

Original article

When blue meets green: Behavioural patterns and social lingering around naturalised ponds in Barcelona

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ABSTRACT

Against the dual challenges of climate vulnerability and biodiversity loss, naturalising urban spaces has emerged as a key nature-based solution for dense Mediterranean cities. This study examined behavioural patterns in urban blue and green spaces, focusing on the presence and influence of naturalised pond environments in public parks. Using a multidimensional systematic observational approach, data were collected from four parks in Barcelona, Spain, each comprising a blue-space area containing a naturalised pond and a nearby green-space area without a pond. Network analysis revealed that green spaces were primarily associated with walking through passage zones, involving both individuals and groups. Blue spaces also supported common activities such as walking and conversing but were additionally associated with distinctive water-related behaviours, including contemplation, interaction with the water, and photography. These activities were predominantly group-based, suggesting that ponds functioned as focal points for social and recreational use. Behaviours associated with lingering accounted for 51.7% of activities in blue spaces, compared with 32.2% in green spaces. These findings indicate that urban blue spaces broaden the range of activities supported by urban parks and are associated with a greater prevalence of social, recreational, and lingering-related behaviours. Incorporating naturalised water features into urban parks may therefore contribute to more engaging and socially supportive public spaces, with potential benefits for community interaction and human well-being.

1. Introduction

Being aware of and experiencing nature generally makes us happier and healthier (Capaldi et al., 2015; Russell et al., 2013) and promotes nature conservation behaviours (Barragan-Jason et al., 2023). Natural settings offer a restorative experience that reduces stress and promotes psychological recovery (Hartig et al., 1997). Because continued access to natural environments is unavailable to a large share of urban residents (Sun et al., 2022), a central challenge in contemporary urban planning is to incorporate nature into the urban environment, primarily through nature-based public open spaces. Vegetated land areas within cities (i.e., urban green spaces) — including parks, green corridors, and landscaped plazas — improve the quality of urban life and boost residents' well-being (Pietilä et al., 2015). In parallel, natural surface water bodies

and naturalised water-related infrastructures featuring aquatic elements (i.e., urban blue spaces) are increasingly recognised as key components of urban naturalisation strategies (Ebi and Bowen, 2023).

Urban blue spaces (e.g., rivers, lakes, canals, fountains, ponds) are widely appreciated for their strong aesthetic appeal (Luo et al., 2023; Subiza-Pérez et al., 2019). In parks, blue spaces play an important role in enhancing visual beauty, as the public perceives them as having high ornamental value, often associated with features such as reflectivity and mirror effects (Nasar and Li, 2004). Additionally, blue spaces are frequently favoured over other urban environments because they provide greater visual and experiential benefits than green spaces (White et al., 2020). Beyond their aesthetic appeal, blue spaces promote citizens' psychological health and wellbeing (Smith et al., 2021; White et al., 2010), emphasising water's role as a restorative feature in urban

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environments (Pradhan, 2012). Water features—including ponds and fountains—together with vegetation and opportunities for social interaction contribute to the overall perceived quality of the environment (Subiza-Pérez et al., 2019; Zhan et al., 2026). This enhanced environmental quality may encourage urban lingering, defined as the spontaneous and non-purposive tendency to remain in a public space beyond the time required to complete a specific task or activity (Cattell et al., 2008; Gamaleldin et al., 2023). However, the extent to which blue spaces specifically influence this behaviour remains poorly understood.

Two complementary theoretical frameworks explain why water specifically generates distinct behavioural patterns. The Attention Restoration Theory (ART; Kaplan, 1995) proposes that water's dynamic properties—movement, reflection, sound, and aquatic biodiversity—engage effortless involuntary attention, inducing relaxed awareness conducive to contemplation and social openness. The Stress Recovery Theory (SRT; Ulrich et al., 1991) complements this by positing that exposure to water elements produces rapid psychophysiological stress recovery, reducing the impulse to leave the space. Together, these mechanisms may help explain why blue spaces function as social anchors that foster contemplation, water-related interaction, and urban lingering beyond what green spaces alone can offer (Fisher et al., 2021; White et al., 2010).

Park design—including amenities, shaded areas, seating, pathways, and visual connectivity—plays a key role in shaping visitors' experiences (Chuang et al., 2022). Additionally, the presence of other people influences perceptions of safety and social interaction (McCormack et al., 2010). These physical and social factors work together to influence visitors' behaviours, determining whether they walk, rest, socialize, or participate in recreational activities.

