

## Location Speaks: Using GIS Approach to Understand an Anti-pornography Campaign in Mainland China

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**Abstract:** Geographic information system (GIS) is a tool for researchers to store, manage, present, and analyze spatial data. Combined with location based social networks, GIS has been applied to the communication discipline to solve the ‘Where’ questions. By using the Dongguan anti-pornography campaign as a case study, GIS mapping suggested that social network service users from economically developed areas have a higher tendency to participate in public discussion. Those who identify them to be part of the news event are also more enthusiastic about expressing their opinions. In addition, the study examined where public opinion leaders leveraged the discussion and how points of interests guided users’ check-in behavior. It is inferred that the power of locative mobile social networks over space creation can be influenced by the accessibility of technologies, socioeconomic environments, social identities, politics, geographic proximity, user demographic information, and city planning.

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### Introduction

In recent years, location-based social network services (SNSs) have aroused much interest in the communication discipline (Frith, 2014; Humphreys & Liao, 2011). By using location-based social network data, researchers can monitor online public opinions, observe social movements, and provide suggestions for city planning (Mocanu et al., 2013). For example, real-time geographic information from Twitter has been widely applied in marketing research, civic participation, and crisis management (Schulz, Hadjakos, Paulheim, Nachtwey, & Mulhauser, 2013). Today more and more SNSs provide their users with check-in functions and allow users to share physical locations with others. These SNSs include Foursquare, Flickr, Instagram, and even some online forums such as Reddit and Tianya.

While emerging media technologies such as Skype and FaceTime have connected users from different locations, how actual geographic distances influence users’ sense of their environments has more frequently been overlooked. Now with the growing use of geographic information systems in city planning, public health, and education, the social implications and social practices of check-in on SNSs can proffer scholars with a new perspective of studying communication.

One important feature of location-based SNSs is that it is frequently installed and used on mobile social media. Humphreys (2013) suggested that mobile social media refer to ‘software, applications, or services through mobile devices that allow users to connect with other people and to share information, news, and content’ (p. 21). The check-in service on mobile devices can help professionals and researchers locate their

targets (Graham, Hale, & Gaffney, 2013). For instance, as Twitter users share their physical locations, researchers, marketing experts, activists, and government officials can access digital trails of public check-in data (Graham et al., 2013). Advertisers can thus rely on check-in data to decide where to promote their products. Physicians can track patients’ check-in data to measure their walking distance and daily activities. Considering that almost every online user can check in their physical locations through their mobile devices and make edits to online maps such as Waze and MapQuest, geographic information has engaged higher civic participation than ever before.

The importance of investigating the role of geographic information in communication has been exhibited in Baidu Qianxi in China. Drawing on the real-time positioning signals from mobile devices, Baidu Qianxi visualized millions of migrant workers in China making 3.62 billion trips during the Chinese New Year holidays (Century, 2014). The data could help Ministry of Transport adjust transportation schedules and manage toll stations for the purpose of controlling passenger flow volume.

The goal of the current study is to apply geographic information system and spatial analysis to examine how individuals use Sina Weibo, a dominant location-based SNSs in China, to demonstrate their physical locations and create their social space. This study focuses on where users create their social space and what patterns exist in people’s check-in behavior. Specifically, an anti-pornography campaign in Mainland China is used as a case study to explore how GIS could be applied in the communication realm.

## Literature review

### Geographic Information System and Communication

Geographic information system (GIS) is a tool for cartographers and geography researchers to save, manage, process, present, and analyze spatial data (Chen, Yap, & Lee, 2013; Wood, 2011). It has been used to visualize a perspective of the world (Sui & Goodchild, 2001). GIS, along with MapQuest, Tableau, and other mapping services, has gradually become a major tool for researchers to map out citizens' social movements, census data, and city facilities (Chen et al., 2013). According to Palmer (2014), GIS has impacted traditional cartographic practices as GIS uses maps as reproduction of reality. GIS allows people to overlay the information such as population distribution on traditional maps. These thematic maps have been perceived as a way of sharing ideas in the form of lines, marks, dots, and characters (Dent, 1972).

The mapping services are no longer the representation of power and authority. With the emergence of GIS, all users can participate in building their communities. Farman (2010) argued that by integrating social networks in GIS technology, the authorial nature has been diluted. Similarly, Jenthani and Leorke (2013) suggested that the burgeoning of online mapping tools like OpenStreetMap has allowed for online users to re-construct public space. Millions of MapQuest users now customize their own maps and design their commuting routes and destinations (Sui & Goodchild, 2001). The users can rely on their own geographic information to make decisions (Wood, 2001).

GIS has been applied to education studies, language studies, city planning, culture distribution, and anthropology studies. For example, as a city-planning tool, the South Florida Water Management District developed a comprehensive GIS database to store key geographic information in fire stations, hospitals, shelters, and other departments (Kawasaki, Berman, & Guan, 2013). Nikolova and Booza (2009) used GIS to study the concentration of language use in the Detroit Metropolitan Area. They mapped out how languages evolved in different regions in Detroit and how some minor languages disappeared in this city. Ben-Harush, Carroll, and Marsh (2012) mapped users' consumption behavior, leisure, recreation, and physical activity patterns in order to understand how mothers of primary school students interact their local environments.

Though the uses and effects of GIS have not been widely examined in communication studies, some scholars have at least mentioned the concept of GIS in their research. Matei, Ball-Rokeach, and Qiu (2001) used GIS and spatial analysis to study residents' perception of urban places in Los Angeles. They found that participants' concerns about Los Angeles were not associated with high crime victimization likelihood. The

main concerns came from race populations, televisions, and interpersonal communication channels.

GIS also has been used to communicate health information and political information. For example, GIS has been perceived as social capital in cancer control (Parrott et al., 2010). Disease maps now allow for individuals with limited education backgrounds to understand complex presentation of statistics (Parrott, Hopfer, Ghetian, & Lengerich, 2007). Ushahidi, a non-profit organization, has used GIS to visualize natural catastrophes and political ideologies. Palmer (2014) found that the Ushahidi project can contribute to the geospatial visualization of residents' testimony.

Based on past works, GIS has provided communication scholars a new perspective of investigating social movements, users' mobile device use patterns, and power relations (Chen et al., 2013). Applying the use of GIS in communication studies would advance researchers' knowledge of SNS users' interaction with their space.

### Information Presentation on Digital Maps

One way to study the uses of GIS in communication is to map user-generated content online. The growth of authorship, the emergence of geospatial web, and the rise of mobile web can all contribute to the information on maps (Graham, 2013). Two examples of annotating maps include using mobile phone data to present conversation flows and using the records of smart transportation cards to trace underground traffic (e.g., Hong Kong's Octopus, New York's MetroCard) (Graham, 2013; Long, Han, & Yu, 2012).

