

# Detecting the Attractive Spots of Hiking Tourism Based on Geo-tagged Photos: The Case of the Northern Outskirts of Guangzhou, China

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## Abstract

Hiking in the outskirts of mega cities as a kind of environmentally friendly and sustainable urban tourism is becoming more and more popular in China. The trend of urban residents participating in hiking in China appears to be relatively late comparing with that in Europe. Therefore, the facilities and management for hiking tourism still need to be improved in China. Hiking activities can help citizens keep physically and mentally healthy because it provides the opportunity to experience the tranquility, solitude and pristine beauty of nature, which are recreational qualities that contrast with the stress of urban life. So, going hiking frequently is a green lifestyle. Since hiking activities are often carried out in outdoor areas with no regular path, it is difficult to use traditional methods to research these activities, especially when the research focus on large-scale area.

The social networking sites for hikers have emerged in China in recent years, which provide opportunities to share geo-tagged photos when going hiking. These photos serve as a new source of data for studying hiking activities. Considering that people take photos to record attractions, geo-tagged photos reflect people's memorable events associated with locations. Therefore, these photos provide insights into hikers' preferences and their interactions with the surroundings. Based on these photos, a novel approach is presented to identify the spots which attract the hikers through density analysis and to get the tags representing features of the spots through image recognition.

In this paper, we made a case study of the hiking activities in the northern outskirts of Guangzhou, China. This area is approximately 1797 square kilometers, having rich ecological resources and attracting numbers of hikers. First of all, the shared geo-tagged photos of the area from March 2010 to March 2017 were obtained. After screening, 13157 photos shared by the hikers were gained. Then, the hot spots attracting hikers were identified through density analysis in GIS. After image recognition, tags representing contents of the photos taken within 50m around the attractive spots were found out. Then top two representative tags were selected for each attractive spot. These tags including "Mountain", "Vegetation", "Water", "Rock", "Building" and "Person", introduce the types of the attractive spots and the contents of the most photos taken by hikers when they stay. Finally, the pattern of distribution of different types of attractive spots were studied and summarized. The information of the attractive spots and the tags can serve as an important reference for planning, governance and management of hiking tourism.

**Keywords:** geo-tagged photos; hiking tourism; attractive spots; representative tags; Guangzhou, China

## 1. Introduction

The tourism sector which is already one of the fastest growing industries in the world is currently undergoing extensive change (Sørensen & Sundbo, 2014). Among various ways of tourism, hiking is becoming more and more popular in China. The rapid development of outdoor activities and Internet have promoted the popularity of hiking tourism. Hiking in the

suburbs of large cities is a typical type of eco-tourism. Citizens from large cities participate in hiking in the outskirts of the cities in order to get exercise, rest and recreation. In this process, they also achieve the purpose of understanding, enjoying and protecting nature. Many developed countries have developed mature systems and commendable facilities for hiking tourism. However, hiking tourism in China appears to be relatively late, and it is still spontaneous. Therefore, the facilities and management for hiking tourism need to be improved in China (Jin, et al, 2012).

The characteristics of tourists' behavior are very important aspects in tourism research (Beeco, et al, 2013). Understanding the tourists' needs and activities is crucial for tourism planning and management (Taczanowska, et al, 2014; East, et al, 2017). However, hiking is often carried out in rural and natural environments so that traditional survey methods are difficult to apply due to the area is lack of monitoring and some hikers lack map reading skills or have difficulties in orientation.

With the development of technology, GPS is integrated into portable equipment, providing new opportunities for tracking travel activities (Nielsen, et al, 2010). With the gradual development of the social networking platform, many hikers share where they are and what they see in the process of hiking by sharing geo-tagged photos on the social networking sites. A large number of geo-tagged photos on the Internet provide a new and valuable source of information for the study of tourists' behavior (Orsi & Geneletti, 2013). The study of the preference and behavior of tourists based on geo-tagged photos has become an important topic in the field of tourism research and management. By analyzing geo-tagged images, we can get information about the places that attract hikers (Arase, et al, 2010). These spots often have charming landscape or interesting things. They are also places that are prone to crowding (East D, et al, 2017). The planning and management of these places need to take into account in terms of both viewing function and security protection.

This study attempts to collect the geo-tagged photos shared on the social networking sites and obtain the attractive spots of hiking tourism through density analysis in the GIS. After using image recognition technology to identify the contents of photos around the attractive spots, the tags which represent the contents interested by the hikers can be gained. The information of the attractive spots and the tags can provide a basis for planning and management of the attractive spots of hiking tourism.

