Research Paper

Recreational visits to urban parks and factors affecting park visits: Evidence from geotagged social media data

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A B S T R A C T

Quantifying park use and understanding its driving factors is crucially important for increasing park use and thus human well-being. Previous studies have investigated the effects of different physical and sociocultural factors on park usage using visitor surveys and direct observations of park users, which are usually site specific and time consuming. We quantified and compared the number of visits for different types of parks in Beijing using freely available geotagged check-in data from social media. We investigated how park attributes, park location, park context and public transportation affected the number of park check-in visits, using multiple linear regressions. Despite potential biases in the use of social media data, using a park typology, we found that the number of visits was significantly different among different types of parks. While cultural relics parks and large urban parks had larger numbers of visits, neighborhood parks had higher visitation rates per unit of area. Park size and entrance fees were associated with increased numbers of visits for all types of parks. For parks that mainly serve local residents, the distance to urban center significantly affected park use. The number of bus stops was positively correlated with park visits, suggesting that increased accessibility through public transportation leads to more visits. The results indicated that improving park accessibility via public transportation and planning small, accessible green spaces in residential areas were effective in improving park use.

1. Introduction

Urban greenspaces, particularly parks, provide multiple benefits to human well-being, including physical and psychological health and social benefits (Hand et al., 2017; Huang & Cadenasso, 2016; Richardson, Pearce, Mitchell, & Kingham, 2013; Tzoulas et al., 2007; Van Herzele & de Vries, 2011; Wright Wendel, Zarger, & Mihelcic, 2012; Zhou, Wang, & Cadenasso, 2017). Park visits offer opportunities to directly experience the benefits of "natural" ecosystems, particularly for urban residents who have limited contact with natural environments (Daniel et al., 2012). Therefore, quantifying residents' visits to urban parks and understanding the factors that influence their visits are crucially important for the planning and management of urban parks.

Quantifying visits to parks and urban greenspaces is essential to understanding their recreational values, and identifying the influencing factors. Traditional methods of measuring the number of visitors include visitor surveys, direct observation and on-site counters (Cohen et al., 2010; Giles-Corti et al., 2005; Wright Wendel et al., 2012). Such methods of systematic observation typically select a representative

sample of urban parks, and collect park usage information, such as the number of visits and the characteristics, activities and behavior of park users. Such methods, however, are usually site specific and time consuming, and thus have limited spatial coverage (Sessions, Wood, Rabotyagov, & Fisher, 2016; Tenkanen et al., 2017).

In addition to traditional survey methods, public participation geographic information systems (PPGIS) have increasingly been employed to measure recreational use of parks and to engage the public in generating spatially explicit information for planning purposes (Brown, Schebella, & Weber, 2014; Laatikainen, Tenkanen, Kyttä, & Toivonen, 2015; Wolf, Wohlfart, Brown, & Bartolomé Lasa, 2015). The PPGIS approach recruits participants to identify the locations where they engage in physical activities (Brown et al., 2014). Online PPGIS mapping has increasingly been used to enhance efficiency compared with field-based PPGIS mapping (Wolf et al., 2015). Additionally, PPGIS has been improved by using actual GPS tracking-based visitor distributions (versus those reported in PPGIS). GPS tracking has been greatly advanced by using participants' own tracking devices (e.g., smartphones) rather than devices supplied by researchers, making participation

accessible to anyone owning a smartphone (Wolf et al., 2015; Wolf, Hagenloh, & Croft, 2012; Wolf, Stricker, & Hagenloh, 2013).

The emergence of freely available social media data provides new approaches for measuring visits to urban parks. Information from social media and other sources of "big data" increases in volume each year, and it can be used to study how people interact with real environments and to evaluate user preferences across space and time (Wood, Guerry, Silver, & Lacayo, 2013). As opposed to PPGIS and GPS tracking which are characterized by purposeful sampling and a structured data collection process, social media data are not generated for the explicit purpose of being used in specific research projects. Such types of data have been labeled with many terms, such as volunteered geographic information (VGI), citizen sensors, user-generated content (UGC) and crowdsourced geodata (Dunkel, 2015). This type of data has been used on a large scale to measure people's preferences for various natural environments, such as lakes (Keeler et al., 2015), protected areas (Levin, Kark, & Crandall, 2015; Tenkanen et al., 2017), national parks (Heikinheimo et al., 2017; Sessions et al., 2016), mountain landscapes (Tenerelli, Demšar, & Luque, 2016), natural treatment systems (Ghermandi, 2016), ecologically engineered wetlands (Ghermandi, 2017), and urban greenway networks (Liu, Siu, Gong, Gao, & Lu, 2016). Data from web-share services have been used to monitor recreational activities in protected areas and urban parks (Campelo & Nogueira Mendes, 2016; Nogueira Mendes, Dias, & Pereira da Silva, 2014; Nogueira Mendes, Silva, Grilo, Rosalino, & Silva, 2012; Santos, Nogueira Mendes, & Vasco, 2014, 2016). In addition, geotagged photos have been used to estimate the aesthetic value in Hokkaido (Yoshimura & Hiura, 2017) and to reveal multiple landscape values around hydroelectric dams and reservoirs (Chen, Parkins, & Sherren, 2017). Most of the emerging VGI studies were conducted in developed western countries, using data from Instagram, Twitter or Flickr. However, few studies have been conducted using data from popular social media platforms to estimate visitation patterns in China (Tenkanen et al., 2017).

