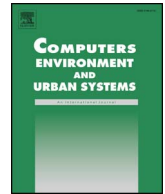




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## Geolocated social media as a rapid indicator of park visitation and equitable park access

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### ABSTRACT

Understanding why some parks are used more regularly or intensely than others can inform ways in which urban parkland is developed and managed to meet the needs of a rapidly expanding urban population. Although geolocated social media (GSM) indicators have been used to examine park visitation rates, studies applying this approach are generally limited to flagship parks, national parks, or a small subset of urban parks. Here, we use geolocated Flickr and Twitter data to explore variation in use across New York City's 2143 diverse parks and model visitation based on spatially-explicit park characteristics and facilities, neighborhood-level accessibility features and neighborhood-level demographics. Findings indicate that social media activity in parks is positively correlated with proximity to public transportation and bike routes, as well as particular park characteristics such as water bodies, athletic facilities, and impervious surfaces, but negatively associated with green space and increased proportion of minority ethnicity and minority race in neighborhoods in which parks are located. Contrary to previous studies which describe park visitation as a form of nature-based recreation, our findings indicate that the kinds of green spaces present in many parks may not motivate visitation. From a social equity perspective, our findings may imply that parks in high-minority neighborhoods are not as accessible, do not accommodate as many visitors, and/or are of lower quality than those in low-minority neighborhoods. These implications are consistent with previous studies showing that minority populations disproportionately experience barriers to park access. In applying GSM data to questions of park access, we demonstrate a rapid, big data approach for providing information crucial for park management in a way that is less resource-intensive than field surveys.

### 1. Introduction

Understanding why some parks are used more regularly or intensely than others can inform ways in which urban parkland is developed and managed to meet the needs of a rapidly expanding urban population. Since 2008, the global population has been mostly urban. By 2050, urban populations are expected to make up 70–80% of the world's total population (United Nations, 2014). As cities expand and grow denser, inner-city parks will be increasingly important for improving environmental quality, human health, and neighborhood livability. In addition to the challenge of expanding service provision, local governments also

face challenges associated with urban patterns of social segregation, community disinvestment, and disproportionate access to public goods. Thus, a key sustainability challenge for local governments is to develop and maintain parks and other public goods in ways that equitably distribute benefits to health, well-being, livability, and the economy. Exploring inner-city park use and correlates of use can help bring to light ways in which these benefits are distributed.

Using field techniques such as on-site counts or surveys, visitor use information is often collected for national parks, large flagship parks and parks that draw large numbers of tourists. However, our knowledge of a broader range of urban parks – particularly small and medium-

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sized community parks which may be integral to the daily routines of urban residents – is limited. Geolocated social media (GSM) is increasingly being used to gain insight into human behavior patterns – from social movements like Arab Spring and Occupy Wall Street to retail consumption patterns in tanning salons and flea markets (Quercia & Saez, 2014). Although GSM indicators have also been used to examine park visitation, studies applying this approach are generally limited to flagship parks, national parks, or a small subset of urban parks (e.g., Hausmann et al., 2017; Schwartz & Hochman, 2014; Sessions, Wood, Rabotyagov, & Fisher, 2016; Wood, Guerry, Silver, & Lacayo, 2013). Here, we use geolocated Flickr and Twitter postings as data to explore variation in use across New York City's 2143 diverse parks, and model visitation based on spatially-explicit park characteristics and facilities, neighborhood-level accessibility features and neighborhood-level demographics. We demonstrate a GSM approach for providing indicators of park visitation in a way that is less resource-intensive than field surveys.

## 2. Literature review

### 2.1. Park visitation and its determinants

Trends in park visitation along geographic, temporal, and socio-cultural dimensions can inform ways in which public agencies and other entities spatially plan, design and manage these resources. Regular visitation estimates are produced for park units in the United States National Park Service system using approaches such as adjusted traffic counts or temporally limited visual pedestrian counts extrapolated over longer time periods (Bruilliard, 2016). However, most studies exploring urban park visitation and drivers of urban park use have limited the number of parks examined to subsets selected according to particular criteria, including most frequently visited parks (Buchel & Frantzeskaki, 2015), importance to particular communities and stratified by socio-economic status (Cohen et al., 2013), stratified by neighborhood (Kaczynski, Potwarka, & Saelens, 2008), or a random sample (Baran et al., 2014). Traditional methods rely on observation and survey questionnaires to ascertain visitation for particular parks or variation in park use over geography, time, socio-cultural groups or activities performed by park users (e.g., Baran et al., 2012). For decades, researchers have argued that park use estimates inferred from limited visual observations could be combined with approaches such as visual, traffic and mechanical counts to help automate estimation procedures (Mowen, 2002). In New York City (NYC), Silver, Giorgio, and Mijanovich (2014) examined the use of ten small parks and playgrounds by conducting a series of interviews with adult park users, which typifies the methodological approach to studying park use in NYC. To date, there is not a single comprehensive study that examines park use across all NYC parks. Here, we suggest that GSM data can be used to supplement existing temporally and spatially-limited estimation procedures as an automated and less resource-intensive way of revealing park use variation and determinants.