## **2. Related Research Review**

In academia, the study of outdoor tourism activities has a long history. In densely populated areas, providing quality outdoor recreation areas is a particularly important topic. The design methods that explore the balance of the needs of tourists and the services have attracted plenty of attention (Bell, 2008). Traditional studies often use written diaries or telephone interviews to obtain information. These methods have problems including the inability to obtain accurate information of travel time and destination location (Murakami & Wagner, 1999). In addition, some studies have conducted interviews with on-site visitors in order to know about the routes of the tourists and explore the spatial behavior of tourists (Taczanowska, et al, 2006). Some studies also explore monitoring options for tourist numbers in natural areas (Cessford & Muhar, 2004).

However, hiking tourism tends to occur in rural areas. If the hikers have difficulties in orientation, it is probably difficult for them to recall the hiking route and the location of attractive spots after hiking activities. So, traditional methods are not applicable in such cases. In contrast, data with geographic coordinate information shows advantages.

Some scholars tried to extract travel information from geo-tagged photos in order to understand the behavior of tourists (Li, et al, 2013), and to obtain the location of the spaces that attract tourists to stay (Papadopoulos, et al, 2011; Henderson, et al, 2010; Li & Ding, 2015). What's more, some studies used geo-tagged photos to speculate the tourist routes (Arase, et al, 2010; Kurashima, et al, 2013; Orsi & Geneletti, 2013). Furthermore, some scholars used geo-tagged photos to identify the behaviors and needs of tourists and to build

a travel route recommendation system (Okuyama & Yanai, 2013). For managers, the information contented in geo-tagged photos is used as a basis for planning tourism routes and arranging tourism facilities (Yoshikawa, et al, 2010).

In addition, some scholars have tried to use GPS data of the track in tourism research. For example, some studies used these data to research tourists' behavior (Orellana, et al, 2012; Meijles, et al, 2014; Donaire, et al, 2015). Base on the characteristics of tourists' behavior, some scholars generated a tourist route selection model (Bierlaire & Frejinger, 2008) or constructed a new tourism route design method (Li, et al, 2016).

It can be seen that research methods for outdoor hiking tourism are constantly evolving. At present, tourism research based on geo-tagged photographs pays more attention to urban built-up areas and less attention to the outskirts of the cities. These researches based on GPS data of the track pay attention to the feature of the behavior of tourists and the generation of routes, and basically have not advantages in identifying the features of spots that attract tourists. This study focuses on the case of the northern outskirts of Guangzhou in China and make comprehensive use of geographical information and visual information carried by geo-tagged photos to obtain the attractive spots that hikers prefer to stay and to identifies the features of the spots.

### **3. Research Foundation**

#### **3.1 Research Object**

Hiking is a walking exercise which always occurs in the suburbs of cities or rural area. In many countries, as leisure time increases, the proportion of people participating in hiking tourism increases (Cole & Buckley, 2004). In China, hiking activities are mainly in short-distance, and their destinations are always in the wild area or rural area (Jin, et al, 2012). Areas that are easily accessible around large cities or densely populated areas often become main destinations for short-distance travel (Bell, 2008).

The Zengcheng District and Conghua District in the northern part of Guangzhou have various ecological and rural resources, attracting a large number of hikers. The "Master Plan of Guangzhou (2011-2020)" introduces that the Liangkou Town, Lvtian Town and Wenquan Town in Conghua District, Paitan Town, Xiaolou Town, and Zhengguo Town in Zengcheng District have advantages in ecotourism. The elevation of this area ranges from 30 meters to 1170 meters and the slope range from 0 degrees to 50 degrees. Thanks to the great change of topography, the ecological resources in this area are abundant. At the same time, this area is in the northern part of Guangzhou and it is relatively convenient to get to. Therefore, this area has been popular for hiking.

This study chose this area as a case, using the geo-tagged photos on the social networking sites to identify the spots that attract hikers to stay and found tags representing the feature of the spots.

