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Spatial and Temporal Distribution Characteristics of Flower-viewing Tourism and Its Influencing Factors in China

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Abstract: Despite the rapid development of flower-viewing tourism in China in recent years, there is almost no systematic research on it. Therefore, this study analyzes the spatial and temporal distribution characteristics of flower-viewing tourism and its influencing factors in China using the spatial statistical analysis methods and the geographic detector method. The study uses the Point-of-Interest data of flower-viewing tourist attractions from networks such as Qunar and Ctrip, the flower observation data from China Phenological Observation Network, Chinese network news, and Weibo, and the statistical data from yearbooks. The results are as follows: 1) The spatial attribution type of flower-viewing tourism in China is aggregated into areas, including two high-density aggregated areas, three medium-density aggregated areas, and one general-density aggregated area. Furthermore, five major types of flower-viewing tourist attractions have formed several aggregated areas. 2) The time of flower viewing in China starts from about February and lasts about eight months till October each year. Florescence and flowering time of different ornamental flowers in different regions are different. 3) The spatial and temporal distribution characteristics of flower-viewing tourism in China are mainly affected by ornamental flower phenology, spatial distribution characteristics of flower-viewing resources, regional permanent population size, youth population size, female population size, regional GDP, and added value of the tertiary sector. These conclusions clarify the spatial and temporal distribution characteristics of flower-viewing tourism and its influencing factors in China. They could provide a scientific basis and useful reference for the coordination and sustainable development of regional flower-viewing tourism in China.

Key words: flower-viewing tourism; influencing factors; spatial and temporal distribution characteristics; tourist attractions

1 Introduction

Flower-viewing tourism is an important part of ecological tourism and leisure tourism. It takes flower and flower culture as the main tourism resources. Flower tourism meets the needs of people for viewing, leisure, entertainment, and learning knowledge. In recent years, with China's rapid economic and social development and the advent of mass tourism, the demands of the leisure tourism market have continued to grow. In this context, flower-viewing tourism has developed rapidly and has become a popular type of tourism activity.

1.1 Development of flower-viewing tourism in China

Flower viewing is a traditional custom in China, and its de-

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velopment is based on Chinese flower culture. The Chinese began to cultivate and use flowers in the pre-Qin period. By the post-Qin era and Han era, the imperial palaces were being decorated with plants like plum and mahogany. In this period, flowers had begun to attain a spiritual appeal for the purpose of viewing (Zhou, 2015). In the Sui and Tang dynasties, flower viewing was a major source of entertainment. During the Sui dynasty, one of the important aims of Emperor Yang's visit to Yangzhou was to view the wild Chinese viburnum. From 690 to 705 A.D., celebration activities would be held in Luoyang when the peony was in its blooming stage (Wang, 1995). In this period, the Flower Fairy Festival began to take form and became popular among the upper class and the official class. After 960 A.D., flower viewing had penetrated many aspects of people's social life and the Flower Fairy Festival had developed into a national festival with a high degree of participation. Over the long term in China, flowers have been integrated into other cultural categories and a flower culture has gradually taken root with flower viewing as an important form of expression. From 1368 to 1911 A.D., the custom of viewing flowers developed further, and many artificially cultivated flower-viewing sites were established. After China's reform and opening-up, the domestic tourism market developed rapidly, and some local governments began to develop flower-viewing tourism deliberately. For example, Luoyang has held the annual Peony Fair every year since 1983. In the 21st century, flower-viewing tourism market has developed rapidly and has become a popular investment and development hotspot in many regions of China (He, 2014; Wang, 2016). The development of flower-viewing tourism is not just restricted to urban areas. In recent years, many rural areas have vigorously developed their flower-viewing tourism activities and have identified it as a key intervention for rural poverty alleviation and prosperity.

1.2 Research on flower-viewing tourism

Due to its rapid development, flower-viewing tourism has attracted the attention of scholars in recent years. Although there is extensive domestic and international research with flowers as the research object, there is a lack of research on flower-viewing tourism. Less than 150 related documents were found on the CNKI database. The content of the studies shows that research related to flower-viewing tourism mostly focuses on the development of flower-viewing tourism products, flower-viewing periods, and the impact of climate change on flower-viewing tourism, among other topics (Dai et al., 2021). Regarding the development flower-viewing tourism products, some scholars discussed the value exploration of flower culture and its application in tourism development (Kan, 2018; Zhu, 2019). Regarding flower-viewing period research, some scholars have found that against a background of climate change, typical ornamental flowers' blooming stages are expected to change in different regions in China. On this basis, scholars have compared the matching degree between the flowering period and the date of the relevant blossom festival, and the results have implications for the development of flower-viewing tourism in China (Ma and Fang, 2006; Liu et al., 2016; Wang et al., 2017). Regarding data acquisition, most plant phenology data are obtained from the China Phenology Observation Network (CPON). However, the CPON has only 55 phenology observation stations, while there is also lack of data on flower-viewing visitors in China's statistical yearbooks. To obtain enough analysis data, some scholars have sought data from mass media platforms, such as Weibo, as a supplement (Wang et al., 2017; Liu et al., 2019). Regarding study scale, the existing study scales are usually small, and there is a lack of country-scale studies that can reveal the spatial distribution characteristics of the overall development of flower-viewing tourism in China. Regarding the study object, tourist attractions are the main space in which the tourism industry is developed in China, and thus, its development situation can reflect the development of the tourism industry to a large extent (Yuan et al., 2010; Li et al., 2018; Jia et al., 2019; Tang et al., 2019). Therefore, taking Chinese flower-viewing tourist attractions as the study object, analysis of its spatial distribution characteristics and influencing factors could effectively reflect the overall situation of the development of flower-viewing tourism in China, and holds great potential to guide the sustainable development of China's flower-viewing tourism.

