

Review

Patterns of Urban Green Space Use Applying Social Media Data: A Systematic Literature Review

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Abstract: Scientific interest in the potential of urban green spaces, particularly urban parks, to improve health and well-being is increasing. Traditional research methods such as observations and surveys have recently been complemented by the use of social media data to understand park visitation patterns. We aimed to provide a systematic overview of how social media data have been applied to identify patterns of urban park use, as well as the advantages and limitations of using social media data in the context of urban park studies. We used the PRISMA method to conduct a systematic literature analysis. Our main findings show that the 22 eligible papers reviewed mainly used social media data to analyse urban park visitors' needs and demands, and to identify essential park attributes, popular activities, and the spatial, social, and ecological coherence between visitors and parks. The review allowed us to identify the advantages and limitations of using social media data in such research. These advantages include a large database, real-time data, and cost and time savings in data generation of social media data. The identified limitations of using social media data include potentially biased information, a lack of socio-demographic data, and privacy settings on social media platforms. Given the identified advantages and limitations of using social media data in researching urban park visitation patterns, we conclude that the use of social media data as supplementary data constitutes a significant advantage. However, we should critically evaluate the possible risk of bias when using social media data.

Keywords: urban green spaces; social media data; park use; systematic review; big data



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1. Introduction

As cities grow and become denser, urban green spaces are becoming a critical component for improving human health and well-being, as well as for social interaction, economic benefits, and environmental quality improvement [1–4]. Urban green spaces provide ecosystem services that contribute to mitigating global climate change-related challenges e.g., by regulating extreme temperatures or floods and reducing air and noise pollution [5–10]. Urban green spaces, such as parks, provide health and well-being benefits such as recreation, social interaction, and a connection to nature [11–16]. Understanding the linkage between urban parks and human well-being under global challenges such as climate change and urbanization may be crucial for sustainable and resilient urban development [17]. Planning for sustainable and resilient urban development requires knowledge on which urban green spaces are used under the contextual conditions of global changes such as periods of heat and drought, or under increasing population densities [5], and which characteristics of particular green spaces such as parks actually attract visitors. This knowledge may help urban planning to further qualify urban green spaces.

To date, it is still challenging to collect detailed information on urban park usage and visitor profiles [18]. Information on park visitation patterns is usually collected based on observations or questionnaire surveys [19–22]. Applying these methods provides researchers with a wealth of detailed information about visitors' personal experiences, behaviour, and perceptions of the parks they visit [21–23]. However, the way in which researchers word their questions may affect responses [24,25]. Observations and questionnaire surveys usually have a limited sample size and are constrained by time and space, and the results may not represent the broad public [5,26,27].

Given these potential limitations of traditional techniques such as questionnaire surveys or observations, the use of social media data has recently been suggested as a new tool for surveying park visitor numbers and for presenting a more holistic picture of what park visitors appreciate in specific park settings, and what they may be missing [28–30]. Detailed information has been gained through the reviews, images, videos, hashtags, and “check-ins” of active daily users of social media in real time on social media platforms such as Instagram, Flickr, Twitter, Facebook, TripAdvisor, or Google Reviews [31–33].

The most prominent social media platforms for urban green space research are Twitter, Instagram, and Weibo [34]. The micro-blogging service Twitter launched in 2006, allowing users to post short messages. Twitter reports that it had 322.4 million active users in 2021 [35], with over 575,000 tweets per minute uploaded daily [36]. Gathered Twitter data have been applied in urban research, such as in the context of urban green space studies [37]. The social network Instagram was created to share photos and other visual content. In 2021, Instagram had 1074 billion active users [38]. While sharing their activities, e.g., in urban green spaces, Instagram users typically upload photos, which may provide more information about the quality of a park's attributes as well as its greenery and infrastructure. This additional information can provide factual, unopinionated information about the state of the facility visited. Since 2016, however, Instagram has restricted access to its application programming interface, limiting the availability of data for research purposes [28]. Weibo is the Chinese equivalent of Twitter, and it is China's one of the largest social media site. Weibo has many users and is one of the largest geo-tagged datasets available. According to Weibo's annual report, there were 246 million daily active users in 2021 [39]. Weibo users can share their locations in real time online. Weibo check-in data have been used as a proxy to measure actual visits to parks in China [40].

In addition to prominent social media platforms such as Twitter or Instagram, online review platforms are organized and structured filtering systems where users post information about their experiences on a particular site [31,41]. Usually, review platforms have no character limit, which allows users to express their experiences and perceptions in detail. Online review platforms, such as Google Reviews, have no direct connection to users' personal information.

The amount of information received on social networks continues to increase yearly, and the number of social media users will continue to grow [42]. Increasing social media data may provide new methodological opportunities to study how people interact within urban green spaces such as parks, and to assess user preferences in space and time for potential use and application in urban planning [42,43].

Given the increased interest in using social media data for researching the benefits of urban green spaces, the main aim of this paper is to provide a systematic literature review based on three main research questions:

- (1) What are the main aims and findings of existing research using social media data to assess green space use and, in particular, park use?
- (2) What are the identified and discussed advantages and limitations of using social media data for urban park studies?
- (3) What are the prospects of the use of social media data in urban green space research in the future?