A considerable amount of research has investigated the effects of different physical and sociocultural factors on park usage (Giles-Corti et al., 2005; Grow et al., 2008; Mowen, Orsega-Smith, Payne, Ainsworth, & Godbey, 2007; Zhang, Chen, Sun, & Bao, 2013; Zhang, Yang, Ma, & Huang, 2015). For example, several studies have found that distance to parks, park size and park attractiveness (e.g., shade along paths and the presence of sports facilities, water features and birds) influence residents' likelihood to use public parks (Giles-Corti et al., 2005). The quality of vegetation is correlated with the recreational appropriateness of urban parks (Zhang et al., 2013, 2015). The population density around parks also plays an important role because people who live closer to a park are more likely to visit it (Mowen et al., 2007). At the same time, the socioeconomic and sociodemographic characteristics of park users also influence park use (Jim & Shan, 2013; Sanesi & Chiarello, 2006; Schipperijn, Stigsdotter, Randrup, & Troelsen, 2010; Wright Wendel et al., 2012). Other variables affecting park use include users' perceptions of safety (Jansson, Fors, Lindgren, & Wiström, 2013; Wang, Brown, & Liu, 2015), the provision of park facilities (Sugiyama & Ward Thompson, 2008; Wright Wendel et al., 2012), and the number of organized activities (Cohen et al., 2010).

These studies have advanced the understanding of factors that influence park use. However, these studies have typically been conducted using visitor surveys and/or interviews and direct observations of park users and activities; these are usually site-specific and time-consuming and include only small groups of people. Recently, however, a small number of studies have used the increasingly available and ready-to-use VGI data, especially in developing countries such as China. While quantifying urban park visits is important for measuring the recreational use of these sites, research on urban park visitation is extremely limited in Chinese cities due to the lack of data on residents' actual park visits (Liu, Li, Xu, & Han, 2017). Consequently, the needs of residents have often been overlooked in the park construction and management

process in China (Zhang & Yang, 2014). With increasingly available VGI data, which can potentially provide a proxy for the number of park visits, it is hoped that research using VGI data can fill this gap. Here, we use geotagged Weibo check-in data, a type of VGI data used as a measure (or proxy) of park visits, to identify and map visits to different types of parks in central Beijing. Specifically, the objectives are to 1) quantify park visits and characterize park visiting intensity among different types of parks and 2) examine the spatial-physical and socioeconomic factors that affect visits to urban park. The results from this study can provide important insights into urban park management and planning.

2. Methods

2.1. Study area

The study was conducted in Beijing, the capital city of China. Beijing has an administrative area of $16,808 \, km^2$. The latest census, from 2016, shows that Beijing had 21.73 million permanent residents. Beijing had $868.09 \, km^2$ of green coverage, with a total area of park green spaces of $295.03 \, km^2$ and per capita park green space of $22 \, m^2$ in 2015 (Beijing Municipal Bureau of Landscape and Forestry, 2016). There are 410 parks of various types in Beijing (Beijing Municipal Bureau of Landscape and Forestry, 2017), in addition to numerous small parks that are not counted, but also contribute to the urban greenspace system.

We focused on the 127 parks within the 5th ring road of Beijing, an urban core with an area of approximately $660 \, km^2$, where check-in records were available. These include 91 parks listed on the official website of the Beijing Municipal Bureau of Landscape and Forestry, as well as 36 small parks that are not listed. The boundaries of the 127 parks were drawn based on Google Earth imagery. We omitted the 16 small parks within the 5th ring road that had zero check-ins.

2.2. Number of park visits based on Weibo check-in data

We used check-in data from Sina Weibo to measure the numbers of visits to urban parks. Weibo is the Chinese equivalent of Twitter and is the largest social media site in China. Weibo has a large number of users and represents one of the largest available geotagged datasets. According to Weibo's annual report, it had 132 million daily active users in 2016, accounting for more than 9% of the Chinese population. Of Weibo users, 77.8% has high levels of education (college degrees or above), and there are more male users than female users (Weibo Data Center, 2016). Therefore, the demographic characteristics of Weibo users are not consistent with the total population. The public interfaces of Weibo's location-based services (LBS) were launched on May 28, 2012. From that time, Weibo users could share their real-time locations on the Internet. As one type of fine-scaled open crowdsourcing data, the Weibo check-in data were the most appropriate dataset we could obtain as a proxy to estimate actual visits to parks. It is unfortunate that we were not able to obtain real park visit data to validate its relationship with the Weibo check-in data. However, a previous study focusing on 87 urban parks in Shanghai, China, has shown that there was a significant correlation between check-in data from the social media platform Jiepang and official visitor statistics (Shen, Sun, & Che, 2017). Additionally, previous studies have shown that Weibo check-in data can well reflect people's preferences and activities in urban spaces. Indexes such as activity closeness, connection and intensity were calculated based on Weibo check-in data at the regional scale to delineate urban boundaries (Zhen, Cao, Qin, & Wang, 2017). Using Weibo check-in data, Shen and Karimi (2016) proposed a novel model that integrates multiple dimensions of the urban function network and thereby enriches the description of the urban network system. Furthermore, although using Weibo check-ins as a proxy of visitation is still rare, previous studies that used data from similar social media platforms,