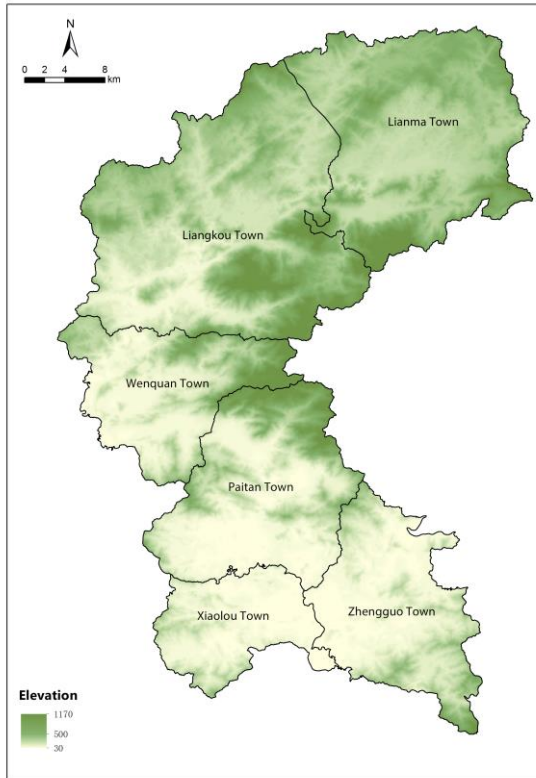


Figure 1: Topographic map of study area

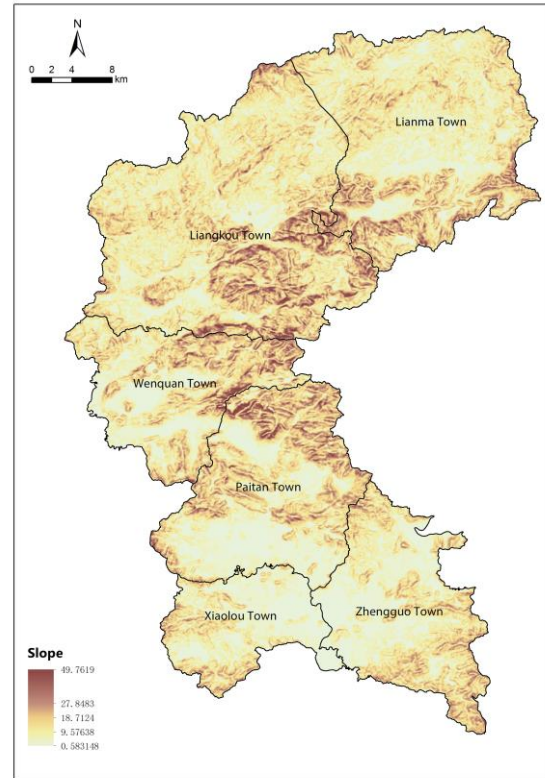


Figure 2: Slope map of study area

### 3.2 Research Methods

With the development of outdoor travel activities and the popularization of GPS technology, social networking sites for sharing geo-tagged photos have appeared on the Internet. These social networking sites provide an opportunity to share photos with geographical coordinates whenever and wherever users are doing outdoor activities. These sites provide hikers with the opportunity to share GPS tracks and geo-tagged images online. They have been gaining plenty of users in China.

After searching with “Conghua” and “Zengcheng” as keywords, this study used the software called LocoySpider to gain geo-tagged images and corresponding GPS tracks on one popular social networking site for hikers. A total of 19664 geo-tagged photos and 4116 corresponding GPS tracks were collected. After importing the original data into GIS for visualization, the data outside the study area, the abnormal or non-hiking travel data were filtered. Finally, 13157 corresponding geo-tagged photos and 2564 corresponding tracks were obtained.

After importing these geo-tagged photos in GIS, we used density analysis to identify places that attract people to stay and take photos. Based on the result of the density analysis, we selected the 100 attractive spots with high density value. Then what people interested in when they stay in these spots was explored. The content of the geo-tagged photos taken within 50m around the attractive spots were studied. Based on the open sources database on the Internet for image recognition, the content of these photos was recognized after running a machine learning model. Then the top two representative tags were selected for each attractive spot. These tags are able to tell us the types of the attractive spots and contents of the majority of photos taken by hikers when they linger at the spot. What's more, the distribution rules of different types of spots were also summarized.





Figure 3: The GPS track and geo-tagged photos on one social networking site (The blue marks on the map represent the location of the shared photos)

#### 4. Detecting the Attractive Spots of Hiking Tourism

##### 4.1 Identifying the Attractive Spots

A small number of the tracks coincide with the existing county roads, while most of the routes chosen by the hikers are just limited to walking. The hikers prefer the unhardened paths in the wild which are always not recorded on the traditional maps. Many hikers find their ways by tracking the GPS data shared by other hikers before. Thus, some routes have become popular among the hikers through the spread of the Internet. The hiking tracks are unevenly distributed across the study area. They are more intensive in the central area. The dense area is in the southeast of Liangkou Town, followed by the north of Liangkou Town, the south of Lvtian Town, the northwest of Wenquan Town and the north of Paitan Town. Correspondingly, the 13157 geo-tagged photos were mainly distributed in the middle of the study area, which match to the dense areas of GPS tracks. It can be seen that the networking sites can provide a great deal of precise information on the behavior of hikers.