2. Materials and Methods

We performed a systematic literature review following the PRISMA protocol (“Preferred Reporting Items for Systematic Reviews and Meta-Analyses”; see Figure 1) [44]. The search was conducted on 2021 April 27, and Web of Science and ScienceDirect were used as major search engines. We focused on empirical studies published in academic journals since 2010 and written in English because social media networks emerged between 2003 and 2010 [45]. We used the following main terms for the search: (I) area, (II) urban green spaces, (III) social media platform, and (IV) activity. We applied multiple Boolean techniques, using they keywords (I) “Urban” OR “City” OR “Cities” AND (II) “Park*” OR “Greenspace*” OR “Ecosystem services” OR “Forest” AND (III) “Social media” OR “Twitter” OR “Flickr” OR “Instagram” OR “Google reviews” AND (IV) “visit*” OR “visitation” OR “visiting” OR “use” OR “access”. We searched for critical terms in the title, abstract, or author-specified keywords of the research. We imported and organized the extracted papers into the Mendeley Desktop (Version 1.19.8) citation tool. We screened the selected papers and excluded them for the following reasons: (I) the title and abstract were not related to the main research questions; (II) they did not focus on social media or review platforms; (III) they had no spatial parameter; (IV) they were conference proceedings; (V) they were books; or (VI) they were not original papers.

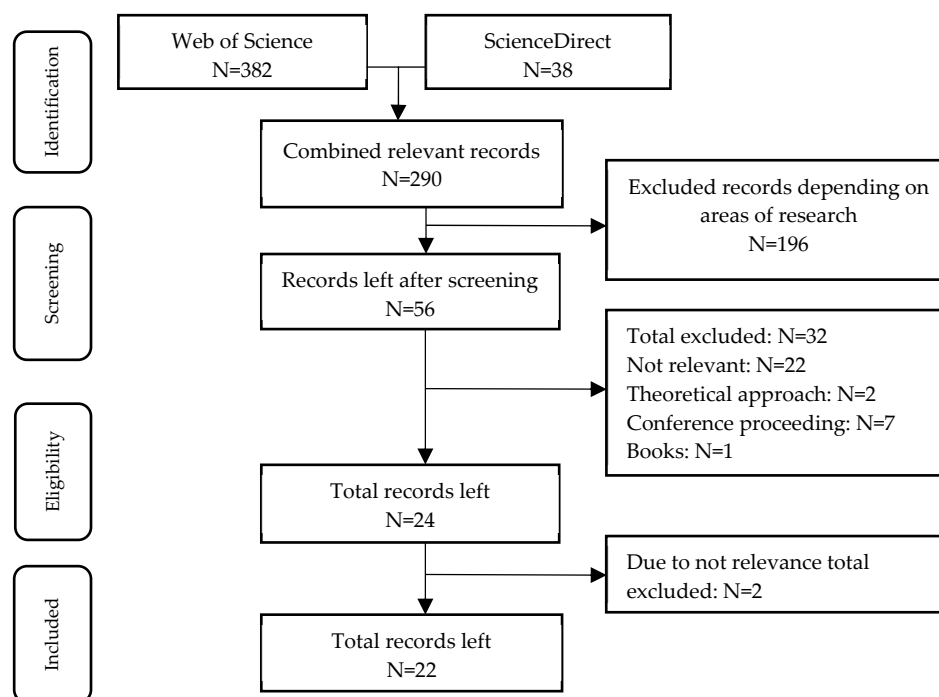


Figure 1. PRISMA methodology scheme.

3. Results

The initial screening identified 290 records that matched the searched keywords in the context of ecosystem services, parks, and health and social media data use. After eliminating duplicates, conducting further in-depth screening, and performing full-article analysis, we finally included 22 studies in the main analysis (Figure 1).

To organize the findings of the eligible papers, we used a data extraction sheet. Table 1 consists of information about the (1) authors; (2) study; (3) year of the study; (4) research objectives; (5) study area; (6) sample; (7) main results of the research; and (8) advantages and limitations of using social media data, as illustrated in the papers.

The first studies in our sample on urban green space using social media data appeared only 5 years ago (in 2017). Since then, the number of such studies has increased (Figure 2).

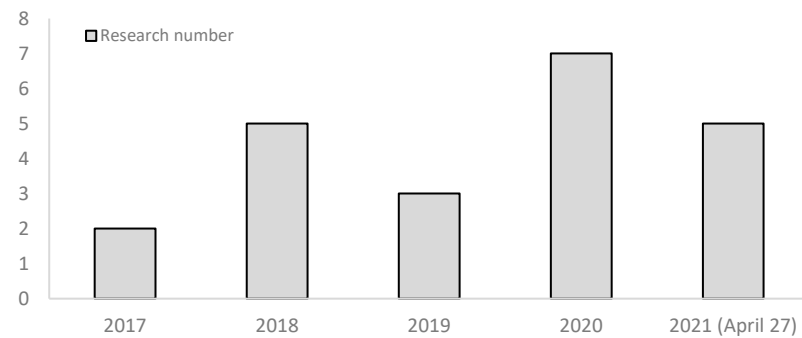


Figure 2. Chronological publication analysis in the data range 2010–2021.