Information presentation can also be reflected on Google Maps (Gordon, 2007). Graham and Zook (2011) found that the place marks on Google Maps can affect some people's understanding of the world as the information such as religion distribution is exhibited more straightforwardly than before. Groff, Kearley, Fogg, and Wartell (2005) did an experiment on participants' perception of symbols on theme maps. They found that graduated symbol maps were least associated with users' fear of robbery or assault compared to density maps and tabular maps. In another research, Doran and Lees (2008) found that the distribution of fear of crime matched the geographical concentration of disorder, suggesting that the government should reinforce the security at the hotspots to lower residents' fear of crime.

Meanwhile, due to the rise of users' participation in mapping information, online maps have gradually become subjective and grass-rooted. Graham and Shelton (2013) suggested that big data on maps have their own narratives as these data are obtained and built under diversified social economic environments. The user-generated data reflect users' perception about their

own space and should be read as part of their culture (Farman, 2010; Flanagan & Metzger, 2008).

### **Location-based SNS on Mobile Devices and Space Creation**

The diffusion of location-based mobile devices has increased the use of mapping tools and locative technologies (Jethani & Leorke, 2013). The proliferation of these devices has enriched social practices and remodeled communication patterns (Humphreys & Liao, 2011). According to Frith (2014), over 50% of adults in the United States have location-based smart phones. These location-based mobile devices, along with SNSs, have enabled people to both share and retrieve geo-tagged information on platforms such as Foursquare and Flickr. Taking Twitter as an example, Dredze, Paul, Bergsma, and Tran (2013) suggested that researchers have four ways to obtain users' geographic information. First, some tweets automatically include a place that is already encoded in the application-programming interface (API). Street names, towns, or cities can automatically be showed in users' tweets. Second, by looking at the coordinates through API, researchers can know the exact location where users tweet the information. Third, birthplaces and working places from users' profiles can contribute to their geographic information. Fourth, researchers can analyze the texts of the tweets to postulate their check-in locations. As Twitter users share their physical locations, Twitter has the potential to provide researchers, marketing experts, activists, and government officials with access to digital trails of public check-in data (Graham et al., 2013). Meanwhile, these mobile technologies allow users to access media content in different places at different times, which leads to a blurry distinction between private and public places (Aveyard & Moran, 2014).

As a type of location-based SNSs, locative mobile social network (LMSN) is a theoretical framework that focuses on the relations between check-in locations and social space (de Souza e Silva & Frith, 2010). According to de Souza e Silva and Frith (2010), LMSNs can be developed when users travel in physical space and interact with each other through location-based mobile devices. LMSNs also enable users to build social relations based on path changes and geographic distances. LMSNs can engender social meanings through demonstrating users' nodes and paths on maps.

Space plays an important role in LMSNs. Scholars have discussed the relationship between place and space. Both Lefebvre (1991) and Dourish (2006) argued that space involves social practices and reflects the socially produced reality. Humphreys and Liao (2011) made a distinction between space and place. They suggested that place refers to specific physical locations, whereas space refers to the realm where people engage

in social practices. Frith (2013) used the term 'hybrid spaces' to describe the overlay of social relationships and digital information on physical locations (p. 250). Though scholars have not achieved consensus on the conceptualization of space and place (Frith & Kalin, 2015; Harrison & Dourish, 1996), in this study, space is used to describe the realm that involves social practices and social memories.

De Souza e Silva and Frith (2010) argued that many factors mediated the relationship between users' interaction with space and the development of LMSNs. Users' perception of space could be dependent on their access to locative devices. Those who have access to locative mobile devices may have different perspectives of space from those who do not. Berry and Goodwin (2012) also mentioned that accessibility of technologies can accelerate users' space creation. They suggested that locative mobile technologies allow users to interpret city elements such as stores, images, sounds, stories, memories, and communities to have their social and cultural implications. Similarly, Hjorth and Gu (2012) investigated how location-based camera images are edited and posted on Jiepan. They suggested that overlaying the images onto physical locations can construct interpersonal networks and can form a distinct type of geospatial sociality.

Researchers also have noticed the time aspect of building social space. Frith (2014) found that two primary time periods during which people check in on Foursquare are at nights and during lunch hours. In addition, users' demographic information may influence their perception of space as well. Users' cultural, social, and economic backgrounds determine the way they use the locative mobile devices (De Souza e Silva & Frith, 2010). Individual characteristics such as political trust and political enthusiasm can leverage the relationship between social media use and civic participation (Ye et al., 2017). Their identity also serves as an important role in using mobile phones and reinvigorating public spaces (Berry & Goodwin, 2012).

Based on the theoretical framework of LMSN and users' interaction with social space, this study uses GIS approach to understand the general research questions of where location-based SNS users create space, how LMSNs evolve over time, and what factors influence the process of space creation.

### **Dongguan Anti-pornography Campaign and Sina Weibo**

A case study of China's Dongguan anti-pornography campaign was conducted to understand the relationships among GIS, LMSNs, and social space. On February 9, 2014, the Chinese state media CCTV exposed the sex industry in Dongguan, a manufacturing hub close to Hong Kong in Southern China (Geng & Chin, 2014). Dongguan region was known as a center

for sex industry in China (Pomfret, 2014). About 300,000 ‘technicians’ were known as sex workers and between 500,000 and 800,000 people in Dongguan were employed in the industry, accounting for about 10% of Dongguan’s migrant population) (Phillips, 2013). On the next day of the news coverage, over 6,500 police officers arrested 67 people and closed twelve hotels and restaurants that were suspected of embroilment in sex industries (Geng & Chin, 2014).

Despite the legitimate arrest, the way CCTV reported anti-pornography campaign led to extensive comments on SNSs such as Sina Weibo. Some people argued that the CCTV news coverage focused too narrowly on the ‘ladies’ (i.e., sex workers) without examining the social background of the sex industry (The New York Times, 2014). According to an online vote hosted by an Internet news portal in China, 63% of 200,000 readers were against the CCTV exposure (Geng & Chin, 2014). Meanwhile, there were others who supported the arrests considering that sex industry was illegal in China.

SNS users have expressed their solidarity with Dongguan by posting ‘Don’t cry Dongguan’ and ‘Hang in there, Dongguan’ on Weibo. Many Weibo users discussed whether the government should legalize the sex industry (Kaiman, 2014). Bequalin, a Hong Kong based researcher at Human Rights Watch, argued that ‘This is the first time in memory that you have a large public debate in which a non-moralistic or punitive point of view dominates’ (Kaiman, 2014). Therefore, based on the unprecedented public discussion of the anti-pornography campaign, this case was selected as it aroused a large scale of discussion on location-based SNSs.

The current study focuses on the check-in function of Sina Weibo in Mainland China. Sina Weibo and Mainland China were the major targets in this study as China is undergoing a rapid and large-scaled Internet and SNS development. About 90% of the 700 million Internet users in China are SNS users (Hong, 2017). SNS in China has provided citizens with open space for discussion of public issues and chance of expressing real thoughts and making judgments (Dong, Liang, & He, 2017). Information on SNS in China has become social capital as it allows for researchers to access public discourse and study civic participation (Ye, Xu, & Zhang, 2017).