Han et al. (2022a, 2022b) conducted a systematic review of studies exploring behaviours in public open spaces with natural features and the factors associated with them. Physical activity was the most common outdoor activity. Walking or strolling occurred in most of analysed public open spaces, while sitting—whether for resting or socializing—was also common. Blue spaces are more commonly associated with passive restoration (e.g., contemplation, sitting) and gentle social interaction, whereas large green spaces are more conducive to vigorous physical activity (Kabisch et al., 2020; Pradhan, 2012). These patterns are consistent with the view that public spaces should provide opportunities not only for relaxation but also for social connection (Gehl and Svarre, 2013). Such connections often arise through informal, low-intensity, even invisible ties (Felder, 2020), which have significant effects on users' well-being (Cattell et al., 2008). Sitting is also associated with non-essential leisure activities, such as reading, chatting, and contemplating natural elements for relaxation and psychological restoration (Liu et al., 2019; White et al., 2021).

By improving the environmental quality of urban areas, blue spaces may create more inviting public environments that encourage people to linger. This involves spending time in public spaces for leisure, socialising, or simply enjoying the outdoors (Zukin, 1996). Natural features may increase the “urban linger factor” by encouraging purposeless or loosely structured use of public space (Gamaleldin et al., 2023). Such lingering can facilitate social interaction, social cohesion, community building, and cultural exchange (Aelbrecht and Stevens, 2019; Asadpour et al., 2022). In waterfront areas in Bhopal, India, Mehrotra et al. (2026) found that perceived safety, parking availability, pleasing design, and memorable public spaces jointly influenced lingering behaviour. Repeated and shared experiences of place may also strengthen a sense of belonging, increase social capital, and reduce social isolation and loneliness (Ljubojevic, 2025), thereby contributing to individual well-being and quality of life (Cattell et al., 2008).

In sum, although a growing body of research has examined blue spaces in terms of aesthetic preferences, psychological restoration, and general health benefits, the literature largely overlooks blue spaces as a source of specific, directly observable behavioural patterns. While green spaces are strongly associated with physical activity and active

recreation, blue spaces are less frequently examined through systematic observational methods and are often framed primarily as settings for psychological restoration, relaxation, or contemplation. Critically, comparative studies that examine how the presence of naturalized water features shapes actual space use—as opposed to perceived or reported experiences—remain scarce. This raises an important empirical question: when a naturalized blue space is present in an urban park, does it elicit specific forms of use? More specifically, do behavioural patterns differ from those typically observed in comparable green spaces?

This study investigates whether and how naturalised ponds in urban parks are associated with behavioural patterns that differ from those observed in comparable green spaces, with particular attention to water-related behaviours and the capacity of blue spaces to foster urban lingering. Using a systematic observational methodology, data were collected across four parks in Barcelona, Spain, each comprising a naturalised pond area (blue space) and a nearby area without water features (green space). Behavioural patterns in blue and green spaces were analysed as complex networks, comparing node indices and cluster configurations to identify and characterise patterns of use.

2. Materials and methods

2.1. The case of Barcelona

Barcelona is a densely populated Mediterranean city, with more than 15,000 inhabitants km⁻², that faces increasing heat exposure, water scarcity, and biodiversity loss. Over the past decade, municipal planning has progressively incorporated nature-based solutions and blue-green infrastructure, notably through the Greenery and Biodiversity Plan and the Barcelona Nature Plan 2021–2030 (Ajuntament de Barcelona, 2021; Satorras et al., 2020).

A major component of this strategy has been the naturalisation of artificial ponds through reduced chemical treatment and the introduction of diverse aquatic vegetation. Previous studies indicate that these ponds can support substantial aquatic biodiversity and provide habitat for species despite strong urban pressures (Montes-Pérez et al., 2025; Pontes et al., 2021). However, naturalised ponds may also be perceived by some users as poorly maintained, highlighting potential differences between ecological management objectives and public responses (Ajuntament de Barcelona, 2021; Mitroi et al., 2022).

2.2. Parks selection

Four parks in Barcelona were selected: Diagonal Mar Park, Mas Ravetllat Park, Turó Park, and Jardins d'Aclimatació Park. These four parks met the basic eligibility criteria of containing an accessible naturalised pond and a nearby terrestrial area without water features. They were purposively selected to represent variation in urban density, park structure, pond size, vegetation, and degree of naturalisation. Rather than providing a statistically representative sample of all urban parks in Barcelona, the selected sites were intended to capture a range of common blue- and green-space configurations across the city. Within each park, two sampling areas were designated: a blue space containing a pond and a nearby green space without water features. Pairing the two areas within the same park helped control for broader differences in urban context, management, accessibility, and surrounding vegetation, while allowing behavioural patterns associated with the presence of a naturalised pond to be compared (Fig. 1).