Most studies were conducted in Southeast Asia, with a total of 13 studies. Three studies were conducted in Europe, five in the USA, and one study in New Zealand and in Poland. The most common social media platform used for data acquisition in the selected papers was Twitter, but it differed based on the study location: in the USA, studies used the social networks Twitter and Flickr; in Europe, Instagram and Twitter. In Asia, we can distinguish between two groups: China and the rest of Southeast Asia. In Southeast Asia, as in the USA and Europe, the most popular social media platforms used for research were Instagram and Twitter [46]. In China, almost all identified studies used the Weibo social media platform (Figure 3).

Table 1. Main findings of the 22 selected eligible papers.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Roberts, 2017 [37]	The paper focuses on the method of using social media data to investigate human interaction with urban green spaces	Birmingham, 24 urban parks	793 tweets	The study shows social media data's potential for better understanding the importance of urban green spaces and the human population.	(1) Compared to traditional methods, tweets are often posted with visual information; (2) Identification of human activities in city parks; (3) Direct messages due to the limited number of characters; (4) Time- and cost-friendly data collection.	(1) Biased information: certain people who go to the park do not use technology; (2) Technical limitations: poor or no internet connectivity and phone coverage; (3) Limited demographic information; (4) social media user privacy settings

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Roberts et al., 2017 [47]	The paper aims to assess the possibility of using social media data to evaluate the relationship between social and ecological interactions through people's physical activity in urban parks.	Birmingham	2847 tweets in summer and 1920 in winter	Seasonal variation, weather conditions, and sports events influence park visitation.	(1) Information about spatial coverage; (2) cost- and time friendly data acquisition solution; (3) The information collected from Twitter data reflects the tweeting behaviour of the urban population, taking into account outdoor physical activities associated with seasonal fluctuations.	(1) Biased information: lack of sociodemographic information; (2) The paper uses a small dataset
Zhang and Zhou, 2018 [31]	The aim is to assess the factors influencing the intensity of visitation at different parks and to evaluate park visitation's spatial, physical, social, and economic aspects	127 parks in Beijing	581,354 check-ins in Weibo from 2012 to 2016	The number of bus stops and the park's size positively correlate with visits to the park. Vegetation cover and water bodies had no significant effect. Parks that are further from the city centre and community parks have fewer visitors than other parks.	(1) Geotagged social media data improve geographic reach; (2) Social media data provide supplementary information for understanding visitor behaviour.	(1) Weibo users' socio-demographic characteristics may differ from those of the general population; (2) Cultural and large parks may be "checked in" more often than in "less popular" parks.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Chen et al., 2018 [30]	The main goal is to understand real-time Tencent user density (RTUD) data use and emphasize the advantage in measuring the temporal and spatial dynamics of urban park use and to identify park attributes that have an impact on park use.	686 urban parks in Shenzhen	3.25 million users	The number of park users depends on the development of the area, park attributes, and the surrounding area. Accessibility is not a limiting factor. To increase the number of park visitors, the paper suggests developing more playgrounds, cafés, toilets, parking lots and other facilities. The method was suitable for measuring city-level or large-scale urban green space utilization.	(1) A wide range, a high spatial and temporal resolution, and large amounts of data; (2) Large data sample with financial and time savings; (3) RTUD data cover approximately 93% of the city's total population at hourly intervals with 25 m spatial resolution.	(1) Only available in China; (2) Park users' activities and sociodemographic information are lacking; (3) Because of the 25 m resolution, some green spaces are excluded; (4) Biased information since Tencent app is not suitable for children.
Kovacs- Gyöeri et al., 2018 [43]	The study aims to show the potential of social media based on park visitor data for urban planning purposes.	1700 parks, London, UK	78,000 tweets	Park visitors tweets 3–4 km from their place of activity. Park users are more likely to tweet positive reviews about city parks. Researchers identified four city park clusters based on the visitor type, emotion, behaviour, and temporal patterns using Twitter data.	(1) Large data sample; (2) High-quality and detailed information throughout the city as input for in-depth and precise research.	(1) Urban people are more likely to tweet about exceptional experiences than typical experiences; (2) Limited demographic information about park visitors; (3) A negligible number of tweets per user regarding the use of park infrastructure.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Donahue et al., 2018 [48]	The main objective is to overcome the challenges of the field survey method by using social media data to forecast park visitation.	1581 urban, peri-urban parks in the Twin Cities Metropolitan Area in Minnesota, USA	Survey data n = 76 Photo user days n = 753 Tweet user-days n = 1388	Park visitors tweets 3–4 km from their place of activity. Park users are more likely to tweet positive reviews about city parks. Researchers identified four city park clusters based on the visitor type, emotion, behaviour, and temporal patterns using Twitter	(1) GSM (geotagged social media) data can provide urban planners and researchers with details and tendencies on entertainment patterns; (3) Low cost compared to field surveys.	(1) Social media data tend to be biased towards young, wealthy, tech-savvy people; (2) A potential limitation where geotagged social media data are not currently available.
Hamstead et al., 2018 [42]	The research aims to explore the benefits of geolocated social media data over field surveys for identifying indicators of park visitation.	New York City	2143—yearly mean of Flickr user days; 2133—yearly mean of Twitter user days	The results of the paper show that water bodies, sport facilities, the distance to bike paths and public transport positively affect urban park visitation. The presence of Wi-Fi might have an influence on a higher number of posts on social media. Crime has no impact on park visitation.	Additional data or alternative options for regularly measuring parks' visits	(1) Gender and age imbalances of USA social media users; (2) The limited understanding of city parks can be incorporated into daily life; (3) Restricted internet connectivity may affect the use of social media.
Sim and Miller, 2019 [33]	This paper studies urban park planning and design by using big data to understand user activities and satisfaction with those activities in parks.	The Gyeongui Line Forest Park (Seoul)	177 responses from the onsite survey 3703 tweets	Survey and social media data show that parks primarily improve positive experiences and user satisfaction with activities (emotions), and parks improve social interactions within the park. Both datasets represent different	(1) Can complement the design and planning process; (2) Social media and big data can help to identify new types of activity in a park.	(1) Tweets are more frequent when park users are with friends; (2) Biased information.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Lyu and Zhang, 2019 [49]	The study aims to identify the patterns of park use in the central part of the city, to compare the two datasets and to assess which is more appropriate for characterizing the parks in Wuhan, and to identify the factors that determine the use of parks in the city.	57 urban parks in Wuhan	Weibo 101,000 user check-ins; Baidu heat map	Analysis of Weibo check-in data showed that greenness in the park positively correlates with park visitation. The Baidu heat map identified the surrounding area, population density, and the accessibility of parks as essential attributes for park visitors.	Convenient and low cost	(1) Geospatial data have limitations in measuring human activity; (2) Weibo data were inadequate to explain the use of Wuhan's common city parks.