Sina Weibo is owned by the Sina Company in China. Weibo is in a dominant position in the Chinese SNS market. According to the 2015 Weibo Annual Report (Weibo Corp, 2016), the number of monthly active Weibo users has achieved 222 million, accounting for about 33% of the Internet users and 37% of the mobile phone users in China. The number of daily active users has achieved more than 100 million.

Among the Weibo users, 76% of them have received college education.

Consistent with Ellison and Boyd’s (2013) definition of social networks, Sina Weibo is a SNS platform that allows participants to have unique identifiable profiles, to have connections that can be explored by other users, and to digest, generate, or interact with user-generated content. The major functions of Weibo includes building a distinct profile, connecting with friends, posting comments, sending private messages, sharing photos and videos, and posting micro-blogs. Also, Weibo can facilitate the shaping of LMSNs as it enables users to check-in physical locations and see each other’s position movements and travel paths. By combining the theoretical framework of LMSNs and the Dongguan anti-pornography campaign, this study seeks to examine the following research questions:

**RQ1:** Where did Weibo users talk about Dongguan and anti-pornography?

**RQ2:** What was the ranking of the provinces that had the most people talking about Dongguan?

**RQ3:** How did the distribution of Weibo check-in data evolve over time?

**RQ4:** For those whose Weibo residence status was set in Dongguan, where did they check in to talk about Dongguan?

**RQ5:** How would males and females differ in their geographic information when talking about Dongguan?

**RQ6:** Where did the public opinion leaders talk about Dongguan?

**RQ7:** What was the relationship between points of interest and users’ check-in locations?

### Method

To answer these research questions, all the posts on Weibo from February 11 to February 12 in 2014 were scrapped using Python through API. A total of six million entries from Weibo on February 11 and February 12 were retrieved. The original data were stored in csv file. Each entry includes case ID, tweet posting time, texts, devices, latitude, longitude, the login ID number of the posters, number of re-tweets, number of comments, registered residency place, gender, number of fans, number of people the user follows, total number of tweets posted, initial account creation time, identification category, number of people who mutually follow users, data collection time, and username.

Python, SPSS, and ArcGIS were used to deal with the six million data. First, Python was used to store the data in a readable format. Then it was used to clean and filter out the data that did not include location-based information (i.e., latitudes and longitudes). In addition, among the tweets, those with ‘Dongguan,’ ‘anti-pornography,’ and ‘Dongguan anti-pornography’ were

selected and saved in separate files. These data were imported into SPSS for further analysis.

After screening, a total of 2,005 posts used the word 'Dongguan' with geographical coordinates. In addition, 351 posts used both 'Dongguan' and 'Anti-pornography' with geographical coordinates. Among the posts that included the word 'Dongguan,' male users posted 1,587 of them and female users posted 418 of them, meaning that males paid more attention to Dongguan than females. In addition, 465 tweets were sent from Guangdong province, among which 146 posts were sent from Dongguan. That is, about a quarter of the posts were sent from Guangdong province. About 7% of all the posts were sent from Dongguan.

ArcGIS 10.2 (ESRI, 2016) was used to manage and visualize the data. As the components of ArcGIS, ArcMap, ArcView, ArcCatalog, and ArcToolbox enabled users to map, manage, share, and analyze the information. First, the geographical coordinates were imported into the software. They were posted on different shape-files for maps of China (RQ1). Then graduated symbols and graduated colors in ArcGIS were used to answer RQ2. To answer RQ3 to RQ6, all data were further split by different time periods, places of residence, gender, and number of followers. To answer RQ7, new shape files were used to compare points of interest and people's check-in locations. A total of nine maps were created using ArcGIS to answer the research questions (Map 1 to 9).

## Results

Two maps were created to answer where Weibo users participated in discussion about 'Dongguan' and 'anti-pornography' (RQ1). Map 1 illustrated the distribution of people talking about 'Dongguan.' The map suggested that more people were talking about Dongguan along the east coastline of Mainland China than inland China. Major check-in locations were distributed among Guangdong province, Shanghai, Jiangsu Province, and Beijing. Map 1 also illustrated that though Guangzhou was the capital of Guangdong province, Dongguan appeared to have more check-in data than Guangzhou.

Map 2 illustrated the concentration of people talking about 'anti-pornography' in China. The result was similar to the findings from Map 1. More people were talking about anti-pornography in major cities such as Beijing, Shanghai, and Guangzhou. Dongguan also had more people talking about this event than other cities in Guangdong province. Places that were closer to Dongguan had more people paying attention to this campaign. Shenzhen appeared to have more check-in data about 'anti-pornography' than the whole Guangxi province.

Map 3 was created to answer the question about the ranking of the provinces that had the most people

talking about Dongguan (RQ2). Graduated symbols were used to represent the rankings. The inset map provided a summary of the check-in data. The map suggested that Guangdong province had the highest number of people talking about Dongguan. Jiangsu province had the second highest number of people talking about Dongguan, followed by Zhejiang, Sichuan, and other provinces. However, when the total population of the provinces normalized the number of people that talked about Dongguan in their provinces, the inset map suggested that people from Beijing and Guangdong talked about Dongguan the most, followed by Jiangsu, Shanghai, and other provinces.

To answer how the distribution of Weibo check-in data evolved over time (RQ3), three more maps were created. Map 4 illustrated the time series of the check-in data about Dongguan. The first inset map in Map 4 illustrated the check-in data from 0 to 6 a.m. on February 11. The second inset map added the data from 6 to 12 a.m. on February 11 based on the first inset map. The third picture added the data from 12 a.m. to 6 p.m. based on the second inset map. The fourth inset map added the data from 6 p.m. to midnight based on the third inset map. With the passage of time, Map 4 suggested that on February 11, more people from inland provinces joined in the discussion. From midnight to 6 a.m., the discussion became highly concentrated in major cities along the east coast of China.

Map 5 illustrated the results of each time session for the two days. The first inset map showed people's discussion about anti-pornography from 0 to 6 a.m. and 6 to 12 a.m. on February 11. The second inset map showed people's discussion about anti-pornography data from noon to 6 p.m. and from 6 p.m. to midnight on February 11. Inset map 3 and inset map 4 showed the corresponding time periods on February 12. Similar to the findings on Map 4, at night, more people along the east coastline were talking about anti-pornography, while in the day, people from inland provinces participated in discussion.

Map 6 illustrated the comparisons of Weibo check-in data about Dongguan on the first day and the second day of the campaign. The distributions of the data on both days appeared to be similar. However, a more careful review of Map 5 suggests that on the first day, there were more check-in data around Dongguan in Guangdong province. On the second day, the number of dots around Dongguan area decreased, but the number of dots within Dongguan area were about the same.

