimensions of river restoration are increasingly gaining attention. However, 40 years of rapid development in China have severely degraded both the rivers and human–river relationships. Recently, large-scale river restoration efforts in China have sought to repair these connections, yet no studies have fully addressed their societal dynamics. This study aims to fill this gap by exploring the ecological, scenic, recreational, sentimental and economic values associated with urban rivers and examining how these are perceived by the public within the context of China's restoration trend.

A qualitative analysis was conducted using visual and textual elaborations provided by respondents about their favourite river sites in three selected Chinese riverine cities through a public survey. The findings reveal that urban residents highly value the multifunctionality of urban rivers, with a strong emphasis on their ecological and recreational benefits. Notably, rivers evoke a profound sense of home and belonging, deeply embedded in Chinese cultural identity.

The results also provide practical implications for future river management in China. Water quality emerged as a pressing issue requiring immediate attention, while biodiversity—often overlooked in current policies—also demands greater focus. Water museums can help transform public perceptions of freshwater biodiversity by developing thematic exhibits, interactive displays, and targeted educational programs, thereby fostering a more holistic understanding of river ecosystems, especially among younger generations in China. Specifically, the study recommends (1) broadening the scope of urban river restoration to address societal needs and create opportunities for stakeholder and public participation, promoting more inclusive river management in China; and (2) developing strategies to balance potential ecological and recreational conflicts related to urban river use, with context-specific mitigation solutions. Ultimately, the study aims to enhance urban river restoration projects, enabling them to achieve broader ecologic, cultural and societal goals, while contributing to the sustainable transformation of Chinese cities—an ongoing effort for nearly a decade through multiscale NbS initiatives.

DATA AVAILABILITY STATEMENT
Data available on request due to privacy/ethical restrictions.

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