Ullah et al., 2019 [50]	The paper's goal is to study how green space visits affect user check-in behaviour	157 parks in Shanghai, China	30,000 Weibo user check-ins	The most important result is that city parks near the city centre have many visitors, peak visits from 4 p.m. to 10 p.m., and more on weekends than on weekdays. Seasonality influences the visitors number, which rises in spring and summer.	Details of qualitative and large-scale data extraction for the entire city.	(1) The number of check-ins per user of the social media platform is small; (2) Gender-based biased information.
Song et al., 2020 [15]	The research aims to investigate the city's variation in recreation behaviour at public parks based on the photographs taken at these locations.	Singapore	94,890 photographs, uploaded by 4674 Flickr users between February 2004 and March 2018	Flickr data can help understand public behaviour in urban green spaces. The results show that locals tend to spend time in urban parks and nature.	The shared geotagged photos represent a person's experience in one place and show the use and pleasure of the park.	Sample population representativeness, data protection concerns, and data quality.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Heikinheimo et al., 2020 [18]	The study aims to assess what valuable information on urban green spaces from different user-generated datasets can be used for urban planning.	Green spaces in Helsinki	Flickr API: 29 287 records from 902 users Instagram: 602 466 records from 113 754 users Twitter: 31 359 records from 5386 users Helsinki 2050 survey Questionnaire: 939 records from 1385 participants Strava Sports tracking application: 161 946 records from 4044 users	Understanding green space usage and preferences is enhanced by using social media data that complement traditional data sources. These data indicate leisure habits and allow further content analysis. Sports tracking data provide information on the type of activity of park visitors. GSM data provide spatial information but no data on park visitor activity. The questionnaire makes it possible to directly with park visitors, enabling a deeper understanding of park attendance.	Social media complement traditional data sources and provide additional insights into park usage and more detailed information about locations and times.	(1) Biased information; (2) Data access barriers; (3) Ethical questions
Li et al., 2020 [23]	To identify which park attributes and how accessibility and the socioeconomic environment influence the frequency of Weibo check-ins.	3759 parks located in all 287 cities across China	2.77 million Weibo check-ins	The results show that similar numbers of visitors are found in similar cities. The number of bus stops, the availability of more services, and the landscape morphology impact the intensity of visits to parks.	(1) Provide cost and labour efficiency; (2) Large number of social media users.	(1) Biased information; (2) The ratio of check-in visitors to the actual number of park visitors depends on the city.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Sim et al., 2020 [25]	The paper examines elevated parks using social media data.	The High Line Park in New York and the 606 in Chicago	12,952 tweets from the 606 and 165,347 tweets from the High Line	Cycling and walking were the most often mentioned activities on social media platforms. Seasonality and social activities impact the number of park visits. Parks have more positive sentiments than negative sentiments.	Provides an understanding of parks with elevated parks.	Population bias: users are more likely to be young, white, and male.
Song et al., 2020 [51]	This study in Singapore studies park visitation using geo-located photographs in park areas.	Singapore	325,173 records from Instagram 94,890 records from Flickr 2000 household surveys	Social media can provide a reasonable estimate of a park's popularity, but future research is still needed. The results indicate that many photos posted on social media include pedestrian facilities, improved urban infrastructure, public transportation, land cover such as waterfronts in and around the park, and natural vegetation. Park size was not a significant attribute for a higher number of posts.	(1) Helps to understand the differences between the parks that each online user prefers; (2) Large-scale study; (3) The combination of several datasets can be a solution to overcome bias.	Instagram has access restrictions on application programming interfaces (APIs), limiting the data available for research purposes.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Song et al., 2020 [52]	This study focuses on the perceptions of Bryant Park in New York City using social media review data.	Bryant Park in New York City	11,419 TripAdvisor reviews from 10,615 users	This analysis shows the potential for online reviews to comprehend and track the perceptions of park users. Weekdays are more critical than weekends for daily recreational activities in Bryant Park. The use of general park facilities is expected to increase on weekends and during the year's warmer months.	(1) Reviews provide long-term information; (2) They can provide a more complete and fairer expression of location awareness.	(1) Potential bias in demographic selection; (2) Fake accounts, missing data, misclassification; (3) Determination between tourists and locals.
Ullah et al., 2020 [53]	The study aims to show policymakers the benefits of urban parks for residents and their health and to provide methodological solutions to ensure accessibility to parks	115 green parks in 10 districts of Shanghai	Approximately 250,000 check-ins on Weibo from July 2014 to June 2017	The number of visitors is increasing year by year near the boundaries of downtown Shanghai. Check-in data can provide more information on extraordinary situations than traditional data. Visits to parks increase on weekends and during the warmer months of April, May and June.	Weibo check-in data are time efficient and provide solid spatial coverage.	The representativeness of social media and actual park visitor data may vary among different parks.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Lu et al., 2021 [54]	The paper aims to determine changes in park visitation and which parks were visited before and during the pandemic.	Hong Kong, Singapore, Tokyo, and Seoul	Instagram users: Tokyo (n = 38,138); Singapore (n = 21,942); Seoul (n = 20,867); Hong Kong (n = 19,285)	Weekly new cases increase the chances of using green space. People prefer a large natural park near the centre and visit it frequently during the holiday week. Weather has an impact on park visitation.	Large data samples improve the trustworthiness and robustness of the study outcomes.	(1) Lack of personal demographic and socio-economic data due to data protection; (2) Differentiating a tourist from a local is complicated; (3) Social media users tend to be young.
Liu and Xiao, 2021 [55]	The aim is to investigate possible reasons for people's satisfaction with parks based on the Dianping dataset.	Shenzhen (79 comprehensive parks)	11,272 comments from Dianping from June 2011 to June 2020	Nine factors, i.e., the signage system, facility and plant maintenance, mosquitoes, the cleanliness of the environment, air quality, vegetation, park size, landscape image quality, and recreational facilities, explain park visitors' satisfaction in Shenzhen.	Financial and time savings and an unlimited number of words.	(1) Biased information; (2) The population without the internet is not included in the study
Guan et al., 2021 [56]	The study focuses on how monthly and seasonal changes influence visitor numbers and the spatial parameter in parks and the park service area (PSA).	23 wards of the Tokyo metropolitan area	1.5 million cell phone IDs 1557 reviews from the Jalan review platform	The number of visitors varied by seasonal, and the degree of variation ranged from park to park. The study identified three types of park visitors: those who live nearby, travel through the park to their destination, and visit the park for an event. The spatial characteristics of a park were closely associated with seasonal cultural events and visitor perceptions.	Jalan details park visitors' perceptions and reactions to seasonality and the relationship to the park's spatial environment.	Small sample size for determining the visitation and demographic information of park visitors.