Map 7 was created to understand where those whose Weibo residence status was set in Dongguan check in to talk about Dongguan (RQ4). Map 7 suggested that Dongguan people out of Guangdong province were talking about this event from different places. However, most of them were still staying within Guangdong province. The closer people were to

Dongguan, the more likely they would talk about their hometown. The third inset map suggested that for those who lived in Dongguan, most of them talked about Dongguan from the northeast corner of the city.

Map 8 was created to examine the gender differences in sharing geographic information (RQ5). The first inset map suggested that males and females did not differ much in their geographic distribution of check-in data. However, many more males than females were talking about Dongguan.

The second inset map in Map 8 showed the distribution of public opinion leaders who were talking about anti-pornography (RQ6). Here, public opinion leaders were operationalized as the users who had over 200,000 followers on Weibo. Those Weibo users were talking about Dongguan from Guangdong, Beijing, and Zhejiang. Weibo users that had over 10,000 followers were generally distributed in East China. Beijing and Guangdong had the densest population that had over 10,000 followers. Inland provinces had fewer public opinion leaders compared to Beijing and Guangdong.

To examine the relationship between points of interest and users' check-in locations (RQ7), Map 9 compared people's check-in locations between Dongguan and Shanghai. The map suggested that in Dongguan, only a few check-in locations overlapped with points of interest. Comparatively, people in Shanghai checked in more frequently at the points of interest in the city, meaning that most Weibo users in Dongguan focused on the Dongguan anti-pornography campaign in residential areas, while users in Shanghai may have concentrated on this topic more frequently in commercial zones such as malls, restaurants, and stores.

### Discussion

This study has applied GIS, an approach that has not been widely used in communication studies, to understand how users check in their physical locations to participate in public discussion. Consistent with Shao and Wang's (2017) arguments, SNSs in China have accelerated the shaping of online space and generated a new form of public participation. SNS users have benefitted from the location-based social media in voicing their political concerns, values, and political enthusiasm. By producing nine maps based on the GIS techniques and spatial analyses, this study not only contributes to the knowledge of users' check-in behavior, but also corroborates the interaction between LMSNs and users' creation of social space.

Weibo users from Beijing, Shanghai, and Guangzhou paid more attention to this campaign than those from other places, indicating that more social space is created in economically developed areas in Mainland China. It is consistent with Berry and Goodwin's (2012) argument about the role of mobile technologies in urban areas. It suggests that higher

accessibility of mobile technologies may have more power over space creation. Li (2014) used GIS to illustrate that mobile penetration in developed cities was higher than other places in China, suggesting that users' check-in data were highly consistent with mobile penetration.

The results also suggested that over time, Weibo users who were far from Dongguan gradually withdrew from the public discussion, while users in Dongguan kept focusing on the campaign. This finding can add to the framework of LMSNs in that both geographic proximity and social identity can shape social space. As Fujioka (2011) suggested, users' attitude toward characters in news coverage was associated with their own identities. As those who lived in Dongguan area may have witnessed the anti-pornography campaign, their jobs, their attitudes, and their behavior might have been influenced by the crackdown of the industry. In addition, users' identities may exert greater influence than the socioeconomic environments on their attention to the campaign. It is consistent with the prior research findings that social identity had stronger effects than economic environments on citizens' engagement with news events (Herdagdelen, Zuo, Gard-Murray, & Bar-Yam, 2013; Knobloch-Westerwick & Hastall, 2010). It suggests that expressing shared interests and cultural values on social media would both reinforce local networks and facilitate the sense of belongings in online sphere (Shao & Wang, 2017; Ye et al., 2017).

The maps also demonstrated that Beijing and Guangdong had the most Weibo users who had over 10,000 followers. The finding suggests that in addition to social identities, politics may be another factor in mediating the relationship between LMSNs and space creation. Although the Dongguan anti-pornography campaign did not occur in Beijing, the campaign was symbolized as an official campaign launched from Beijing, the political hub of China.

In addition, the maps suggested that many more males than females were talking about this event. Perhaps females were reluctant to talk about this event as this campaign was closely related to prostitution and sex industry. It may also be because females were more likely to communicate privately and less likely to participate in public discussion than males (Hoffman, Kalsbeek & Novak, 1996). Herring (2000) investigated the gender differences from the perspective of computer-mediated communication. Herring (2000) argued that there is a tendency for 'gender differences to work to the disadvantage of women, especially when they function as cues to attract predatory or harassing attention from men' (Paragraph 17). The finding about gender differences in the current study validates the theoretical framework of LMSNs where users'

demographic information determines the way they use location-based mobile devices to create social space (De Souza e Silva and Frith, 2010).

Users in Dongguan checked in at points of interest less often than users in Shanghai. It might be because in Dongguan, some hotels, restaurants, and hair salons were closed after the anti-pornography campaign. In Shanghai, most users checked in at points of interest, indicating that they preferred to participate in public discussion when they were in public places. The contrast between Shanghai and Dongguan suggests that social space would be created where stores, landmarks, restaurants, communities were widely available. These points of interest can provide users with convenience in creating their space (Berry & Goodwin, 2012). The comparisons between points of interest and check-in locations can also endow public places with more social memory, social meanings, and users' behavior patterns (Frith, 2010).

The current work implies that using GIS to explain users' check-in behavior and to detect public discussion patterns has both theoretical implications and practical implications. This study corroborates the validity of the theoretical framework of LMSNs and suggests that users create social space and build social relations through check-in on location-based social media. In addition, this study not only confirms that accessibility of technologies, demographics, and the time of posting tweets contribute to the shaping of LMSN, but also demonstrates the heuristic value of LMSNs in that social identities, opinion leaders, and socioeconomic environments play an essential role in developing LMSN and constructing social space.

Apart from that, compared with previous research that focuses on the questions about 'why,' 'what,' 'how,' and 'whether,' GIS in communication has provided a prospect for visualizing 'where' citizens engage in news events and campaigns. The visualization of civic engagement reflects the growth of user-generated content in GIS. The user-generated content enables mapping to gradually shift from being an authorial official practice to being a grass-roots practice. As was argued by Parrott et al. (2010), GIS could be interpreted as social capital and could enhance our knowledge of space and networks at the macro level.

### Conclusions, Limitations and Future Research

This study applies GIS approach to map where people check in their locations to participate in public discussion. By using the Dongguan anti-pornography campaign as a case, it is inferred that the power of LMSNs over space creation can be influenced by the accessibility of technologies, socioeconomic environments, social identities, politics, geographic proximity, user demographic information, and city planning.

This study is explorative and descriptive in understanding the effects of LMSNs and GIS. However, it has some limitations. First, according to past research, Geo-tagged tweets represent only about 2% of all tweets and 3% of Twitter users (Dredze et al., 2013). Thus, the data that had coordinate systems might not be representative of the public discussion patterns. More research is needed to examine the characteristics of the users that are inclined to check in and disclose their physical locations (e.g., personalities, motivations for check in, and mobile device use habits).