Although several studies have been carried out on flower-viewing tourism, there still is a lack of systematic analysis on China's overall development of it. Therefore, this study adopts the flower-viewing tourist attractions of China as the study object. First, it uses the spatial analysis methods and the geographic detector method to analyze the spatial distribution characteristics of China's flower-viewing tourist attractions. Then the data from the CPON, network news, and Weibo are used to analyze the temporal distribution characteristics of China's flower-viewing tourism. Last, this study analyzes the influencing factors of spatial and temporal distribution characteristics of flower-viewing tourism, with the aim of providing a scientific basis and useful reference for promoting the coordination and sustainable development of flower-viewing tourism in China.

2 Materials and methods

2.1 Data

2.1.1 Point of Interest (POI) of flower-viewing tourist attractions

In this study, we define a flower-viewing tourist attraction as a tourist attraction that takes flowers as its main tourism resource. 1) The flower-viewing tourist attraction data are from the networks Qunar (www.qunar.com) and Ctrip (www.ctrip.com) using Octopus Collector. The data information includes name, level, flower type, best viewing time, address etc. (up to March 2020). 2) We resolve addresses to geographic coordinates by using XGeoCoding App, and

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then import the POI data on a map of China using ArcGIS10.3. Finally, 1137 flower-viewing tourist attractions were selected. Among them, peach blossoms, lavender, rhododendrons, cherry blossoms, and peonies attracted the most tourists (10.6%, 10.1%, 8.7%, 8.50%, and 7.1%, respectively).

2.1.2 Flower observation data

(1) Ornamental flower phenology data

The ornamental flower phenology data in this study were from the CPON (http://www.cpon.ac.cn/). Up to now, more than 30 observing stations have been established. The CPON has the most field observation stations in China, the richest observes species, and the longest and most continuous plant phenology data. According to the standard observations of the CPON, the first flowering date (FFD) is defined as the date when at least one flower blooms in each agglomeration of the entire plant. The end of the flowering date (EFD) is defined as the date when most petals have fallen. The peak flowering date is the period when half of the flowers are open. The period between the FFD and EFD can be regarded as the flowering duration.

(2) Network text data

Because the number of observation stations of the CPON are too limited to cover the whole of China, this study collects ornamental flower observation date data of different tourist attractions in different provinces from the network. The network text data are used as the supplement to the data of the CPON.

(3) Weibo messages

Since visitors' data are not available from yearbooks, we collect data from social media, Sina Weibo (http://weibo.com), as an indicator of the number of visitors. We use "peach blossom" "sakura" "peony" "rhododendron" and "lavender" as keywords and obtain the relevant messages from January to December 2016–2020. Each message contains three attributes, namely, publish time, content, and address. To ensure the effectiveness of the data, we filter them by setting up blacklists and whitelists. In the end, we collect effective Weibo messages with the keywords "peach blossom" (1624), "sakura" (991), "peony" (1183), "rhododendron" (2341), and "lavender" (353).

2.1.3 Influencing factors

The spatial distribution characteristics of flower-viewing tourism development is affected by many factors, such as the spatial distribution pattern of tourism resource, social economy, traffic network, and regional culture. Based on the results of relevant studies (Yuan et al., 2010; Pan and Li, 2014; Li et al., 2018; Jia et al., 2019; Tang et al., 2019; Li et al., 2020; Wang et al., 2020) and data accessibility, we select eight indicators from the aspects of market-scale, industrial structure, infrastructure conditions, the level of economic development, and the level of tourism development as social and economic influencing factors for quantitative analysis (Table 1).

