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Analyzing and visualizing the spatial interactions between tourists and locals: A Flickr study in ten US cities

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ABSTRACT

As urban tourism becomes an indispensable part of urban dynamics, tourist attractions are increasingly woven into residents' everyday living spaces. However, the spatial patterns of, and level of mix between tourist and local attractions have remained largely unknown. Taking advantage of the recent development in volunteered geographic information, we used Flickr data to examine how tourists and locals' destinations overlap spatially. We combined a density-based spatial clustering algorithm, a dissimilarity index, spatial scan statistics, and location-based tag clouds to explore the potential spatial and social interactions between tourists and local residents in ten US cities: Atlanta, Boston, Chicago, Houston, Los Angeles, New York City, Orlando, San Francisco, Seattle, and Washington, D.C.. At the city-level, we report the spatial distributions of visitors' and locals' destinations and compare the overall level of segregation between the two groups. Within each city, we identify the hotspots for visitors and locals and investigate the semantic content for reasons behind visiting specific places. Finally, we discuss our findings and provide implications for urban planning and tourism research.

1. Introduction

Urban tourism is an important driving force of urban socio-spatial change, bringing vitality and fluidity to cities. Increasingly, urban tourist destinations are interwoven into residents' living space, leading to socio-spatial interactions between tourists and residents. These socio-spatial interactions between tourists and residents have significant implications for planning, especially in cities popular with tourists. An important, but sometimes neglected, topic is the mix of locals and visitors at the city and the neighborhood scales, and how such chance encounters influence peoples' experience. However, fine-scale spatial patterns of interaction and segregation are hard to obtain with traditional research methods.

Recent growth in volunteered geographic information (VGI), participatory GIS, and open GIS data has enabled researchers to delve into the fine-scale local interactions, while maintaining an overall grasp of city-wide patterns (Bugs, Granell, Fonts, Huerta, & Painho, 2010; Liu et al., 2015). With VGI, citizens play a critical role in producing geographic data through georeferenced web-sharing platforms (e.g., Twitter, Flickr, and Weibo). These data pertain to each individual's place-based experience, but when taken together, they are representative of overall patterns (Zhen, Cao, Qin, & Wang, 2017). With

these technologies, real-time occurrences and encounters can be tracked and analyzed (Elwood, Goodchild, & Sui, 2013).

The aim of this study is to examine the spatial patterns and interactions of tourists and local residents in ten major cities in the United States using Flickr data. Specific questions of this study include:

-How do the cities compare and contrast with each other regarding the number of unique visitors and number of destinations for tourists and local residents?

-How spatially mixed are the tourists' and locals' destinations for the ten cities?

-Within each city, which areas are predominantly visited by tourists, and, which areas are predominately visited by local residents?

1.1. Tourist-host interaction

Tourist-host interaction has long been a focus of tourism research. Residents and tourists are linked by shared spaces, amenities, and services (Sherlock, 2001; Zhang, Inbakaran, & Jackson, 2006). Most studies exploring tourist-host interactions focus on residents' attitudes toward tourists and the impacts of tourism on local communities (Harrill, 2004). The social exchange theory and the emotional solidarity theory have been used as frameworks to investigate residents' positive and

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negative attitudes toward tourism (Woosnam, Norman, & Ying, 2009). Other studies modeled the effects of perceived economic, social, and cultural benefits and costs on locals' attitudes, and argued that the attitudes change according to the phase of the tourism development (Gursoy, Chi, & Dyer, 2010).

The spatial aspect is often neglected in these studies, though it has been reported to influence residents' and tourists' experience. For example, studies report mixed findings on how distance influences interaction (Deery, Jago, & Fredline, 2012). One common assumption is that the closer residents live to centers of tourist activities, the more negative perceptions they have of tourism. Some studies support this assumption. For example, a study conducted in Bath, Britain found that those who live closer to the central tourism zone were more likely to support restrictions on tourism development (Haley, Snaith, & Miller, 2005). This result echoed findings from a study in Charleston, South Carolina showing that in neighborhoods located in the tourism core, attitudes toward tourism were more negative. As neighborhoods got farther from the center of tourism, perceptions became more positive (Harrill & Potts, 2003). However, evidence supporting the opposite also exists, with residents exhibiting more negative attitudes if they lived further away from tourist spots (Belisle & Hoy, 1980). Harrill (2004) posited that these conflicting results might be explained by the level of local economic dependence on tourism. In other words, attitudes and interactions between tourists and residents are complex, and proximity alone cannot account for these patterns. However, beyond proximity, we have little information regarding the spatial relationships between tourists' and residents' destinations.