Second, it was premature to draw conclusions only from the visual effects of maps. As was suggested, more content analysis and textual analysis could be used to examine what people were tweeting and how their tweets were related to their geographic positions.

Third, the study only included the data on February 11 and February 12. It is likely that the information communication flow would change in the following days. However, as Weibo has reinforced its control over sensitive data mining including geographic information, retrieval of the geographic information in 2014 required higher level of access due to both users' and Sina Corp's concerns over privacy management.

Fourth, more social and economic data were needed to map the potential explanations of the distribution of the check-in data. For example, more census data, more news institutions data, and more accurate and updated points of interest data will be needed to answer the questions about 'where' in communication research.

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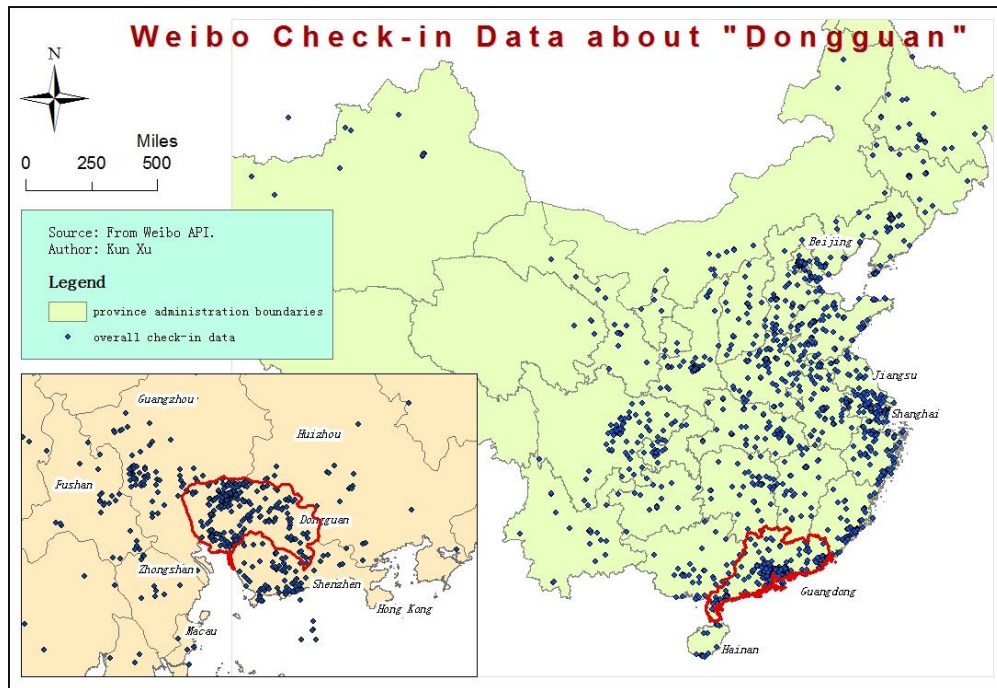
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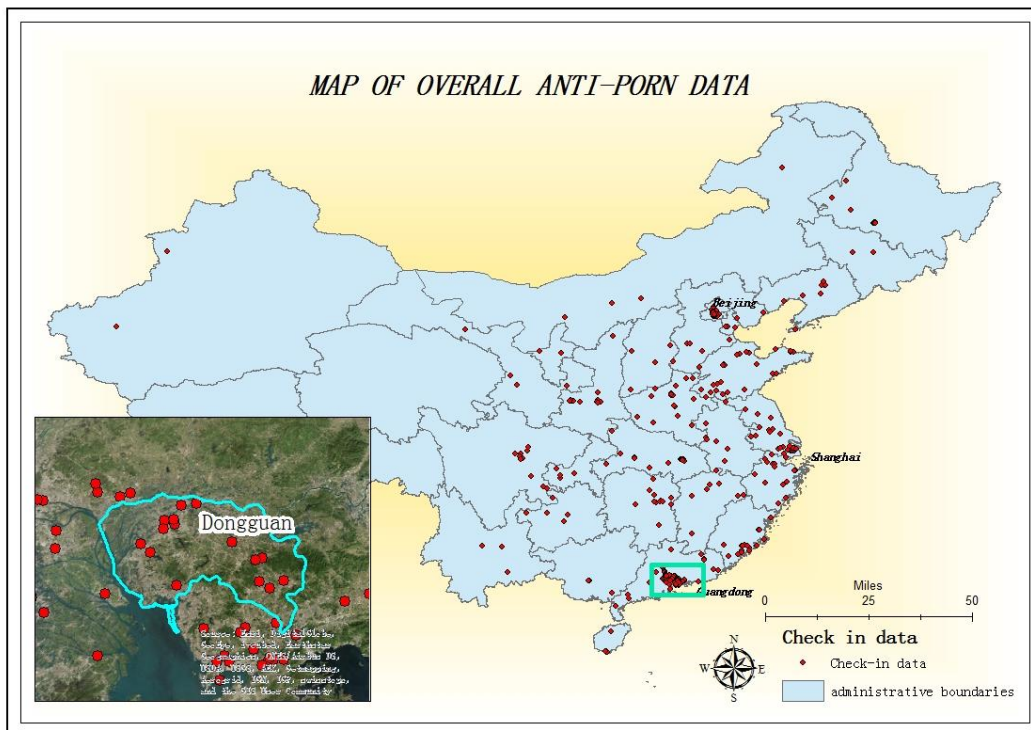
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Map 1  
Weibo check-in data about "Dongguan" on February 11 and February 12



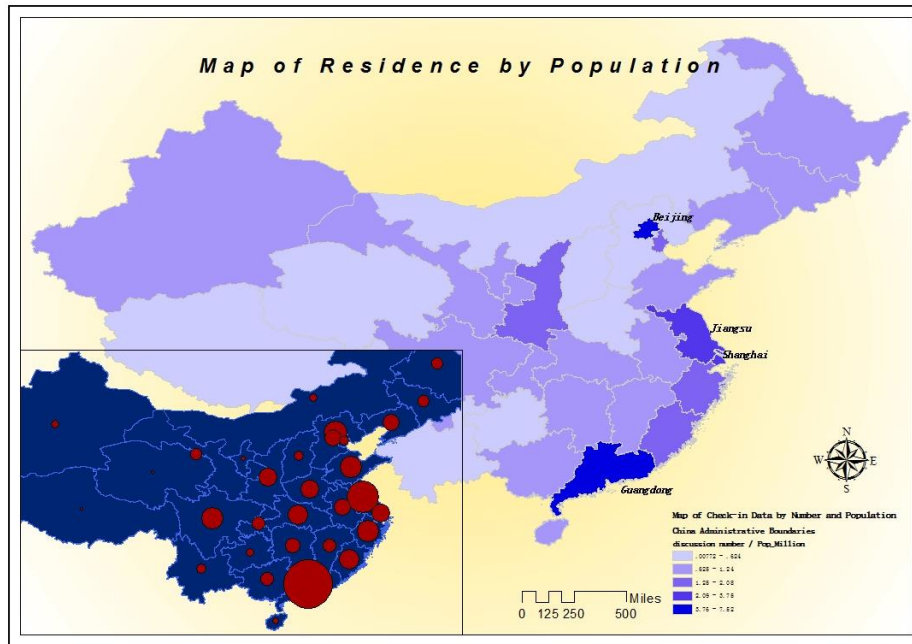
Note: The red part in the background map shows Guangdong province. The red part in the front map shows geographic boundary of Dongguan.