Specifically, there are four secondary indexes under the first level index "Customer market potential", which include domestic tourist market, elderly tourist market, youth tourist market and female tourist market. First, due to the "two-day weekend" work and rest system, the golden week and other short-term holiday policies, as well as the popularity of self-driving tour and peripheral tour , local visitors might become an important tourist market of flower-viewing tourist attractions. Second, with an increase in the aging population, the elderly consumer groups have become a huge tourist market in China. Since the characteristics of flower-viewing tour matches the tourism demand of the elderly, this demographic might be important to the development of regional flower-viewing tourism. Third, women, children and teenagers are usually interested in enjoying flowers, so they might become an important demographic as well.

The results of previous researches show that the regional social and economic conditions and the supply capacity of goods and services restrict the development scale, the development level, and the management capacity of tourist attractions. Specific to the first level index "social economic conditions", we use three secondary indexes including "level of economic development", "level of service sector development", and "level of tourism industry" to represent it. Most studies use Gross Domestic Product (GDP), GDP per capita, added value of tertiary sector, proportion of tertiary sector and tourism income to present three secondary indexes respectively.

Existing studies show that visitors usually take spatial distance and accessibility of tourist attractions (e.g., time, energy, and economic conditions) into consideration before traveling. Therefore，this study takes regional traffic conditions as a potential influencing indicator. The evaluation index "provincial comprehensive road network density" is formed from several indicators, including railway mileage, expressway mileage, national highway mileage, and provincial highway mileage. The weight of each indicator is assigned by the entropy weight-TOPSIS method (Zhang et al., 2011).

2.2 Methods

2.2.1 Nearest neighbor index

The nearest neighbor index measures the distance between each feature centroid and its nearest neighbor's centroid location. We use this method to analyze the spatial distribution pattern of flower-viewing tourist attractions in China. The nearest neighbor index is expressed as the ratio of the observed mean distance to the expected mean distance. The expected distance is the average distance between neighbors in a hypothetical random distribution. The nearest neighbor index is (Ebdon, 1985):

$$\overline{r} = \sum_{i=1}^{n} \frac{r_i}{n} \quad (1)$$

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Table 1 Influencing factors and sources of the spatial distribution of flower-viewing tourist attractions

First level index	Secondary index	Evaluation index	Data sources
Customer market potential	Domestic tourist market	Permanent population by province	China Statistical Yearbook 2019
	Elderly tourist market	Elderly population by province (above 65 years old)	
	Youth tourist market	Youth population by province (0–14 years)	
	Female tourist market	Female population by province	
Social economic conditions	Level of economic development	Provincial GDP, GDP per capita by province	Statistical Bulletin of National Economic and Social Development of Provinces in 2018
	Level of service sector development	Added value of tertiary sector by province, Proportion of tertiary sector by province	
	Level of tourism industry development	Tourism income by province	
Regional traffic conditions	Traffic accessibility	Comprehensive road network density by province (including railway mileage, expressway mileage, national highway mileage, and provincial highway mileage)	Year Book of China Transport & Communication 2017

$$\overline{r_E} = \frac{1}{2}\sqrt{\frac{n}{A}} = \frac{1}{2}\sqrt{D} \tag{2}$$

$$R = \frac{\overline{r_i}}{\overline{r_E}} \tag{3}$$

where R is the nearest neighbor index of flowering-viewing tourist attractions in China; r_i is the distance between flowering-viewing tourist attraction i and its nearest neighbor; $\overline{r}$ is the observed mean distance between each flower-viewing tourist attraction and its nearest neighbor; $\overline{r_E}$ is the expected mean distance for the flower-viewing tourist attractions given in a random pattern; and A is the area of a minimum enclosing rectangle around all flower-viewing tourist attractions.

A represents the area of the research region. If index R is less than one, the pattern exhibits clustering; if index R is greater than one, the trend is toward dispersion or competition.

2.2.2 Kernel density estimation

Kernel density estimation calculates the density of features in a neighborhood around those features. The larger the number, the greater the probability that an event will occur in the region (Silverman, 1986). The formula is as follows:

$$f_n(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \tag{4}$$

where $f_n(x)$ is the density estimation of feature x; n is the quantity of observations; h is the bandwidth; K is the kernel function; and $(x–x_i)$ is the distance between two points.

2.2.3 Geodetector

Geodetector is a statistical method to detect spatial stratified heterogeneity and reveal the driving factors behind it. This method with no linear hypothesis has an elegant form and definite physical meaning. It assumes that the study area is divided into several subareas. The study area is characterized by spatial stratified heterogeneity if the sum of the variance of subareas is less than the regional total variance; and if the spatial distribution of the two variables tends to be consistent, there is statistical correlation between them (Wang and Xu, 2017). The formula is as follows:

$$q = 1 - \frac{\sum_{h=1}^{L} N_{D,h}\sigma_{D,h}^2}{N\sigma_H^2} \tag{5}$$

where q is q-statistic, which can represent the spatial stratified heterogeneity. The value of q is strictly within [0, 1]. D denotes the influencing factor; N represents the number of samples; H denotes the affected index; σ_H^2 represents the variance of H; L is the stratum number of H; $N_{D,h}$ is the sample number of D_h; and $\sigma_{D,h}^2$ is the variance of the affected index of D_h.