Determinants of park use that have been identified through a broad range of leisure studies, public health, as well as child and youth studies include park characteristics such as size, recreational facilities, physical activity facilities (Baran et al., 2014; Kaczynski et al., 2008), programming (Tester & Baker, 2009), neighborhood conditions such as safety, availability of pedestrian access facilities, urban form, socio-economic conditions, racial heterogeneity (Baran et al., 2014; Van Dyck et al., 2013; Gomez, Baur, Hill, & Georgiev, 2015) and socio-cultural characteristics of park users (Baran et al., 2012; Mowen, Payne, & Scott, 2005; Lin, Fuller, Bush, Gaston, & Shanahan, 2014). Conversely, determinants of park nonuse may include financial constraints, time constraints, long travel distances, inadequate park space, racial discrimination, inequitable park programming, and park users' perceptions that parks are unwelcoming or unsafe (Byrne, 2012). Current and historic social relations, park design and park management can play key

roles in mediating these determinants. Exclusionary practices on the basis of race and ethnicity (Cutts, Darby, Boone, & Brewis, 2009), income (Crawford et al., 2008), age, language and other social characteristics can be embodied in park design (Byrne, 2012), public space policies that deter activities preferred by social subsets (Owens, 2002) or practices that effectively ostracize and discriminate (Byrne, 2012). These observations are not limited to urban parks that are solely managed by local governments. A comprehensive survey of the National Park System in the United States that was conducted in 2000 – which supported an earlier study conducted from 1982 to 1983 – indicated that smaller proportions of racial and ethnic minorities tended to visit national park system units relative to Whites (Floyd, 1999; Solop, Hagen, & Ostergren, 2003). Hispanic Americans were more likely to be more concerned about safety than non-Hispanics, and African Americans were more likely than Whites to feel uncomfortable in parks and believe that park employees provided poor levels of service. Given that public park resources are often inequitably distributed, a key concern for public administrators is to understand variation in those resources across geography, socio-economic and demographic conditions, toward developing programming that more evenly distributes benefits.

### 2.2. Geolocated social media (GSM) data indicators of visitation and visitation drivers

Big data produced through social media networks – particularly micro-blogging platforms such as Twitter and Flickr – have recently given rise to new branches of social and geographic research and the inception of so-called digital social sciences (Edwards, Housley, Williams, Sloan, & Williams, 2013; Housley et al., 2014) and a “neogeography” (Antoniou, Morley, & Haklay, 2010) based on user-generated spatial content. Such new data and methods create potential to augment conventional approaches for studying urban parks, drivers of their use and nonuse as well as the social and public health benefits they provide. While the use of GSM data in urban parks research is still in its infancy, over the past few years, a growing number of studies have used GSM data for research in the fields of geography (Lin & Cromley, 2015; Naaman, 2011; Prager & Wiegand, 2014), landscape and urban planning (Dunkel, 2015; Shelton, Poorthuis, & Zook, 2015; Sonter, Watson, Wood, & Ricketts, 2016), and urban ecology (Guerrero, Møller, Olafsson, & Snizek, 2016). Scholars have emphasized new opportunities that data at this scale with nearly real-time monitoring provides for research and practice across multiple scientific domains. In urban parks research, the multiplicity of digital traces that people leave – from tweets, to images, text, tags, and shared locations – can provide new insights into which public investments (e.g., urban parks) are most used, how people are using them and why. We suggest that such knowledge could be an important new source for informing public policy and supporting citywide planning efforts.

Over the past few years, a subset of GSM research has suggested that geotagged social media data can serve as a proxy for visitation data at a variety of public venues (including parks) (Heikinheimo et al., 2017; Keeler et al., 2015; Sonter et al., 2016; Wood et al., 2013) and aid the discovery of major points of interest in the urban environment. Social hubs, routine activity patterns, hotspots of social activity and tourism, as well as work-related activities have been studied using social media in New York, Paris, London, Los Angeles, Chicago, and elsewhere (Bawa-cavia, 2011; Ferrari, Rosi, Mamei, & Zambonelli, 2011; Girardin, Fiore, Ratti, & Blat, 2008; Jankowski, Andrienko, Andrienko, & Kisilevich, 2010; Martí, Serrano-Estrada, & Nolasco-Cirugeda, 2017; McKenzie, Janowicz, Gao, & Gong, 2015; Steiger, Westerholt, Resch, & Zipf, 2015).

Studies in the U.S. and Europe have used GSM to predict and model visitation in national parks and conservation areas. More specifically, geotagged Flickr images have been found to be a reliable proxy for the visitation of lakes in Minnesota and Iowa (Keeler et al., 2015), over 30

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