Map 2.  
Weibo check-in data about Anti-pornography on February 11 and February 12



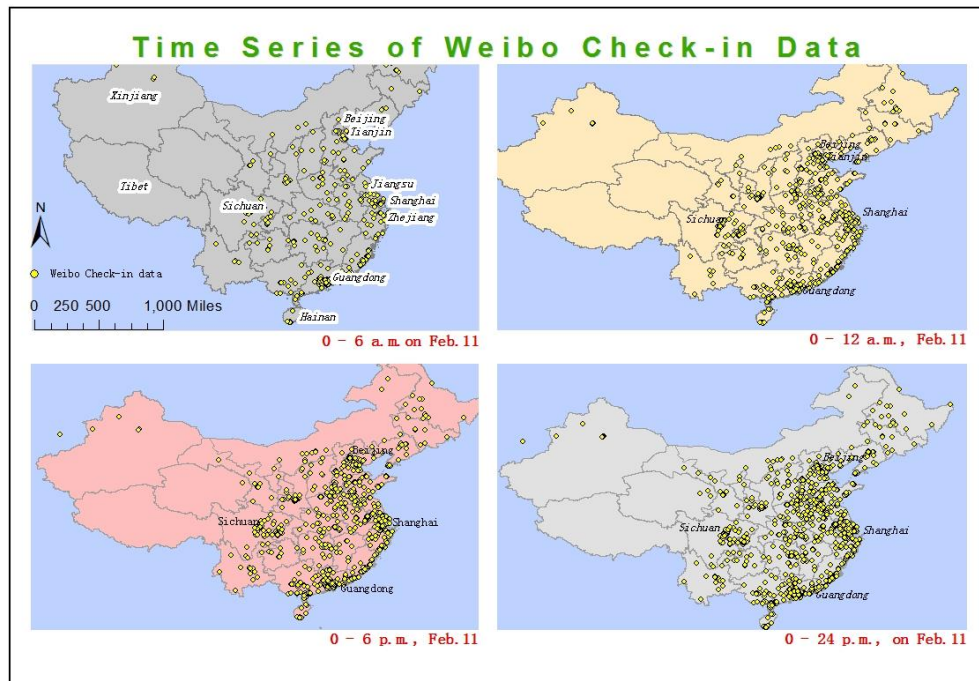
Note: The front map was about where people checked-in in Dongguan.

Map 3  
*The ranking of place of residence among Weibo users*



Note: The inset map was about the number of tweets sent from the provinces. Graduated symbols represented the rankings of the provinces. Large symbols meant higher number of people talking about Dongguan. The background map was about normalized number of people talking about Dongguan. The number of Weibo check-in users was normalized by the province population.

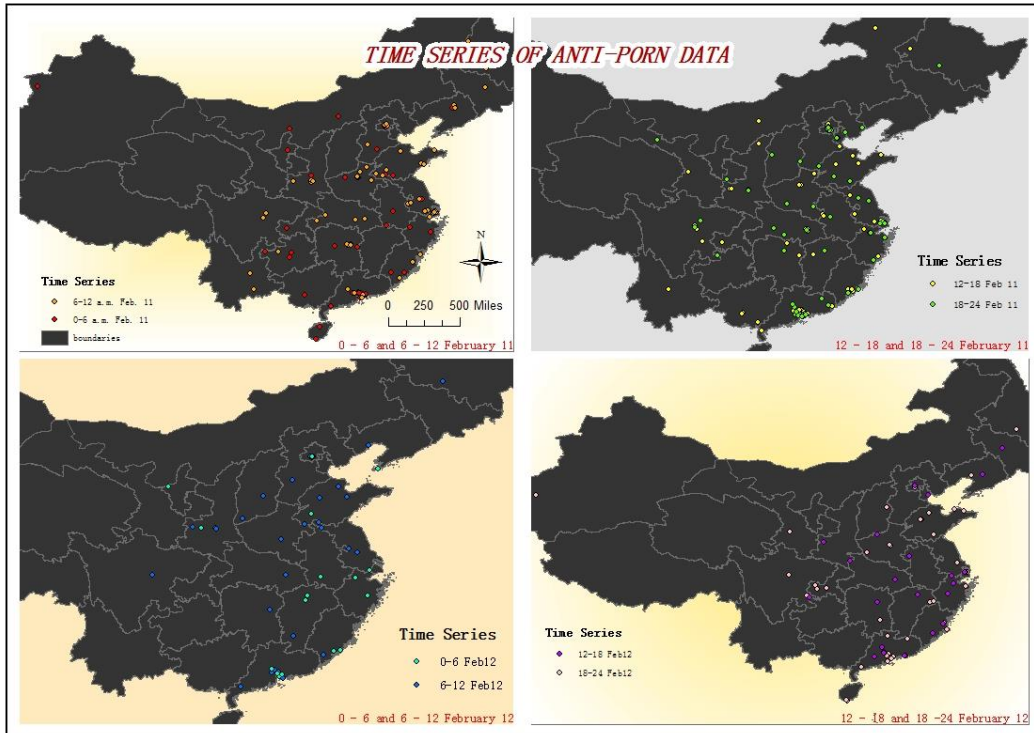
Map 4  
*Time series of Weibo check-in data about Dongguan (Cumulative)*



Note: The maps only showed Weibo tweets on February 11. As time passes, information diffuses from coastline to inland China.