Diagonal Mar Park (41°24'30"N 2°12'51"E) is located within a densely built modern urban area close to the sea. The blue-space sampling area (4422.2 m²) included part of a large pond (12,000.0 m²) and its adjacent shoreline. The pond has an irregular shoreline combining hard engineered edges, gently sloping vegetated banks, and patches of emergent aquatic vegetation. Its surroundings include lawns, shrubs, scattered trees, and pedestrian boardwalks and bridges. The green-space sampling area (7239.6 m²), located north of the blue-space area, was



dominated by paved surfaces interspersed with scattered trees, sculptural metal structures, and numerous seating areas (minimum distance between zones: 1.64 m).

Mas Ravetllat Park ($41^{\circ}24'55''\text{N}$ $2^{\circ}10'13''\text{E}$) is in the densely built Guinardó neighbourhood. The blue-space sampling area (828.2 m^2) encompassed a small pond (107.1 m^2) and its immediate surroundings. The pond contained abundant and diverse emergent, floating-leaved, and submerged aquatic vegetation and was bordered by historic architectural elements. Its surroundings included mature trees, shrubs, and

walkways. The green-space sampling area (646.2 m^2), located south of the blue-space area, was dominated by mature trees and walkways (minimum distance between zones: 18.29 m).

Turó Park ($41^{\circ}23'40''\text{N}$ $2^{\circ}08'25''\text{E}$) is in the densely built Sant Gervasi–Galvany neighbourhood. The blue-space sampling area (3860.2 m^2) encompassed a medium-sized pond (1060.9 m^2) and its adjacent surroundings. The pond contained abundant aquatic vegetation, particularly floating-leaved water lilies, interspersed with open water. Its surroundings included numerous mature trees and benches,

with dense tree cover and shading along the northern shore. The green-space sampling area (2649.4 m²), located northeast of the blue-space area, was dominated by an open lawn centred on an ornamental fountain that was dry during sampling and bordered by sandy walkways, scattered trees, and seating areas (minimum distance between zones: 56.55 m).

Jardins d'Aclimatació Park (41°21'56"N 2°09'10"E) is located on Montjuïc hill, within a predominantly green and less densely built part of the city. The blue-space sampling area (1161.6 m²) included a small pond (63.8 m²) and its immediate surroundings. The pond contained abundant emergent, floating-leaved, and submerged aquatic vegetation, while its surroundings comprised mature trees, shrubs, and walkways. The green-space sampling area (959.6 m²), located east of the blue-space area, was dominated by mature trees, shrubs, and walkways (minimum distance between zones: 6.51 m).

In all four parks, dense vegetation, including mature trees, shrubs, and embankments, between the paired zones prevented direct visual exposure of one area from the other. Representative photographs of each paired blue and green zone are shown in Fig. 2.

2.3. Methodological approach

Observational methodology has been employed to analyse various features of urban public and green spaces (Pinheiro et al., 2008; Sampson and Raudenbush, 1999; Wang et al., 2021). Recent research has incorporated systematic observation into the study of public spaces by examining large datasets using specific analysis techniques such as Coordinate Polar Analysis (Pérez-Tejera et al., 2018; 2022) and Network Analysis (Valera and Casakin, 2022). This study adopted a multidimensional observational design characterised by: (i) nomothetic observation across different locations and groups; (ii) intersessional follow-up tracking of multiple sessions; and (iii) examination of multiple macro-criteria involved in the observational method (Anguera, 2003).

2.4. Instrument

The EXoDES tool (<https://www.exodes.es>; Pérez-Tejera et al., 2011; 2018; Valera, 2020; Valera et al., 2018) was used to systematically record behavioural and environmental information. This tool records simultaneous behaviours involving multiple criteria by using a combination of category systems and field formats. Category systems comprise predefined categories derived from previous research, such as gender, age, or ethnic groups, whereas field formats allow categories to be generated according to the observed data, such as activity type (Anguera and Hernández Mendo, 2013).

The version used in this study included 280 mutually exclusive codes distributed across 26 dimensions and four macro-criteria: (i) context, (ii) group and individual profiles, (iii) activities, and (iv) environment. Information about the setting was coded based on its function (e.g., passage zone, resting zone, playground, green area) (Table 1).

2.5. Procedure

Observations were conducted in the four parks from June to December 2023, covering summer (June–September) and autumn (October–December). Ten observers were trained using photographs, field exercises, and 20 one-minute videos of urban scenes. Inter-rater reliability was high (Fleiss' $\kappa = 0.916$, SE = 0.003, 95% CI = 0.909–0.922, $p < 0.001$), indicating an exceptionally high level of reliability in the observers' ratings agreement (Landis and Koch, 1977).