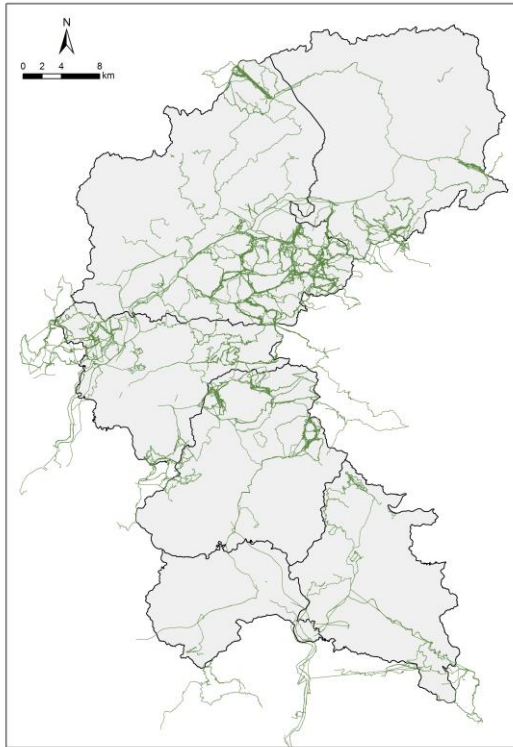


Figure 4: The distribution of GPS tracks

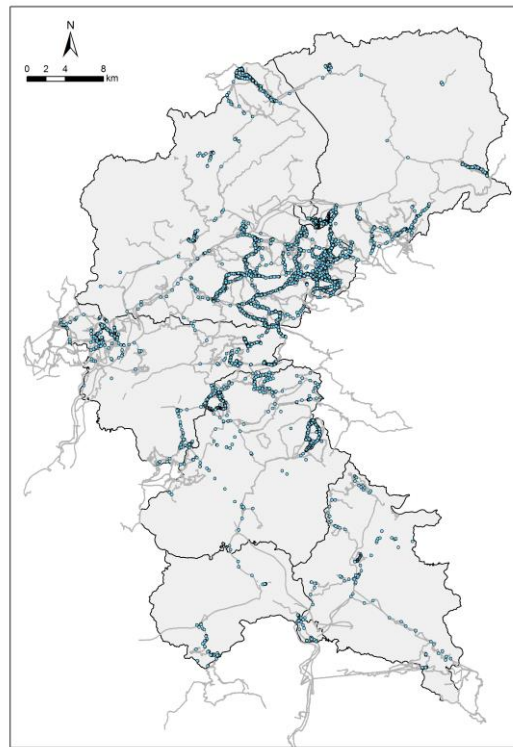


Figure 5: The distribution of geo-tagged photos

If a place attracts many hikers to take photos, these places are supposed to have high-quality landscapes or special events to attract hikers to stay (Arase, et al, 2010; Henderson, et al, 2010). Based on the density analysis in GIS, 100 attractive spots with high-density value were selected. These spots are mainly concentrated in the central-eastern part of the study area, and a small number are located in the northern part of the area. They are concentrated in the area where the topography changes greatly.