Table 1. Cont.

Study References	Main Objective	Study Area	Sample	Main Results	Advantages	Limitations
Herman and Drozda, 2021 [57]	The study aims to research the impact of urban green infrastructure during the COVID-19 pandemic.	Wellington, New Zealand, and Warsaw, Poland	In-depth interviews (n = 12) Miramar: 63 posts by 50 individual users during level 3 and 4 lockdowns (23rd March to 13th May) Polińskiego Park: 81 photos posted by 63 different Instagram users from the beginning of March to the end of June 2020	The results show that it was only after the quarantine was declared that park attendance dropped. However, with the loosened quarantine restrictions, attendance at parks increased as other attractions such as cinemas were still closed.	Conveys an understanding of user activity during the COVID-19 lockdown in city parks	Small number of pictures related to the pandemic.
Liang and Zhang, 2021 [58]	This study aims to assess the visitation of urban parks using multiple social media data.	300 urban parks in Shanghai	DZDP 61,212 visit number Ctrip (with Sum(SUD) of 21,411 Weibo in (with Sum(SUD) of 33,123	People preferred parks in the heart of space and visited parks during the spring and holidays. The layout of the parks in the city impacts the intensity of park visitation, with parks closer to the city centre receiving a higher number of visitors. However, parks further away from the city receive higher and better feedback. Park visitation activity is directly related to population density	(1) Low cost; (2) Multiple social media data sources in different regions can be used to investigate all users or parks.	(1) Overlapping users and data; (2) Data only from a one-year period.