3 Spatial distribution pattern of flower-viewing tourist attractions in China

From the perspective of the overall spatial distribution pattern, the most flower-viewing tourist attractions are located in the southeast of China and the least are in the northwest. There are 1080 (94.99%) flower-viewing tourist attractions to the east of the Hu Line and 57 (5.01%) to the west of the Hu Line (Fig. 1).

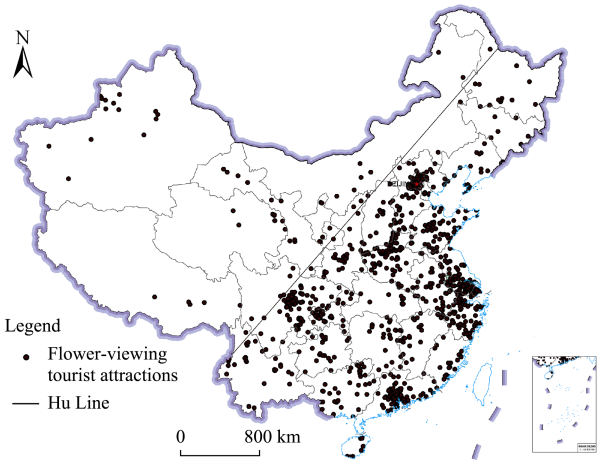


Fig. 1 Spatial distribution of flower-viewing tourist

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attractions in China

Furthermore, we use ArcGIS 10.3 tools to calculate the nearest neighbor index of flower-viewing tourist attractions in 31 provinces in China. The result shows that the total nearest neighbor index of flower-viewing tourist attractions in China is 0.396, and passes a significance test of $P<0.01$. The overall spatial distribution pattern of flower-viewing tourist attractions is aggregated. Specifically, flower-viewing tourist attractions in 15 provinces display a significant aggregated distribution pattern, while only four provinces display a significant discrete distribution pattern (Table 2). The nearest neighbor index of 12 other provinces fails the significance test, which indicates that the flower-viewing tourist attractions in these provinces tend to have a random distribution.

From the perspective of all five main types of flower-viewing tourist attractions, their nearest neighbor index is significantly less than 1 ($P<0.01$). The result reveals that these five types of flower-viewing tourist attractions all show aggregated distribution. However, the nearest neighbor index of each of the five main types of flower-viewing tourist attractions is higher than the total nearest neighbor index (0.396). This shows that the aggregate level of the five main types of flower-viewing tourist attractions is higher than the overall level (Table 3).

By calculating the nearest neighbor index of flower-viewing tourist attractions, we use the kernel density estimation method to calculate the density of flower-viewing tourist attractions, and then we use the method of nature of breaks (JENKS) to divide them into high-density aggregated areas, medium-density aggregated areas, and general-density aggregated areas. The results are shown in Fig. 2. The figure shows that two high-density aggregated areas, three medium-density aggregated areas, and one general-density agglomeration area have formed in China. The two high-density aggregated areas are located in the region around Beijing and the Yangtze River Delta region; the three medium-

Table 2 The nearest-neighbor index and spatial distribution types of flower-viewing tourist attractions in China

Region	Number of tourist attractions	Nearest neighbor index (R)	Z value	P value	Distribution pattern
China	1153	0.396***	–38.988	0.000	Aggregated
Beijing	80	0.680***	–5.468	0.000	Aggregated
Tianjin	9	0.384***	–3.742	0.000	Aggregated
Hebei	41	0.731***	–3.292	0.001	Aggregated
Shanxi	17	1.071	0.562	0.574	–
Inner Mongolia	10	1.407**	2.338	0.019	Discrete
Liaoning	26	0.749**	–2.453	0.014	Aggregated
Jilin	7	1.664***	3.363	0.001	Discrete
Heilongjiang	15	1.416***	2.981	0.003	Discrete
Shanghai	24	0.926	–0.694	0.487	–
Jiangsu	101	0.639***	–6.943	0.000	Aggregated
Zhejiang	89	0.839***	–2.912	0.004	Aggregated
Anhui	31	0.764**	–2.518	0.012	Aggregated
Fujian	26	0.765**	–2.185	0.029	Aggregated
Jiangxi	26	0.881	–1.157	0.247	–
Shandong	66	0.788***	–3.290	0.001	Aggregated
Henan	106	0.597***	–7.945	0.000	Aggregated
Hubei	15	1.106	0.784	0.433	–
Hunan	26	0.965	–0.337	0.736	–
Guangdong	103	0.652	–1.324	0.185	–
Guangxi	48	0.562	–1.324	0.185	–
Hainan	10	0.864	–0.864	0.410	–
Chongqing	42	0.729***	–3.363	0.001	Aggregated
Sichuan	90	0.744***	–4.641	0.000	Aggregated
Guizhou	22	1.091	0.801	0.423	–
Yunnan	36	0.632***	–3.981	0.000	Aggregated
Xizang	8	1.907***	4.908	0.000	Discrete
Shaanxi	29	0.743***	–2.600	0.009	Aggregated
Gansu	15	0.904	–0.634	0.526	–
Qinghai	10	1.147	0.888	0.374	–
Ningxia	7	0.538**	–2.336	0.019	Aggregated
Xinjiang	18	1.075	0.594	0.553	–