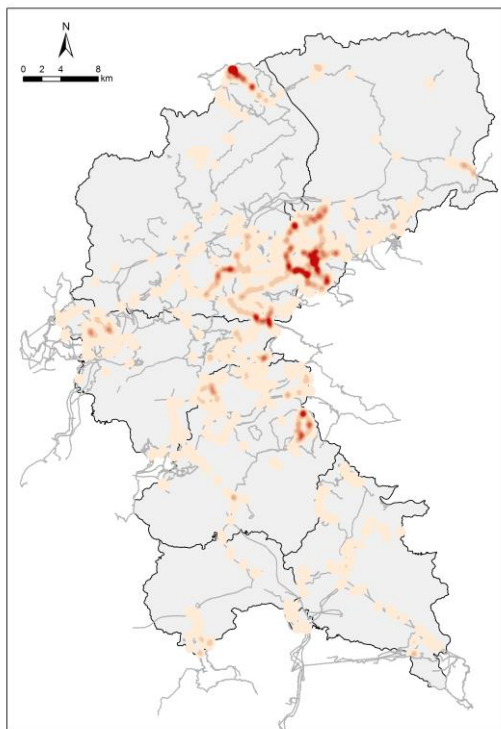


Figure 6: The density of the geo-tagged photos

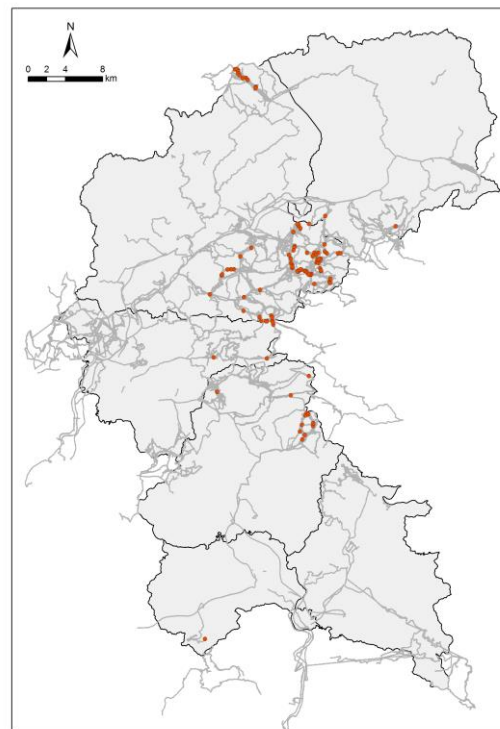


Figure 7: The 100 attractive spots selected



#### 4.2 Tags Generation of Attractive Spots

A total of 4403 geo-tagged photos taken within 50m around the attractive spots were selected in this study. Based on the open database called ADE20K<sup>i</sup> for image recognition on the Internet, the contents of these photos were recognized after running a machine learning model.

The most frequently occurring contents include “Mountain”, “Vegetation”, “Water”, “Rock” “Building” and “Person”. For each photo, the proportions of “Mountain”, “Vegetation”, “Water”, “Rock”, “Building” and “Person” were counted.

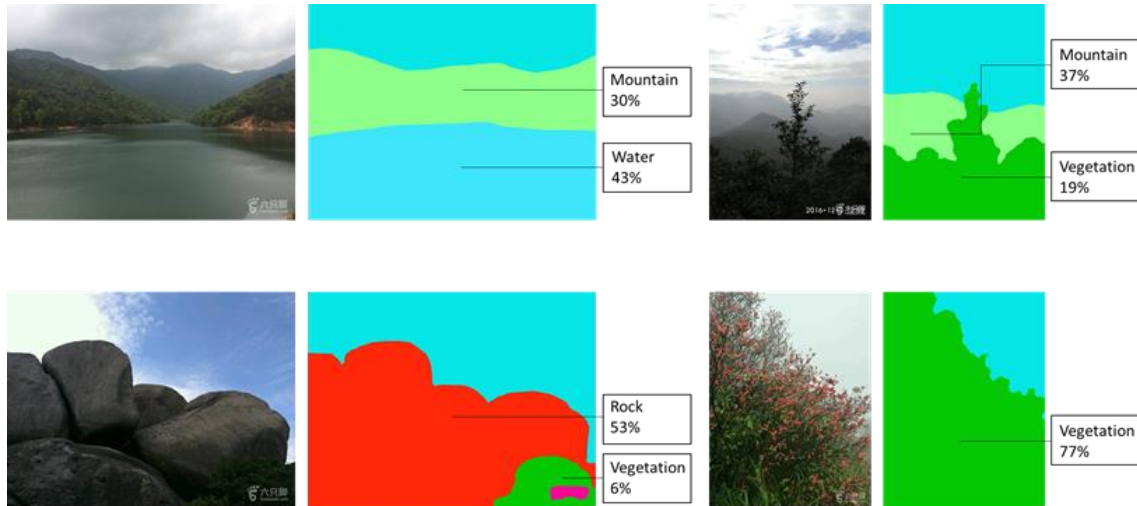


Figure 8: Some examples of photo identification

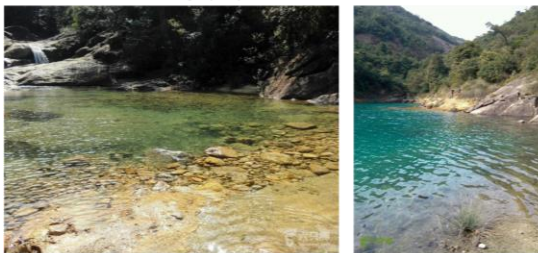
Photos which have large proportion of “Mountain”



Photos which have large proportion of “Vegetation”



Photos which have large proportion of “Water”



Photos which have large proportion of “Rock”



Photos which have large proportion of “Person”



Photos which have large proportion of “Building”



Figure 9: Photos with different main content

For every photos, we calculated the relative proportion of each type of content in all photos to achieve standardization. Since one spot usually has more than one attractive content, we selected two representative tags including a primary tag and a secondary tag for each attractive spot. The primary tag represents the first dominant content of the photos and the secondary tag represents the second dominant content. These tags can tell us the types of the attractive spots and contents of the majority of photos taken by hikers.