The lack of knowledge costs us. Without understanding the spatial patterns of tourist and local attractions, we miss the opportunity to provide infrastructure and offer alternative tourist development to mitigate the undesired consequences. Sustainable development calls for a harmonious relationship between visitors and host communities. To make urban space multifunctional and multicultural, and to achieve mutually beneficial outcomes for tourists and hosts, we must first understand the varying level of interaction in different neighborhoods. Identifying local areas that witness very heavy local visits and few tourist visits and those that are highly developed with heavy tourist use allows us to examine their socio-economic differences through another lens and guide development based on the particular phases each neighborhood is experiencing.

1.2. Volunteered geographic information and its applications in tourism research

Volunteered geographic information (VGI) presents great opportunities for analyzing city-wide destination clusters and measuring space attractiveness. Photo-sharing services in particular provide a huge number of geotagged photographs that can be used to generate spatial patterns and narratives of urban space.

Flickr data can be used to find out the number of trips made, visit frequencies, and to identify tourist sites with certain types of views (Popescu, Grefenstette, & Moëllic, 2009). In a study conducted in Berlin, heatmaps and route similarity clustering were used to show the density of destinations across the city (Gavric, Culibrk, Lugonja, Mirkovic, & Crnojevic, 2011). In another study, density maps were used to visualize attractive areas and clusters of destinations (Kisilevich, Krstajic, Keim, Andrienko, & Andrienko, 2010). Other clustering approaches have been used to better understand tourist destinations in Chicago and Zurich (Straumann, Cöltekin, & Andrienko, 2014; Zhou, Xu, & Kimmons, 2015). In addition to identifying clusters, the multi-destination trips and trip chaining pattern has been investigated based on Flickr data (Önder, 2017). Other studies used scaling methods to investigate the sublinear and superlinear relationships of area attractiveness to the size of the area (Bojic et al., 2015; Sobolevsky et al., 2015). Studies aimed at confirming the use of Flickr data to detect the number of tourists found that geotagged photos are good predictors of

the actual tourist numbers at the city level (Önder, Koerbitz, & Hubmann-Haidvogel, 2016).

Despite the surge of interest in using VGI in tourism research, only a few have examined the destinations of locals and tourists. A study examining urban activities mapped the attractiveness of cities in different countries and found that tourist activities are more scattered than resident destinations (Paldino, Bojic, Sobolevsky, Ratti, & González, 2015). In another study, Kádár and Gede mapped the geographical locations of photographs taken in Budapest, Hungary, and found different patterns between tourists' and locals' destinations; urban landmarks such as the House of Parliament and Vista sites attracted more visitors, while residential areas and community recreational spaces such as parks and local theaters were visited more by locals (Kádár & Gede, 2013). Another study demonstrated differences in spatial patterns between the two populations and also examined the relationships between tourist and local destinations using spatial autocorrelation (García-Palomares, Gutiérrez, & Mínguez, 2015).

As more crowdsourcing platforms allow geotagging that reveals real-time place visits, e.g., Twitter, Instagram, Facebook, it is crucial that we find approaches to analyze the data efficiently. Building on the methods used in previous studies, we aim to identify and develop a set of statistics that could describe the degree of spatial mix between tourists and locals at the city-level and neighborhood-level. These analyses could facilitate VGI visualization and quantification and allow researchers to compare spatial mix between different cities.

2. Methods

2.1. Dataset and definition of residents and tourists

The data used for this research are from the Yahoo Flickr Creative Commons 100 Million Dataset (YFCC100M). Released in 2014, this dataset contains 99,206,564 Flickr photos uploaded between 2004 and 2014. 48,366,323 of these images were geotagged. This dataset includes images of many cities across the world with photo attributes such as ID, URL to the photo, tags, and geo-coordinates.

In order to determine whether each unique user was a resident or visitor, we used the Flickr users' profile information. Previous studies have determined whether users are residents or visitors by examining the number of pictures taken and the duration of the time stamps on the photos (García-Palomares et al., 2015). However, a resident may only take a few photos of his home city, or a visitor may stay in one place for more than a month. In the current study, we extracted users' profile information (their answers to the question "city you live in now") using the Flickr Application Programming Interface (API: www.flickr.com/services/api).

2.2. Cities selected for analysis

To compare cities with a broad range of within-city economic, social, and cultural variations, we selected ten cities in the US with the highest population density, tourism popularity, or current-dollar GDP: Atlanta, Boston, Chicago, Houston, Los Angeles, New York City, Orlando, San Francisco, Seattle, and Washington DC. Flickr photos that fall within the city border of the ten cities were extracted.

After matching each photo with user profile and classifying the user as either resident or visitor, we pulled three primary information columns: the user ID, the coordinates of the photos, and the tags. This process yielded a total of 2,245,697 photos uploaded by 33,687 unique users.

2.3. Analytical methods

We presented descriptive statistics regarding the number of tourists and locals, as well as the number of photos they uploaded. To account for the fact that an individual may publish multiple photos of the same

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