Note: **, and *** represent significance at the 5%, and 1% level, respectively.

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Table 3 The nearest neighbor index and spatial distribution patterns of five main types of flower-viewing tourist attractions in China

The type of flower	The number of tourist attractions	Nearest neighbor index (R)	Z value	P value	The type of spatial structure
Peach blossom	122	0.569***	–9.101	<0.001	Aggregated
Lavender	117	0.527***	–9.785	<0.001	Aggregated
Rhododendron	101	0.696***	–5.835	<0.001	Aggregated
Cherry blossoms	98	0.604***	–7.491	<0.001	Aggregated
Peony	82	0.672***	–5.681	<0.001	Aggregated

Note: *** represent significance at the 1% level.

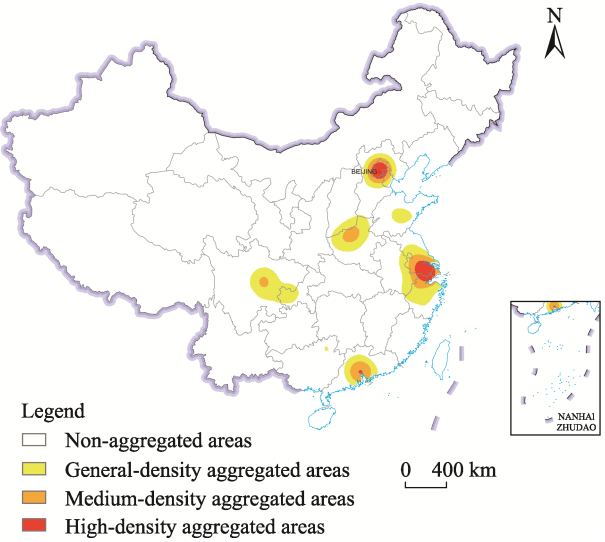


Fig. 2 Kernel density of flower-viewing tourist attractions in China

density aggregated areas are located in the Pearl River Delta region, the region around Zhengzhou, and the region around Chengdu and Chongqing; and the general-density aggregated area is located in the region east of Shandong province. In addition, the result shows that the Pearl River Delta region is gradually developing into a high-density aggregated area.

The analyzed results show that several aggregated areas of the five main types of flower-viewing tourist attractions have formed. The two high-density agglomeration areas of peony tourist attractions are located in the region around Beijing and the region between northwestern Henan Province to southwestern Shanxi Province. Tourist attractions for peach blossom formed a high-density agglomeration area located in the region around Beijing and tourist attractions for lavender formed a high-density agglomeration area around the Yangtze River Delta region. No agglomeration area of tourist attractions formed for rhododendron or cherry blossoms (Fig. 3).