#### **4.3 Distribution of Different Types of Attractive Spots**

Different types of attractive spots have significant differences in attractive contents and location distribution. For example, the attractive spots with the tags of "Mountain" are generally places for enjoying the distant mountains with a good view; the attractive spots tagged by "Vegetation" often have beautiful plants; the attractions of spots tagged by "Water", "Stone" and "Building" generally have close view of landscape; the attractive spots with the "Person" tags are places where hikers usually stay for a longer period of time and take portrait photos and they are usually the starting places or the resting stations of the routes.

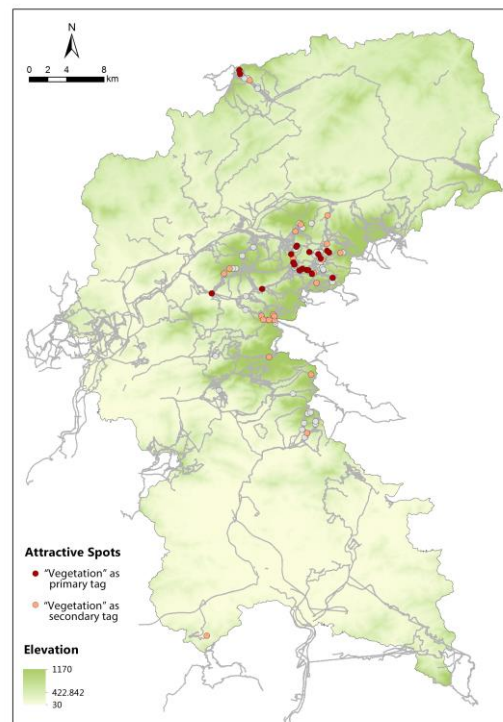
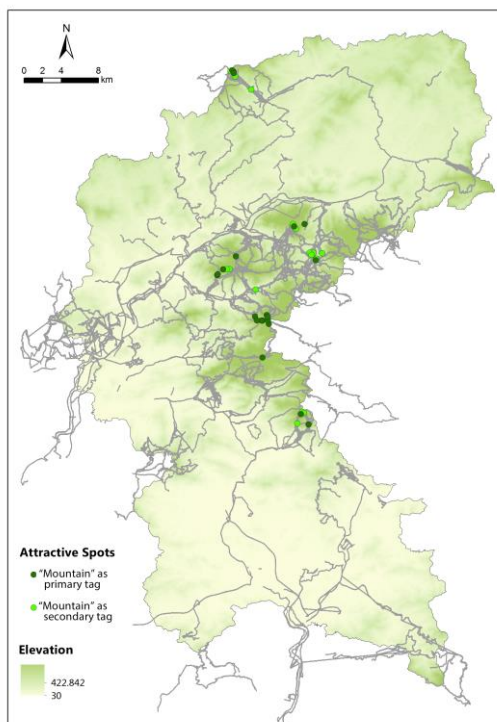


Figure 10: The spots tagged by "Mountain"      Figure 11: The spots tagged by "Vegetation"



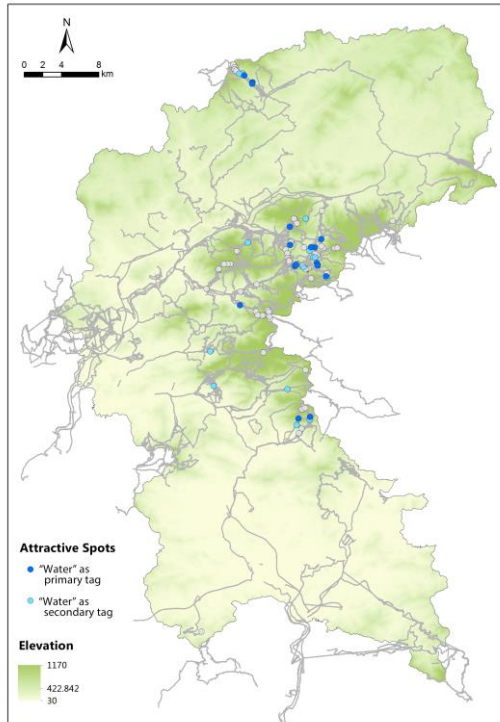


Figure 12: The spots tagged by "Water"