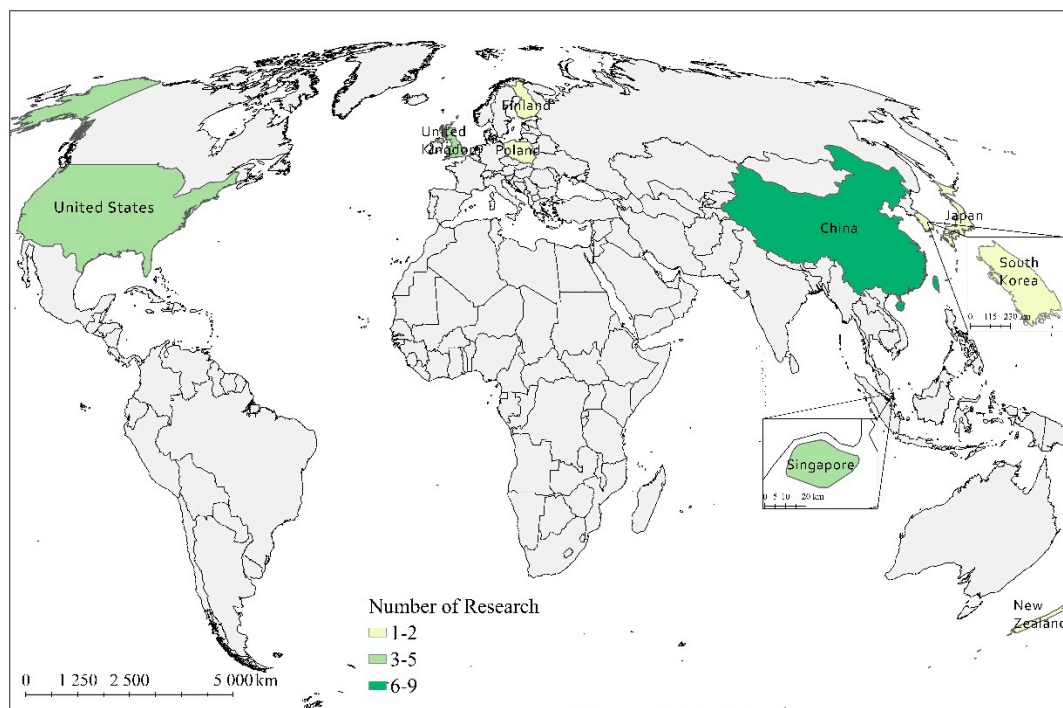


Figure 3. Spatial representation of countries in which social media platforms were used in the 22 studies. Base map credits National Geographic Society.

3.1. Main Aims and Findings of Studies Using Social Media Data to Assess Urban Green Space Use

The systematic analysis of the articles identified which research questions on social media data applications were posed to study urban green space visitation patterns. The identified papers aimed to evaluate: (I) what activities are popular among urban green space visitors [18,33,47]; (II) the relevance of specific park attributes for park visitation [23,30,31,49,55,56,58], including research that focuses on the impact of seasonal variations on park visitation [47,56]; and (III) the spatial and socio-cultural aspects influencing urban green space visitation [31,43,47,58].

In the following, we provide an overview of the main findings of the selected studies related to the main groups of study aims indicated above.

(I) Activities of urban green space visitors.

A study in Birmingham showed that jogging, walking, and team sports were the most popular physical activities in urban parks [37]. In contrast, research conducted in Seoul revealed that park users tended to spend time with friends, eat or drink, do their hobbies, such as photography, or commute through the park [33]. Researchers grouped the tweeted activities in parks in New York and Chicago into five main clusters: (I) social: spending time with friends and family; (II) physical: walking and running; (III) cultural: art and galleries; (IV) picnics: food, lunch, and coffee; (V) overlooking: viewing and watching [25]. In both the High Line park in New York and the 606 park in Chicago, the most frequent activities mentioned were in the cultural cluster. In addition to the activities mentioned in previous studies, a study conducted in Helsinki showed dog walking and water activities were often mentioned on social media [18]. In summary, the green space activities identified through social media data analysis were very diverse, including activities not only for physical wellbeing (jogging, walking) but also for mental and social wellbeing (meeting with friends, etc.).

External environmental factors such as temperature fluctuations, weather seasonality, rainfall, and daylight hours were also found to slightly influence urban green space visitation patterns [47,56]. A study in Birmingham showed that temperature had no significant

impact on physical activities in urban parks, although rainy conditions were shown to result in a reduced number of visitors [47].

(II) Park attributes

Specific park attributes, characteristics or qualities may influence park visitors' behaviour, experience, and feelings while choosing one urban green space over another. Studies show that there are specific park attributes that influence park visitation. In particular, visitors tend to prefer parks with sufficient parking spaces [30], a number of public toilets [30], a short distance from public transport [42], restaurants, and cafés [51], a sufficient number of children's playgrounds or themed park areas [30], a clean and tidy environment [55], park paths [48,51], and the existence of a water body [42,48,51] in the park. For example, research in Shenzhen concluded that the maintenance of plants, vegetation, and air quality resulted in a higher number of park visits [55]. Additionally, a study in Singapore showed that the presence of natural vegetation positively impacted park use [51]. However, research in Beijing revealed that the presence of certain particular vegetation characteristics had no influence on park use [31]. Additionally, the surrounding environmental features were shown to determine park visitation [23,30]. A study in Shenzhen identified that the density of facilities, such as hotels, restaurants, sports fields, buildings, and population, influenced park visitation [30]. The number of services in the vicinity, such as the number of bus stops around the park, were also essential factors related to urban green space use [23,42]. The availability of free Wi-Fi in a park was also shown to influence the number of posts on social media, and encouraged people to share their observations on social media more frequently [42]. Our results from the review show that the popularity and intensity of a park's attendance depend on well-developed park infrastructure and entertainment offers that were mentioned in the social media data. At the same time, the environmental surroundings of a park seem to be decisive for green space use, too.