Observations covered eight daily time slots between 10:00 and 20:00, excluding 14:00–16:00 because of typically low park use. To reduce observer bias, each site was assessed by at least three observers on at least three different weekdays. During each 60-min session, observers visually scanned the site from left to right and recorded all observed events using the EXoDES application. Each record included the

observer, site, date and time, demographic information, activity performed, and environmental characteristics of the location. The final database included 6.330 records: 1882 from Diagonal Mar Park, 1542 from Mas Ravetllat Park, 1863 from Turó Park, and 1043 from Jardins d'Aclimatació Park. Each park was surveyed during 52–59 sessions across its blue- and green-space areas, corresponding to 25–31 sessions per area (Table 2). These records were collected across 219 sessions at different times. The full dataset is available through the Open Science Framework (OSF) repository (see Data Availability Statement).

2.6. Data analysis

Observational data were analysed using Network Analysis (Valera and Casakin, 2022). Each EXoDES code was represented as a node, and two nodes were connected when they co-occurred within the same observational record. Edge weights represented the frequency of these co-occurrences, producing weighted, undirected networks of the relationships among user characteristics, activities, environmental conditions, and spatial functions.

Networks were constructed and analysed using the software Pajek: Program for Analysis and Visualization of Large Networks (<http://mrvar.fdv.uni-lj.si/pajek/>) (de Nooy et al., 2018). Two node-level centrality indices were calculated. The Degree index (d) indicates the number of nodes directly connected to a specific node, reflecting its centrality and influence within the network. The Weighted Degree index (wd) counts the number of connections to other nodes and reflects a node's relevance in terms of frequency and network presence. Network-level metrics included density and degree, closeness, and betweenness centralisation, which provide complementary information on network connectivity and organisation (Rubinov and Sporns, 2010).

Networks were subsequently exported to VosViewer software (<https://www.vosviewer.com>; Van Eck and Waltman, 2011) for visualisation, clustering analysis, and network layout optimisation.

Comparisons between blue and green spaces focused on three groups of nodes: spatial-zone functions, activities or uses, and user profiles, including whether users were alone or in groups, age, gender, and group composition. All nodes included in the analysis are detailed in Supplementary Material S4.

A lingering-capacity indicator was developed to quantify the relative network prominence of activities associated with remaining in a space. Activities were classified a priori as either lingering-associated, including resting, conversing, reading, eating, observing the pond, and taking photographs, or non-lingering-associated, including walking, jogging, running, cycling, and maintenance work. For each space type, lingering capacity was calculated as the sum of the weighted-degree values of lingering-associated activities divided by the sum of the weighted-degree values of all activities, expressed as a percentage.

Because EXoDES records behavioural occurrences rather than visit duration, this indicator does not directly measure the time users spent in each space. Instead, it represents the relative prevalence and network prominence of behaviours associated with lingering during fixed-duration observation sessions. The indicator includes both general activities that can occur in blue and green spaces and water-related activities restricted to blue spaces; differences between space types should therefore be interpreted as differences in their overall behavioural profiles.

3. Results

3.1. Node analysis

Green and blue spaces showed similarities and differences in the location of observed activities (Supplementary Table S1). In green spaces, passage zones were the key locations where actions took place. They were important as central nodes in the network ($d_{\text{PASSAGEZONE_GREEN}}=72$), especially considering how often they appear,



Fig. 2. Representative views of the paired blue and green zones in each of the four study parks. Left column: naturalised pond areas; right column: adjacent green areas without water features. (A) Diagonal Mar Park; (B) Mas Ravetllat Park; (C) Turó Park; (D) Jardins d'Aclimatació Park. All photographs were taken by the research team.

Table 1

EXODES Structure and Coding Scheme. Based on Pérez-Tejera et al. (2018) and Valera (2020).

Macro-criterion	Dimensions / Examples of Variables	Examples of Codes
(i) Context	Function of space	Passage, resting area, playground, green area
(ii) Individual and Group Profiles	Gender, age composition, ethnicity, homelessness	Male/Female; Children, Teenagers, Adults, Elders; White, Latin, Arab, Asian, African
(iii) Activities	Main activity, transport mode, social incivilities	Resting, playing, walking, reading; Bicycle, wheelchair; Drinking, drug use, vending
(iv) Environment	Maintenance, cleanliness, graffiti, visual control	Clean/Dirty; Presence/Absence of graffiti; Level of vegetation maintenance

Table 2

Distribution of records and sessions in blue and green spaces from the four investigated parks in Barcelona.

Park	Place	Type	Records	Sessions
Diagonal Mar	Place 1	Blue	832	31
Diagonal Mar	Place 2	Green	1050	28
Mas Ravetllat	Place 3	Blue	816	27
Mas Ravetllat	Place 4	Green	726	27
Turó Park	Place 5	Blue	903	27
Turó Park	Place 6	Green	960	27
Jardins d'Aclimatació	Place 7	Blue	569	27
Jardins d'Aclimatació	Place 8	Green	474	25
		TOTAL	6.330	219

which indicates the total number of connections to other nodes ($wd_{PASSAGEZONE_GREEN}=7923$). Rest areas ($d_{RESTAREAS_GREEN}=61$; $wd_{RESTAREAS_GREEN}=2023$) and green areas ($d_{GREENAREAS_GREEN}=61$; $wd_{GREENAREAS_GREEN}=713$) were secondary contexts, much less prominent than the passage zones. Sport areas completed the set of main places detected ($d_{SPORTCOURT_GREEN}=40$; $wd_{SPORTCOURT_GREEN}=449$).