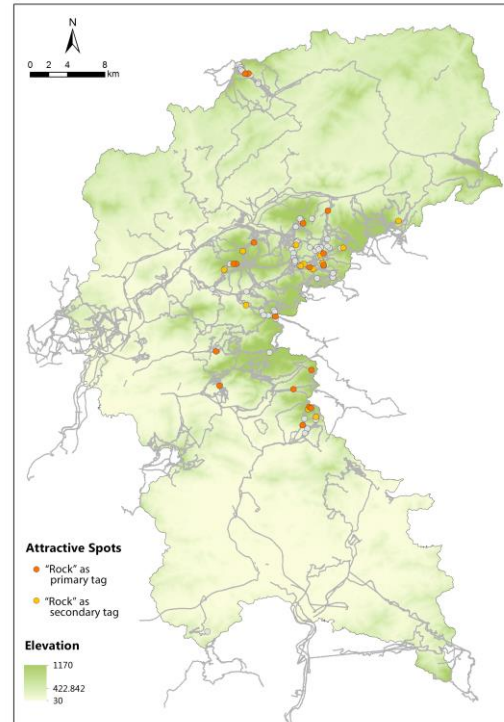


Figure 13: The spots tagged by "Rock"

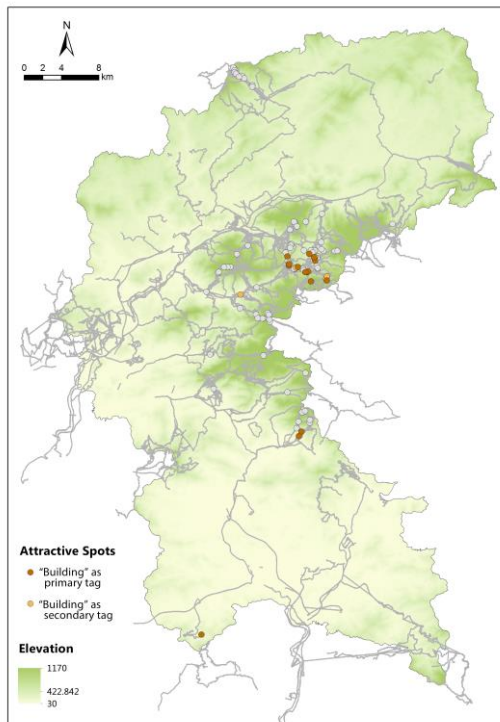


Figure 14: The spots tagged by "Building"

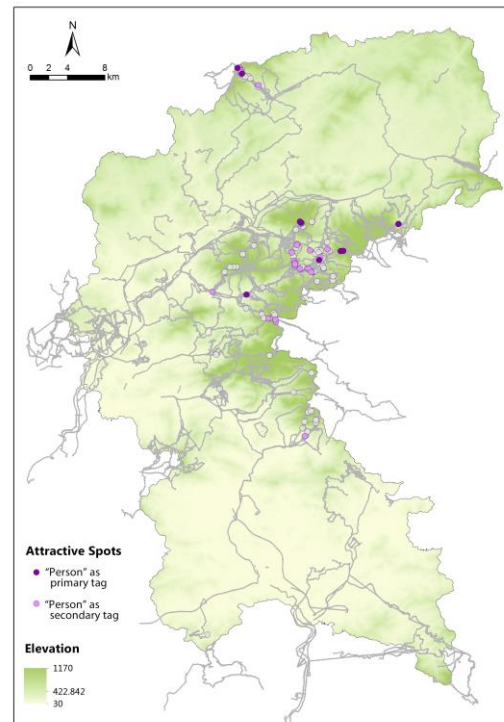


Figure 15: The spots tagged by "Person"

The elevation and slope information of each attractive spot were obtained to analyze the distribution characteristics. It is seen that the attractive spots tagged by "Mountain" are the highest in elevation and slope comparing with other categories. And they mostly occurred on the top of the mountains or on the slopes. The spots tagged by "Vegetation" are widely distributed in various elevation and slope. They are always in mountainous area which is dense with vegetation. The spots with tags of "Water" have wide distribution of elevation but most of them have gentle slope, indicating that the places with charming water view are

distributed at different elevations, but the water banks are slow in slope. The spots with tags of "Stone" have low elevation distribution similar to the spots tagged by "Building", but the slopes of these spots are higher. The attractive spots with the " Person " tags where hikers take portrait photos as souvenirs are most widely distributed in elevation and slope. There is not specific relationship between these spots and their topography. They are mainly choices for resting places.