Seasonal and temporal variation can affect the number of park visitors depending on the region. In Asia, the number of park visitors increases in April, May, June and October [50,53,56,58], while in Europe, both late spring (from May onwards) and the summer months show the highest number of park visitors [18,43]. May, June, September, and October [25] and, in New York, December, which apparently shows an increase [52], are the peak months in North America. However, worldwide, visits to urban green spaces are mainly popular on weekends and on public holidays [18,43,50,53,58]. A study in Bryant Park, New York City, showed that Mondays and Wednesdays are the most popular weekdays [52].

(III) Spatial and socio-cultural aspects influencing urban green space visitation

Given the rising number of studies, using social media data seems to be most relevant in the discussion and analysis of the distance that citizens are willing to travel to a park. A study in London, UK, indicated that visitors tend to tweet about parks that are rather far away, 3-4 kilometres from their location of activity [43], which may be due to safety reasons; alternatively, they may tweet that a nearby park does not satisfy visitor needs. The results of a case study of Shenzhen revealed that accessibility was not a significant indicator in the choice of a park [30]. Other studies use the distance to a park as a dummy variable that depends on the size of the park, its popularity, its accessibility, or the existence of cultural events [23,56]. Moreover, in some parts of the world, such as the United States, it seems that from social media data, the perception of parks and the number of park visitors, as shown by the number and kind of social media data platform uses, are also related to social-cultural context conditions [42].

3.2. Advantages and Limitations of Using Social Media Data for Urban Park Studies

The systematic literature analysis also identified several advantages and limitations of using social media data that were discussed transparently in the studies (Figure 4a,b).

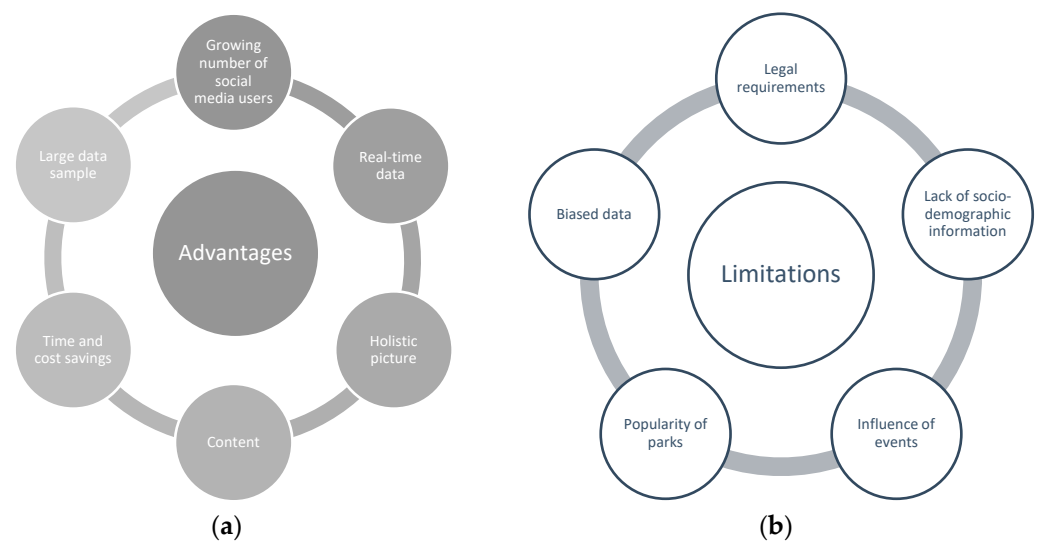


Figure 4. (a) Advantages of using social media data for understanding urban park use; (b) limitations of using social media data for urban park use.

One of the essential advantages of using social media data to analyse park use seems to be the large amount of available data [30]. As a reliable substitute for practical information on park visitation, social media data offer an inexpensive and effective way to research park visitation patterns [30,37,42,48,49,58]. Thousands of records can be obtained in relatively little time. Moreover, using social media data provides real-time information [30] and content that is not influenced by interviewers and that might provide a more holistic picture of park or urban green space use [25]. In addition, the hitherto untapped potential of review platforms such as Google Reviews, TripAdvisor, and others opens up the possibility of gaining new insights into parks, satisfaction with parks, and the use of park facilities [55]. In total, only four studies that were part of our systematic literature review used review platforms [49,52,53]. One study used TripAdvisor as a data source to analyse the daily use of Bryant Park, New York [52]. Such review platforms provide information for a longer time period and usually have no limit of signs for entering text information [52,56].