In blue spaces, the passage zone was relevant in terms of the number of connections ($wd_{PASSAGEZONE_BLUE}=4767$); however, the more central node that defined the main context was water area ($d_{WATERAREA_BLUE}=68$). Green areas ($d_{GREENAREAS_BLUE}=60$; $wd_{GREENAREAS_BLUE}=826$) and rest areas ($d_{RESTAREAS_BLUE}=62$; $wd_{RESTAREAS_BLUE}=1925$) also represented relevant contexts. Unlike in green areas, however, water elements emerged as central contexts for observed activities, particularly in relation to the types of behaviours performed.

Similarities and differences in activity types were also observed between green and blue spaces (Supplementary Table S2). Walking was the most prominent behaviour in both green ($d_{WALKING_GREEN}=58$; $wd_{WALKING_GREEN}=6815$) and blue spaces ($d_{WALKING_BLUE}=55$; $wd_{WALKING_BLUE}=4627$), followed by conversing, although with substantially lower values. In blue spaces, water-related activities were also relevant, including watching ponds' water ($d_{WATCHWATER_BLUE}=44$; $wd_{WATCHWATER_BLUE}=1381$), interacting with the water, such as touching or splashing ($d_{INTERACTWATER_BLUE}=36$; $wd_{INTERACTWATER_BLUE}=580$), and taking photographs ($d_{PHOTOS_BLUE}=35$; $wd_{PHOTOS_BLUE}=588$). In green spaces, playing was the third most frequent activity ($d_{PLAYING_GREEN}=40$; $wd_{PLAYING_GREEN}=789$).

Regarding user profiles (Supplementary Table S3), groups dominated both green ($d_{GROUP_GREEN}=84$; $wd_{GROUP_GREEN}=7332$) and blue spaces ($d_{GROUP_BLUE}=86$; $wd_{GROUP_BLUE}=295$). Individuals appeared less often than groups, especially in blue spaces ($wd_{SINGLE_BLUE}=3839$; $wd_{SINGLE_GREEN}=4101$). No marked difference in gender composition was observed between green and blue spaces. In both space types, groups consisted mainly of women or mixed-gender, whereas individuals were predominantly male. Complete node indices for zones, activities, and user profiles are provided in Supplementary

Tables S1–S3.

3.2. Network analysis

Network analysis revealed distinct patterns of use in green and blue spaces (Figs. 3 and 4). In green spaces, the dominant pattern comprised walking through passage zones, involving both individuals and groups (Fig. 3). Other activity clusters were associated with playgrounds, sports courts, and green areas. Groups, particularly those including children and young people, were mainly linked to playing and other activities in these areas, whereas individuals were more frequently associated with running or sedentary activities such as reading, sleeping, and using electronic devices. Conversing and resting formed less prominent patterns.

In blue spaces, walking through passage zones remained common but was more strongly associated with individuals, whereas groups were mainly linked to water-related behaviours (Fig. 4). These included observing the pond and its biota, interacting with the water, feeding birds, and taking photographs. A further cluster comprised resting, conversing, eating, reading, and device use in green and seating areas surrounding the ponds. Thus, the presence of water was associated with a broader and more socially oriented behavioural profile than that observed in green spaces.

The networks shown in Figs. 3 and 4 displayed evidence of internal community structure. Modularity (estimated using the igraph library in R) was slightly higher in the green-space network ($Q = 0.38$) than in the blue-space network ($Q = 0.32$), both values being consistent with the existence of internal structures. Accordingly, the Laplace matrix estimates (Fiedler's indicator) showed a greater than zero number of eigenvalues close to 0 in both networks, suggesting weakly connected internal partitions.

Density maps restricted to spatial and activity nodes further showed that walking in passage zones dominated green spaces, whereas water-related and mainly group-based activities formed a distinctive cluster in blue spaces (Fig. 5). Additionally, chatting in resting areas created distinct patterns in both blue and green spaces, and playing activities were more commonly linked to groups of users in green spaces.

The green- and blue-space networks were similar in their numbers of nodes and edges and in overall density (Table 3). The green-space network had a higher mean degree, whereas degree, closeness, and betweenness centralisation were slightly higher in the blue-space network, indicating a stronger concentration of connections around a subset of nodes.