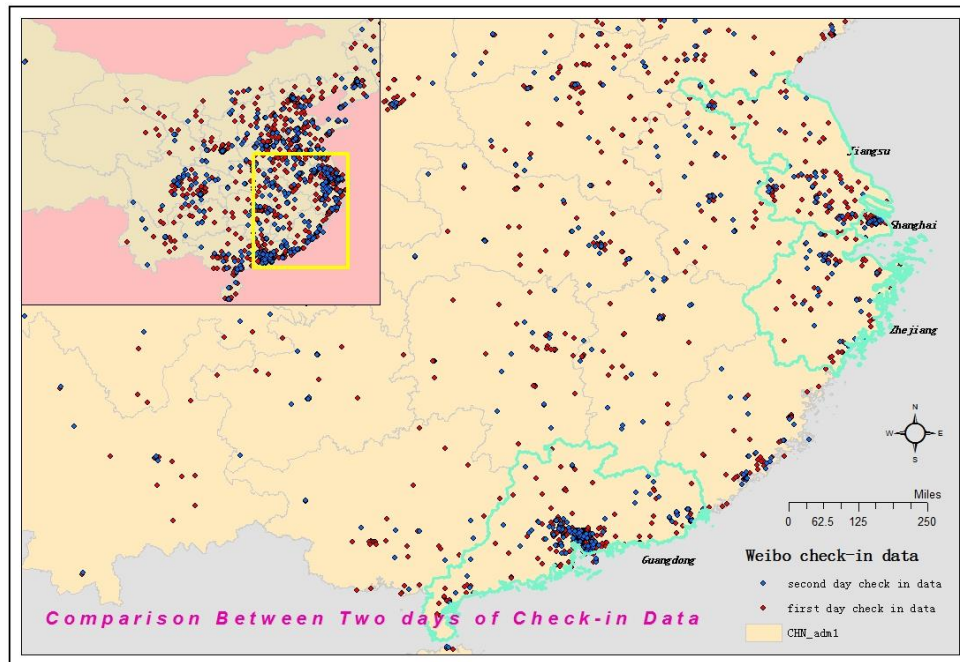


Map 5  
*Time series of anti-pornography data (Split sessions)*



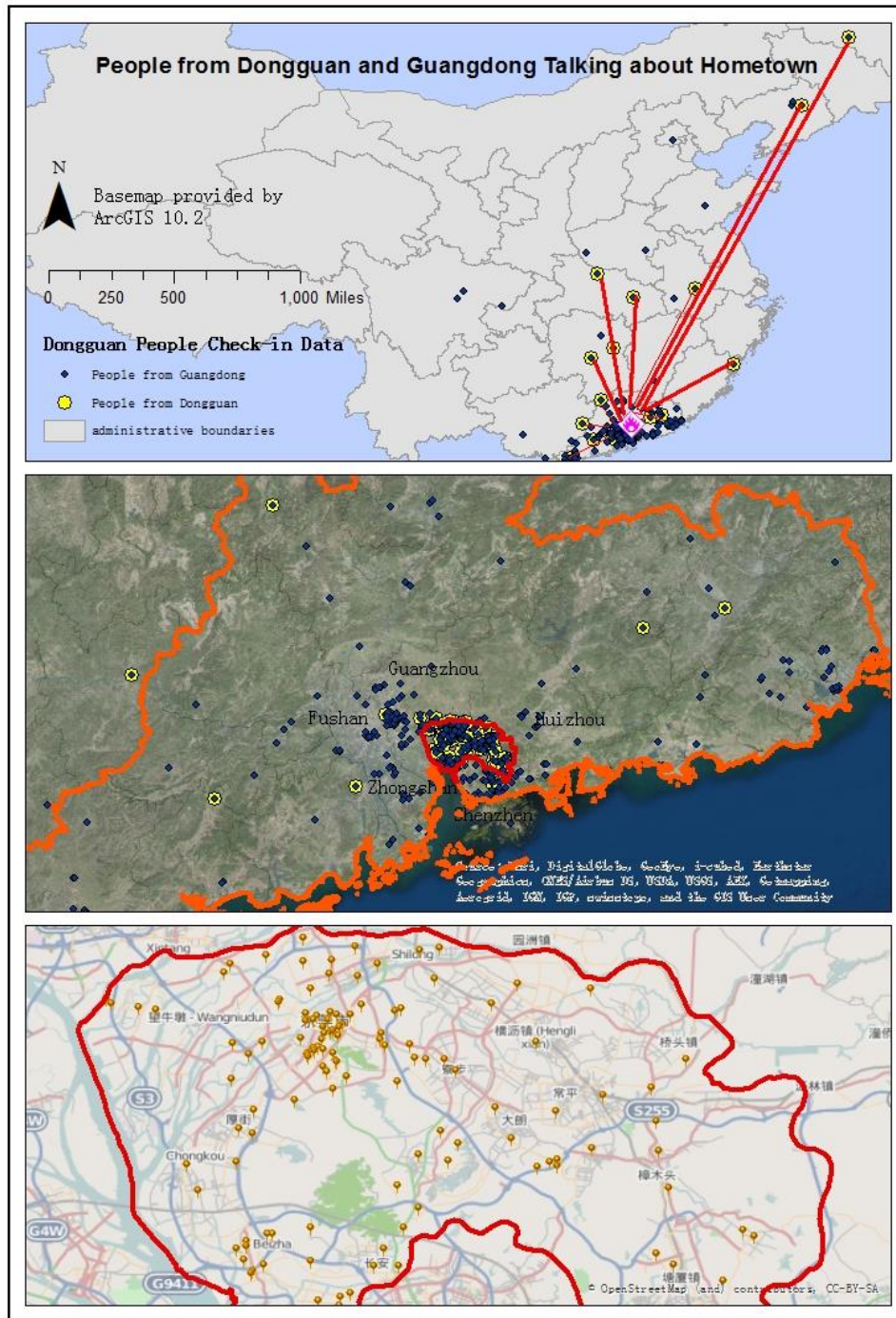
Note: The upper two maps showed the anti-pornography tweets on February 11. The lower two maps showed the anti-pornography data on February 12.

Map 6  
*The comparisons of check-in data about Dongguan between first day and second day*