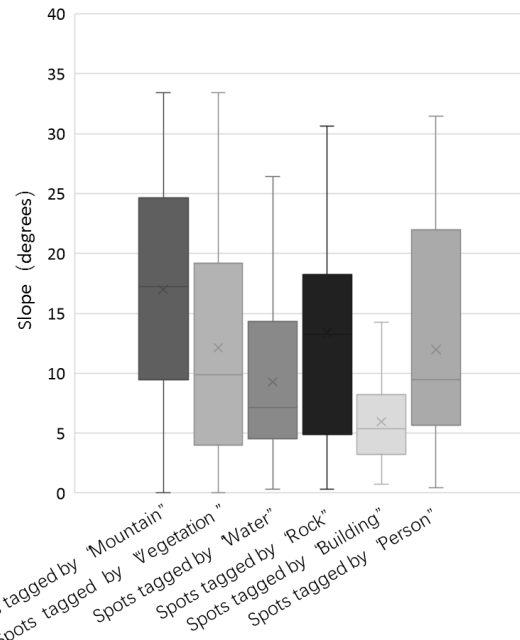
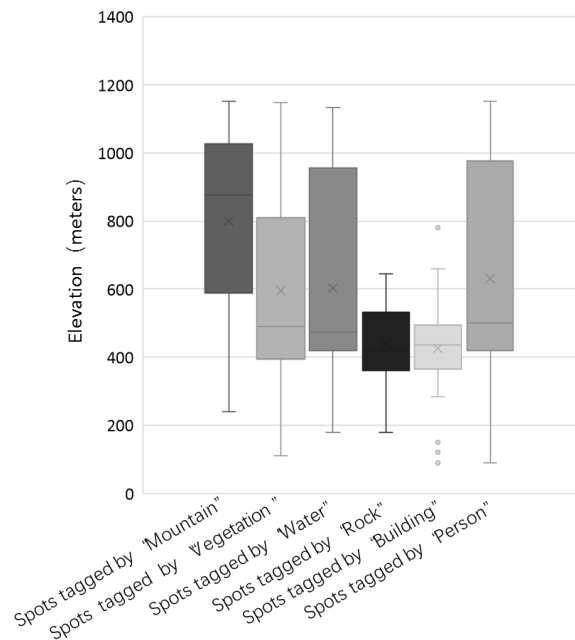


Figure 17: Distribution of elevations of the spots

Figure 18: Distribution of slopes of the spots

## 5. Conclusion and Discussion

Hiking in the outskirts of mega cities as a kind of environmentally friendly and sustainable urban tourism has significant benefits. For a long time, Internet has been the major information media for hiking tourism, continuously expanding the market scale (Huang, 2005). This study used geo-tagged photos on social networking sites to detect the attractive spots of hiking tourism. It provides new ideas and directions for the study of hiking tourism. The attractive spots obtained using this method can provide basis for the planning and management of hiking tourism. For example, these spots can be places to provide travel services after being fully equipped with service facilities. Besides, these places are where the hikers prefer to stay, so they easily tend to be crowded. The security protection facilities and the measures to prevent congestion should also be considered. The improvement of the landscape quality of the spots based on their tags is also very important. For example, the spots tagged by "Mountain" are generally places to enjoy the distant mountains, so they should be ensured to have good visions. While the attractions of spots tagged by "Water", "Stone" and "Building" always have close views, the promotion of the original landscape and the addition of new landscape structures can be taken into consideration.

The method used in this study has great potential in the planning and management of hiking tourism, but there are still some limitations: 1) The chosen social networking site is mainly targeted to groups loving hiking and reflects the information of many hikers, but it cannot fully cover all the information of hikers. 2) If the satellite signals are not good enough in some jungle districts, the geo-tagged information may be biased (Taczanowska, et al, 2008).

With the development of social networking sites and GPS technology, the information of geo-tagged photos shared on the Internet will become more abundant, comprehensive and

accurate. In actual planning and management, the attractive spots of hiking tourism obtained by this method can provide effective early guidance. However, in the process of deepening planning and management, this method needs to be combined with on-site investigation because on-site investigation can verify the results obtained using this method and provide corrections.

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<sup>i</sup> Database source: <http://groups.csail.mit.edu/vision/datasets/ADE20K/>

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