Park-specific analyses showed broadly consistent patterns across all four parks (Supplementary Figures S1 and S2). Across green spaces, walking and passage zones formed the principal network structure, while resting areas and sports courts were generally secondary, although they were more prominent in Turó Park. Across blue spaces, walking and passage zones remained relevant, but water areas and water-related activities consistently formed an additional cluster associated mainly with groups.

3.3. Urban lingering

Fig. 6 compares the prevalence of lingering- and non-linging-associated activities in green and blue spaces. In green spaces, lingering activities such as resting, conversing, relaxing, eating, reading, or using devices accounted for 32.2% of all observed activities. In contrast, this percentage rose to 51.7% in blue spaces, where additional water-related behaviours included exploring or observing the pond water and its associated natural features, splashing or playing with water, and taking photographs. Blue spaces therefore did not only attract groups and foster social activities but also showed a higher prevalence of behaviours associated with prolonged stays.

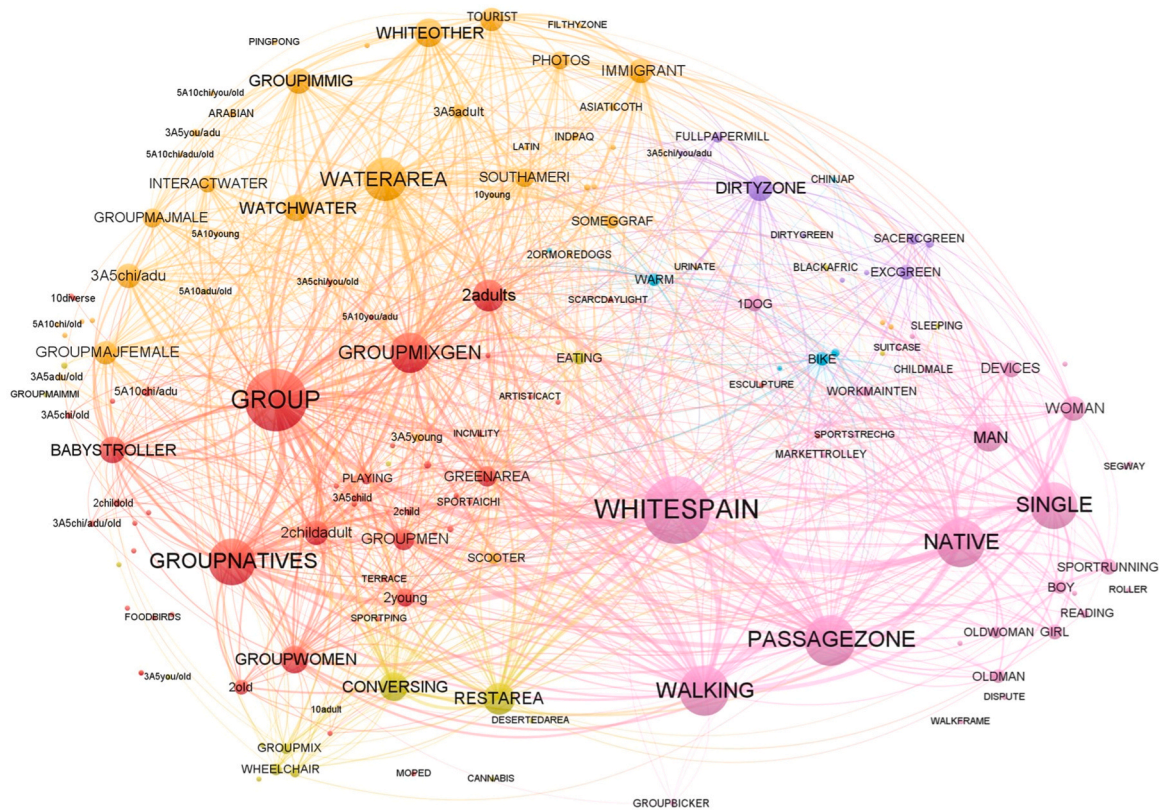


Fig. 3. Data network of green spaces. See [Supplementary Material S4](#) for definitions of abbreviations.

4. Discussion

In cities, contact with nature through green and blue spaces provides essential physical and psychological benefits (Barragan-Jason et al., 2023; White et al., 2020). Natural and water-related features, including trees, fountains, and ponds can improve stress relief, perceived well-being, and restorative effects among visitors (Jiang et al., 2014).