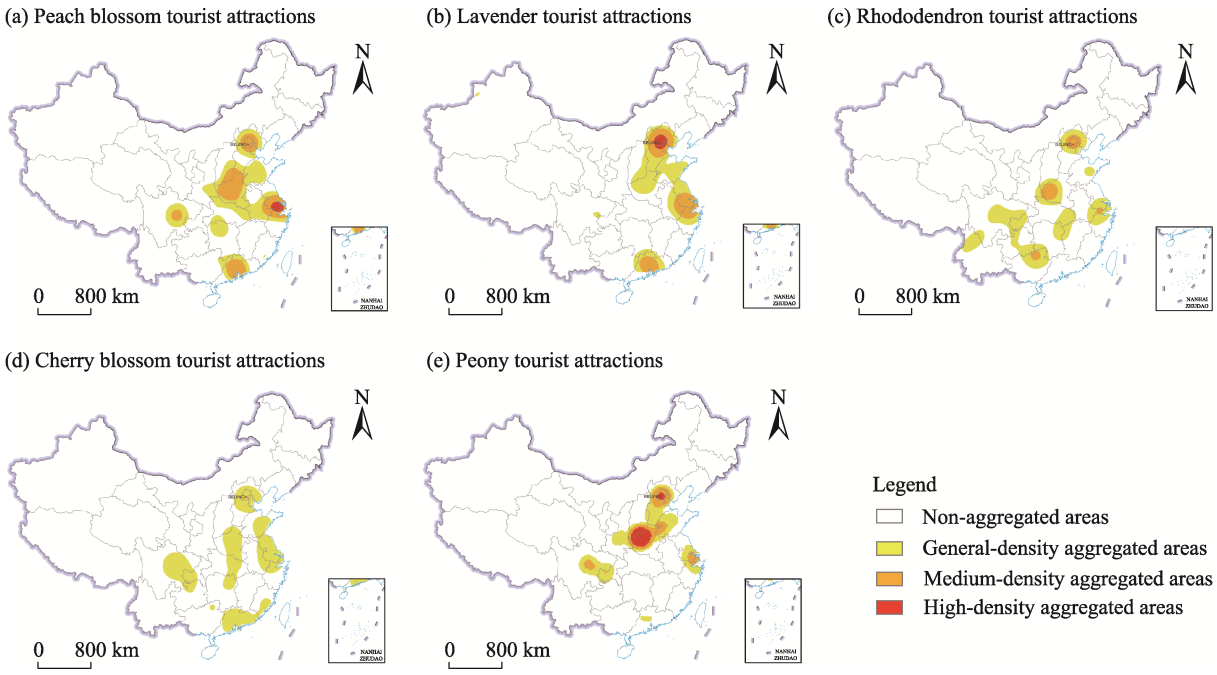


Fig. 3 Kernel density of five main types of flower-viewing tourist attractions in China

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4 The temporal distribution characteristics of the flower-viewing period

The study calculated the flowering duration of main ornamental flowers in different regions of China according to data from the CPON and network text. Because visitors can view flowers at any time during flowering, we defined flowering duration as the flower-viewing period. The results show that the flower-viewing period of main ornamental flowers in China lasted about eight months, from February to October. Eastern China started flower-viewing first, followed by western China, central China, and northeastern China in order. Meanwhile, western China was the first to end flower viewing. The overall flower-viewing period in eastern China lasted longest, from early February to late September, while the duration for northeastern China was shortest, from late April to late September (Fig. 4).

The average viewing period of peach blossoms in China lasted 20.27 days, from early February to early May. Based on the number of messages posted on Weibo, the peak of posts for viewing peach blossoms occurred in late March, accounting for 66.03% of the total number of posts. The average viewing period of lavender in China was 36.48 days, from March to mid-September. The peak of Weibo posts for viewing lavender was in late June, accounting for 45.04% of the total number of posts. The flowering duration of peony was relatively short, with an average viewing period of about 9.12 days. The viewing time was concentrated in late March and late April. The proportion of Weibo posts during these two periods was 46.24% and 41.08%, respectively. The average viewing period of cherry blossoms in China was 23.47 days, and the viewing time lasted from early March to early May. The peak of Weibo posts for viewing cherry blossoms occurred in early April, accounting for 55.2% of the total number of posts. Because of different variety and different regional climate conditions, the flowering duration of rhododendron lasted a relatively long time, from April to June. The average viewing period of rhododendron in China was about 24.96 days. The peak of Weibo posts for viewing rhododendron occurred in late April, accounting for 46.26% of the total number of posts (Fig. 5).