Although the reviewed studies mentioned a number of advantages and benefits of using social media data for urban green space research, they also highlighted several limitations. One of the mentioned limitations was the issue of biased information [18,25,37,42,50,52]. For instance, data might be biased in terms of a low representation of particular age groups [30,37,47]. Social media platforms are already becoming more popular among several age groups, but are still rarely used among, e.g., older people [37,42,43,47]. The limited representation of particular age groups also relates to the issue of a lack of socio-demographic information [30,37,43,47,56]. Information on residence is usually private, which makes it challenging to assess, for example, whether a park visitor is an urban resident or a tourist [30,43,49]. Tourists may more often visit popular parks, which can cause bias in the number of tweets. Community parks are usually less known and popular, and posts and tweets via social media are potentially less frequent, e.g., during daily walks [31,43]. Similarly, the number of social media posts may be influenced by the size of the park. Large parks often host sporting events, concerts, art galleries, and more, increasing the number of social media posts [47].

Finally, data access can be difficult because of specific regulations e.g., the General Data Protection Regulation (GDPR) in Europe. Depending on the user's privacy settings, it is possible to obtain shared information [15,18,37]. Processing data from social media can also be challenging because researchers need programming skills, such as Python, R, or other languages, to work with the data [33]. In addition, the developers of social media platforms often change the data accessibility requirements, with each change may posing new challenges [33].

4. Discussion

The application of social media data is a rather new field in urban green space research. In this respect, however, the number of studies has increased, in the last years. This systematic literature review summarized the main aims and related findings of recent research that used social media data to assess green space use and park use. We found that the main purposes were to identify particular park activities and related park attributes. Urban park visitors mainly engage in activities for physical, mental, and social well-being [18,31]. As indicated by social media, different park attributes that influence park use were identified, and included park maintenance, the availability of free Wi-Fi, and surrounding facilities such as cafés or bus stops [23,31,42]. From the review, we identified a number of advantages and limitations of using social media data for urban park studies. The advantages included the availability of a very large amount of data that cannot be obtained through traditional methods such as surveys, and the possibility of receiving more “honest” answers [52]. The potential limitations identified include respondent bias, data security issues, and others.

4.1. Social Media Data Constitute Biased Information for Understanding Urban Park Use

The biased information coming from social media data is one of the main drawbacks mentioned in the studies. Age group bias is particularly relevant. Researchers acknowledge that urban green spaces are essential for people’s well-being, focusing on children and older age groups [59–61]. Thus far, however, social media data mainly represent the needs of people from adolescence to retirement age [62–65]. A recent review study on social media data resources used for urban green space studies, with a specific focus on the geospatial methods used for data collection and analysis, also noted this issue of bias related to age, or to very specific social media user groups (e.g., tourists), represented with Twitter user data [34]. Urban park planners and managers may not be able to meet the needs of the entire urban population based solely on the information provided by social media, with an emphasis on the requirements of selected groups.

As a prospect for future research, studies may assess the bias in answers and results that come from an over- and underrepresentation of park users [18,25,52]. Certain age groups that are not familiar with social media may be less able to articulate their preferences. Thus, one prospect for future research using social media data could be the combination of traditional field surveys, questionnaires, observations, and social media data [21,24,26]. It would be interesting to see how an underrepresentation of certain values and demands may have already led to a certain development of urban space that potentially does not reflect the needs of all population groups.

4.2. Using Social Media Data for Urban Green Space Planning

From this systematic literature review, we conclude that many studies have highlighted the possibility of incorporating social media data into urban green space planning [33,43], but none of the studies report on how social media data were actually used in planning practice in reality. Appropriately carrying out city and urban green space planning to meet the demands of all population groups and the actual needs of existing vegetation, while responding to the challenges of climate change, is a significant challenge. Given time and budget limitations, planners may also lack the expertise [42] and time to work with social media data. These challenges of using social media data may change in the future, with more digital processes entering city administrations [66–68].

To develop cities further in terms of climate resilience and sustainable urban transformation, the question of whether the promise offered by the advantages of social media data may be over-estimated remains. Given the many limitations and data security issues, applying social media data for urban planning may be too complex if the departmental structure does not provide the appropriate digital expertise and environment [69].

However, there are certainly small-scale domains in which social media, as near real-time data, are very helpful in the urban context. Real-time data with visual and textual

information allow responsible authorities to assess a park's current state. For example, social media data may provide information to identify vegetation damage caused by storms (e.g., uprooted, broken trees) or vandalism issues, which potentially limit urban (green) space use. Here, social media information can accelerate and improve urban green space maintenance activities.

4.3. Limitations of the Systematic Review

Our review paper is limited to the time frame, key search terms and search engines that we used for the literature search. Due to these limitations, the review may not include all available studies, e.g., it may not include work that used other social media platforms. For example, our study showed that the Weibo social media platform was referred to in Chinese studies, but other social media platforms such as the Tencent data platform [70] may also be widely used by the local population, resulting in additional studies on urban green space use. However, our search terms did not focus on country-specific social media platforms; the search terms were used to identify studies in the most common social media databases.

5. Conclusions

Despite their limitations, social media data will likely be used in future urban research. Social media provide crucial information on visitor behaviour, interaction with the environment in real time and, to a certain degree, spatial information. The growing number of social media platform users each year shows that the population is willing to share textual or visual information and opinions about their activities, places visited, beliefs, and experiences. Given the limitations of the information provided, such as the residency status, the lack of socio-demographic information, and the lack of appropriate algorithms, the future application of social media data in research will require an improvement in existing methodologies and the development of a framework that improves data extraction and analysis so that also urban planning is supported by data extraction procedures.

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