Blue spaces are often preferred to green spaces because water provides additional sensory and aesthetic features such as reflective surfaces (Nasar and Li, 2004), pleasant soundscapes (Liu et al., 2022), and opportunities to explore aquatic biodiversity (Higgins et al., 2019). Nevertheless, comparatively little attention has been paid to whether these environments support different behavioural patterns. In our study, walking, representing physical activity, was the dominant activity, while resting and conversing, representing social activity, were also common, consistent with previous observations of public open spaces (Han et al., 2022a). These patterns support the recognised role of urban natural environments, especially green spaces, in facilitating physical activity and promoting human health (Joseph and Maddock, 2016). Additionally, the presence of nature attracts people and encourages rest and relaxation, thereby supporting mental health by helping to reduce anxiety and depression (Bray et al., 2022; Liu et al., 2019).

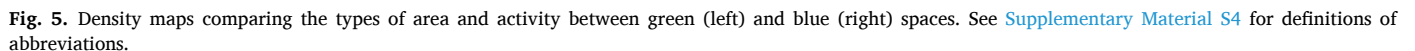
While these behaviours dominate the dynamics of green spaces, behavioural patterns differ significantly when blue spaces are present, as water features encourage specific activities that balance physical activity and social interaction. Blue spaces were associated with behaviours such as contemplation, photography, and exploring native bird and plant species. These activities are consistent with the attentional fascination and psychological recovery mechanisms proposed by ART and SRT and may be linked to relaxation and restorative effects at the individual level, although these psychological outcomes were not directly assessed in this study (de Bell et al., (2017)). Our findings strongly support this, as evidenced by the higher frequency of social interactions and conversations among people in blue spaces compared to

green spaces. In addition, while walking in green spaces occurred equally among individuals and groups, a distinct pattern emerged in blue spaces: individuals tended to walk alone, whereas groups were often found near ponds and their surroundings. This supports the idea that blue spaces are associated with higher rates of social interaction and non-essential activities than green spaces (Gehl and Svarre, 2013). Ludic activities such as exploring biodiversity, touching the water, and splashing were observed across all age groups, consistent with previous studies highlighting the capacity of water features to stimulate exploration and play, particularly among children (Fisher et al., 2021; Leblanc et al., 2019; Pradhan, 2012).

Regarding the structure of the networks and their centralization indices, the comparison between green and blue spaces revealed a slight difference: the blue spaces' network appeared a little more complex, connected, and compact than the green spaces' network. However, blue spaces displayed greater behavioural diversity, largely because water features supported additional activities not observed in green spaces, including water-related exploration, interaction, and photography (Leblanc et al., 2019).

No distinct user profile was associated with either space type. Groups prevailed over individuals in both green and blue spaces, and there were no differences by gender or age. These findings suggest that the contrasting behavioural patterns were broadly shared across user groups and were more closely associated with the characteristics of the spaces than with the demographic composition of their users.

Blue spaces showed a greater lingering capacity than green spaces, with a higher proportion of observed activities associated with prolonged stays. This pattern is consistent with previous evidence that people may prefer blue spaces over green ones for staying and leisure than merely passing through them (Park and Khanal, 2025; White et al., 2010). Specifically, non-essential activities such as contemplating the water, photographing of natural elements, and interacting with the water were more prominent near ponds (Kabisch et al., 2020; Pradhan, 2012). These behaviours may reflect the greater perceived richness and



A key limitation of this study is that it did not capture the full multidimensional quality of blue spaces, for which assessment frameworks remain underdeveloped (Mishra et al., 2021; Subiza-Pérez et al., 2019). Lingering patterns may also be partly contingent on microclimatic conditions, since water features can enhance thermal comfort and thus influence people's propensity to remain in place (Mehrotra et al., 2021). More broadly, the observational design did not allow for systematic control of other spatial variables that may influence behavioural patterns, such as the availability and distribution of seating, the degree of shade cover, the visibility between zones, or the overall spatial

The operationalisation of urban lingering through behavioural categories carries inherent limitations. First, the classification of activities as 'lingering' or 'non-lingering' relies on theoretical assumptions about which behaviours are associated with voluntary prolonged stays, which may not capture the full complexity of lingering as a phenomenon. Second, the same activity — such as conversing or resting — may reflect very different durations of stay depending on the individual and context,

Table 3
Indices of green and blue networks.

Green spaces network		Blue spaces network	
Number of vertices (n)	158	Number of vertices (n)	157
Total number of lines (edges)	2927	Total number of lines (edges)	2827
Density	0.236	Density	0.231
Average Degree	37.051	Average Degree	36.013
Network Degree Centralization	0.651	Network Degree Centralization	0.681
Network Closeness Centralization	0.641	Network Closeness Centralization	0.686
Network Betweenness Centralization	0.075	Network Betweenness Centralization	0.098