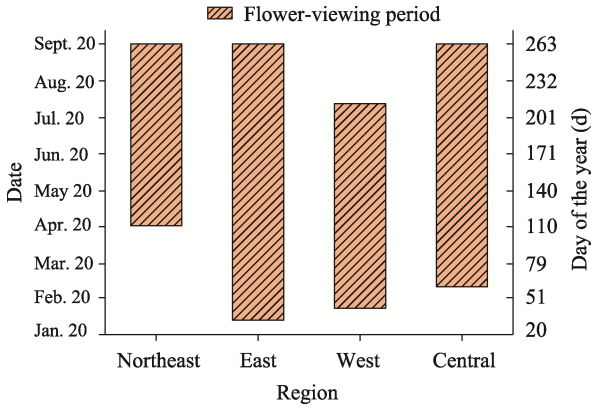


Fig. 4 The overall flower-viewing period in different regions of China

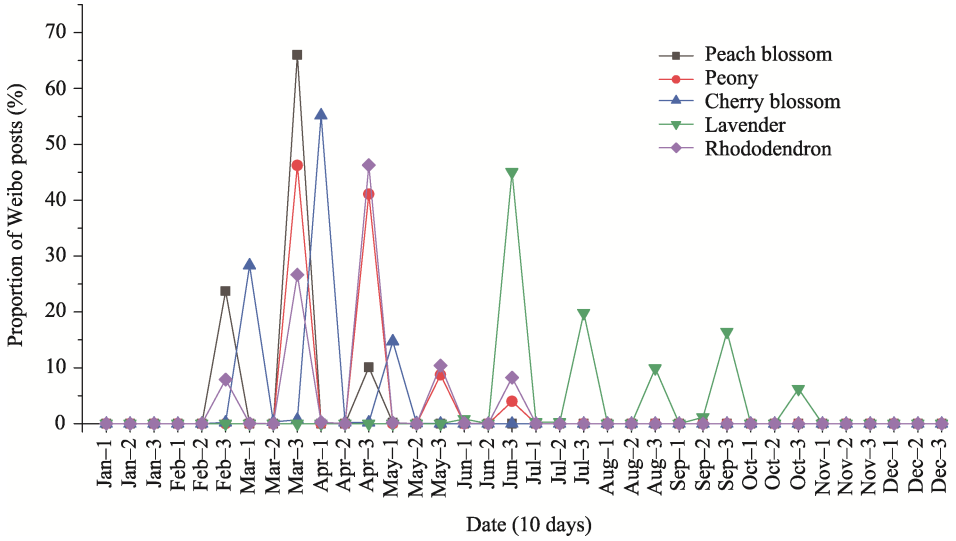


Fig. 5 The centralized posting time for all kinds of ornamental flowers on Weibo

5 Influencing factors on the temporal and spatial distribution characteristics of the development of flower-viewing tourism

5.1 Influencing factors of temporal distribution characteristics

The phenological landscape formed by the flowering duration of ornamental flowers is the main attraction of flower-viewing tourism. Because of the physiological factors of ornamental flowers and the climatic conditions, the flowering duration varies among different ornamental flowers and different regions, and thereby affects the formation of the temporal distribution pattern of flower-viewing tourism in China. By comparing the data on flowering duration col-

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lected from the CPON and other sources, we found the posting peak of Weibo messages related to relevant flowers matched their flowering duration as well.

Besides the natural and geographical influencing factors, the legal holiday arrangement and the date of blossom festivals significantly affected the time when visitors view flowers. There was a high degree of match between the dates of the blossom festivals and the posting peak of Weibo messages related to relevant tourist attractions, such as the Beijing Botanical Garden and Yuyuantan Park from 2010 to 2014 (Fig. 6). Global warming and climate change have markedly altered the FFD, peak flowering date, and flowering duration of ornamental plants over recent decades in response to temperature variability (Tao et al., 2015). However, the results of previous research have revealed that the administrators of some flower-viewing tourist attractions determine their blossom festival date (BFD) based on their experience rather than the FFD of corresponding plants. Therefore, a mismatch between BFD and FFD may occur at some locations, which reduces the tourism experience of visitors (Wang et al., 2017).

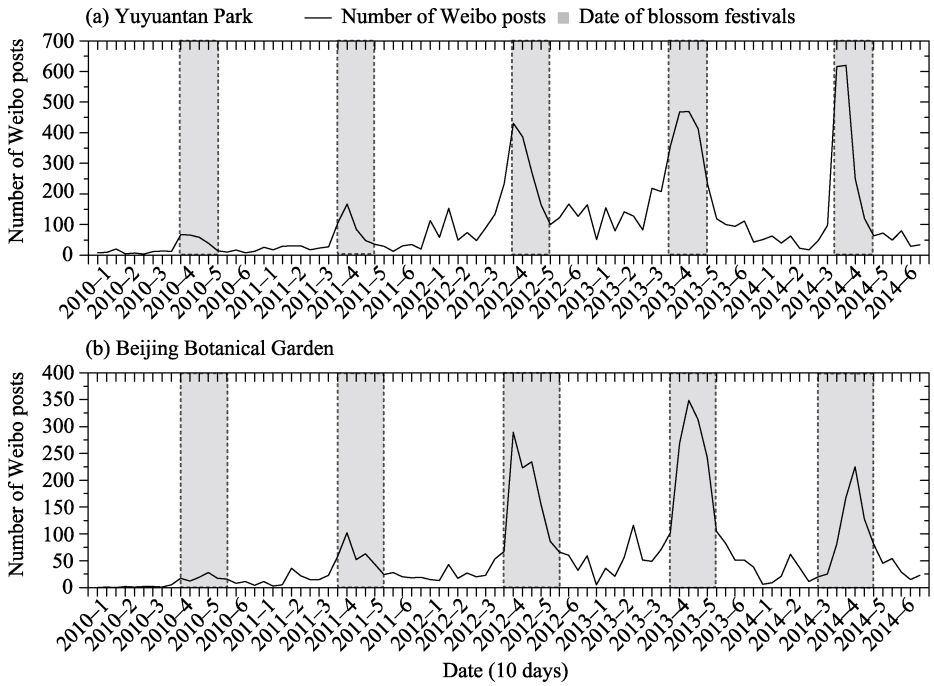


Fig. 6 The matching situation between the dates of the flower-viewing festivals and the peak period of Weibo posts