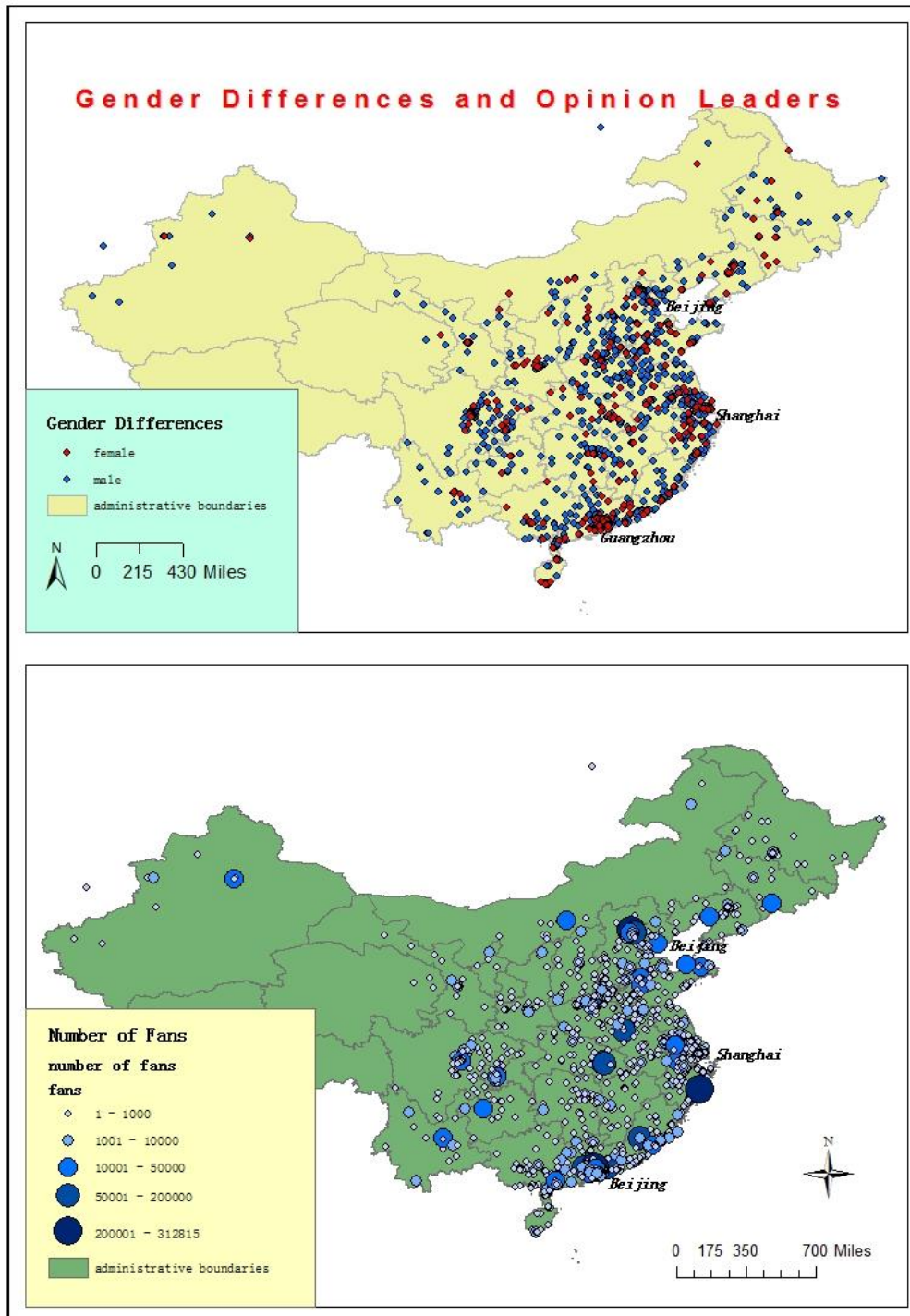
Note: The inset maps showed the overview of the first-day data and the second-day data. The background map showed how dots were distributed in southeast China, especially in Guangdong, Jiangsu, and Zhejiang provinces.

Map 7.  
*Dongguan people talking about Dongguan out of their hometown*



Note: These pictures showed where those whose permanent residence was in Dongguan, Guangdong province talked about their hometown.

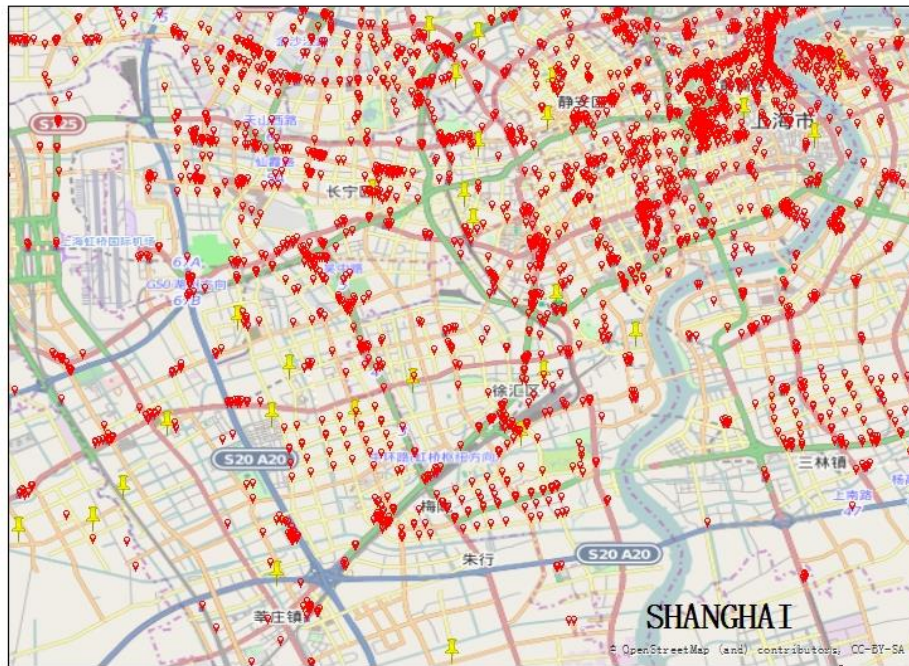
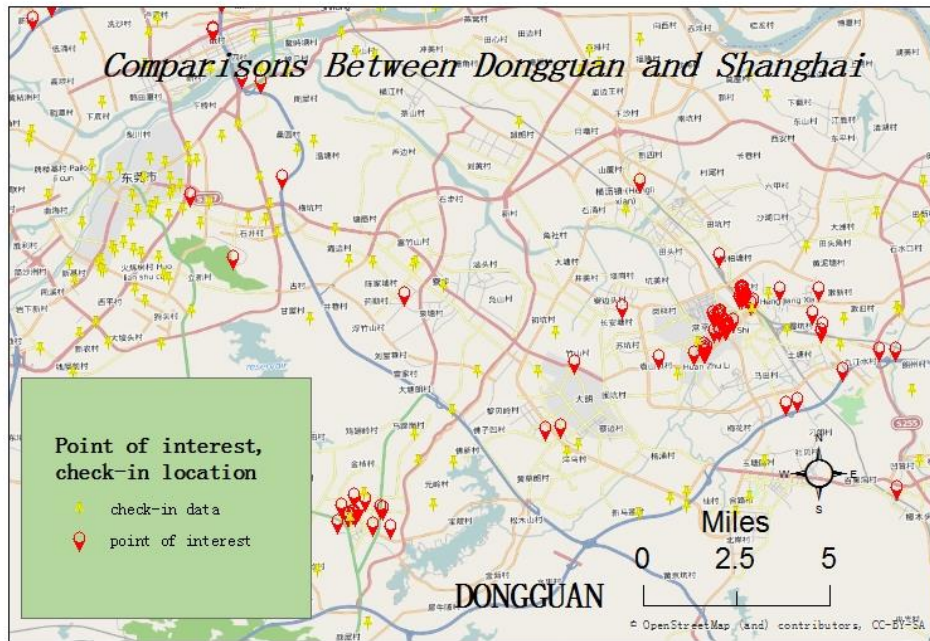
Map 8  
Gender differences and distribution of public opinion leaders.



Note: Graduated symbols represent the number of fans Weibo users had. The larger the circles were, the more fans the Weibo users had.



Map 9  
Check-in data with points of interest in Dongguan and Shanghai



Note: The upper map showed the comparisons between points of interest and people's check-in locations in Dongguan. The lower map showed the comparisons between points of interest and people's check-in locations in Shanghai.

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