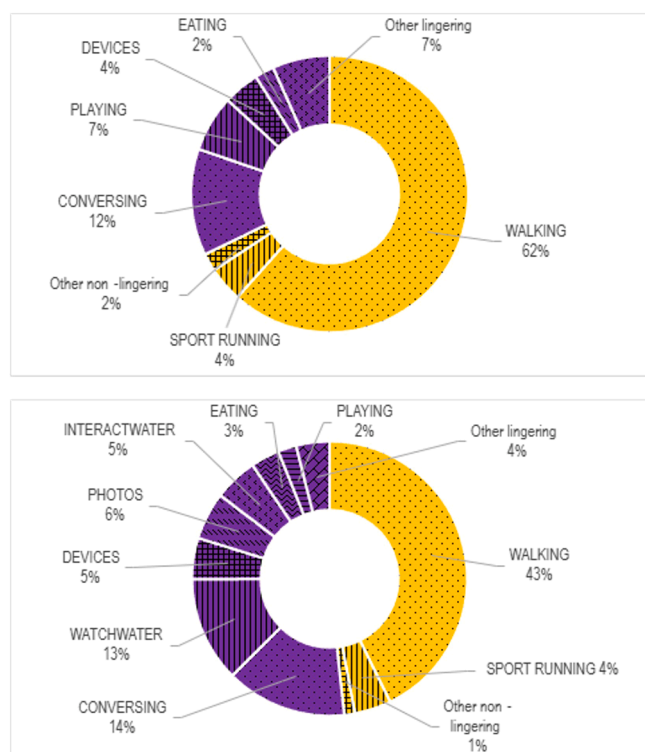


Fig. 6. Lingering capacity of green (top) and blue (bottom) spaces, operationalised as the relative prevalence of activity types associated with prolonged stays rather than as a direct measure of visit duration. Orange indicates the percentage of activities that do not foster lingering; purple indicates the percentage of lingering activities.

a nuance that frequency-based indicators cannot fully capture. Future research combining systematic observation with self-reported measures of visit duration would allow for a more direct validation of lingering indicators derived from behavioural data.

The observation period, spanning June to December 2023, did not cover spring or winter months, which may limit the generalisability of the findings across seasons. Future research should extend observations across the year and include concurrent meteorological and thermal-comfort measurements to distinguish seasonal and environmental influences on park use. The observed behavioural patterns may not be generalisable across the diversity of public open-space typologies (e.g., parks, streets, squares), underscoring the need for comparative research across urban settings. Relatedly, this study did not explicitly evaluate equitable access or differential benefits among social groups, despite evidence that exclusion from the most advantageous urban

environments can shape who uses and benefits from naturalised spaces (Mombelli et al., 2026). Moreover, although the within-park paired design controlled for many potentially influencing variables, differences in the size and spatial configuration of blue- and green-space areas may have influenced the results and were not formally accounted for in the analysis. Finally, the analysis focused on behavioural responses without concurrently assessing ecological effects of these interventions. Integrating behavioural, social and ecological dimensions remains an important next step towards a more comprehensive evaluation of urban blue-space interventions.

5. Conclusions

Naturalised ponds were associated with distinct patterns of use within Barcelona's urban parks. Compared with nearby green spaces, blue spaces supported a broader range of activities, including observing aquatic features and wildlife, interacting with the water, and taking photographs. Water-related activities were mainly associated with groups, whereas walking through green spaces involved both groups and individuals. These patterns were broadly shared across age and gender categories, suggesting that naturalised ponds can engage diverse park users.

Blue spaces also showed a higher prevalence of social, recreational, and other behaviours associated with prolonged stays. Although visit duration and psychological outcomes were not measured directly, these findings indicate that naturalised ponds may encourage urban lingering and strengthen the social use of public spaces.

Naturalised urban ponds therefore represent a promising component of park design. By supporting distinctive water-related activities and creating settings for social interaction and lingering, they may complement the functions traditionally associated with urban green spaces. Incorporating visible, accessible, and ecologically managed water features into urban parks could contribute to more engaging and socially inclusive public environments, although their wider effects on well-being, equity, ecological quality, and urban resilience require further investigation.

CRediT authorship contribution statement

Castrechini-Trotta Angela: Writing – review & editing, Writing – original draft, Investigation. **Daniel von Schiller:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization. **Sergi Valera:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Formal analysis, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation and the revision of this work, the authors used Grammarly, solely to enhance the text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Ethics statement

This study involved non-participant observation of people in public spaces where no expectation of privacy exists. No interventions were made, no personal data was recorded, and no photographs or videos of individuals were included. The study was therefore exempt from ethics committee review and informed consent requirements, in accordance with applicable national and institutional guidelines.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ufug.2026.129643](https://doi.org/10.1016/j.ufug.2026.129643).

Data availability

The observational dataset supporting the findings of this study is openly available in the Open Science Framework (OSF) repository under the title “When blue meets green: Behavioural patterns and social lingering around naturalised ponds in Barcelona”, at <https://doi.org/10.17605/OSF.IO/763WX>

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