5.2 Influencing factors of spatial distribution characteristics

5.2.1 Ornamental flower resources

Because flower-viewing tourist attractions are the main space carriers for the development of flower-viewing tourism, we analyzed the influencing factors of spatial the distribution pattern of flower-viewing tourist attractions to reveal its influencing factors. Regional flower resources are the foundation for the development of flower-viewing tourism in different regions. The spatial differentiation of flower resources, which are affected by different regional climatic conditions, impacts the formation of the spatial distribution pattern of flower-viewing tourist attractions in China. According to data from "Flora of China," peach blossoms (*prunus persica* and *prunus davidiana*) are distributed in all provinces and cities in China, and are concentrated in Beijing, Shandong, Henan, and the Yangtze River Delta region. Rhododendron (*rhododendron simsii*) is mainly distributed in the southern part of Yangtze River basin. Lavender (*lavandula angustifolia*) has a dispersed distribution in China, concentrated in Haidian District of Beijing, Xunxian County of Henan Province, Xi'an City of Shaanxi Province, and Huocheng County of Xinjiang. Cherry blossoms (*prunus pseudocerasus*) are widely distributed in China. In eastern China, cherry blossoms are concentrated in Ningbo City of Zhejiang Province and Shuyang County and Changzhou City of Jiangsu Province. In southeast China, cherry blossoms are concentrated in Chengdu City of Sichuan Province. In northern China, cherry blossoms are concentrated in Taian City, Changyi City, and Rizhao City of Shandong Province, and Shijiazhuang City and Baoding City of Hebei Province. In southern China, cherry blossoms are concentrated in Guangzhou City and Shaoguan City of Guangdong Province. Peony (*paeonia suffruticosa*) is mainly distributed in the middle and downstream of the Yellow River in China for several reasons, such as climate conditions, historical aspects, and cultural customs. New cultivation centers of

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peony have been established in the Yangtze River Delta, areas around Lake Taihu, southeast Anhui, and Chengdu city and Pengzhou city in Sichuan province (Fig. 7). In this study, by overlaying the locations of different ornamental flowers and the locations of their corresponding flower-viewing tourist attractions, we found that they match each other well.

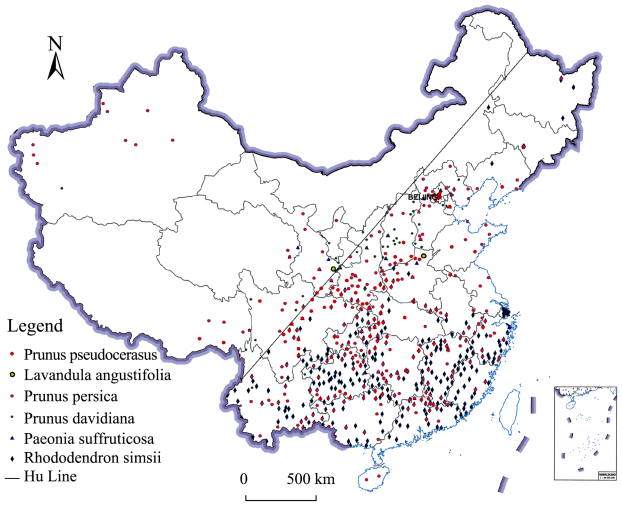


Fig. 7 The spatial distribution of ornamental flower resources in China

5.2.2 Social and economic factors

In this subsection, we used the Geodetector analysis tool to detect the social and economic factors that affect the formation of the spatial distribution pattern of flower-viewing tourist attractions. The result shows that several factors significantly impact the formation of spatial distribution of flower-viewing tourist attractions. Regarding the factors of the potential of a custom market, regional total population size, especially the population size of women and teenagers, have significant impacts. Regarding the factors of economic development conditions, the level of overall regional economic development and tertiary sector development have significant impacts. However, among factors of transportation conditions, the influence of no factor is significant (Table 4).

Among factors of the potential of custom market, permanent population played an important role in the formation of spatial distribution of flower-viewing tourist attractions (q=0.570，P<0.01), which is in line with expectations. With improved living standards and the advent of mass tourism, increasing demand for leisure tourism by the regional permanent population has become an important driver of the development of flower-viewing tourist attractions. The size of regional female population (q=0.584, P<0.01) and the size of the youth population (q=0.432, P<0.05) have significant impacts on the formation of the spatial distribution pattern of flower-viewing tourist attractions. The female market is an important component of the tourism market, and female tourists have gradually developed into a newly favored segment (Ding and Lu, 2006). Most women are more interested in enjoying flowers than men. Thus, the female market is an important customer market for flower-viewing tourism. In recent years, the family tourism market in China has been developing rapidly. One of the main motivations for family trips is children's leisure, which includes taking children out for relaxation and knowledge about tourism destinations (Wu and Fan, 2020). As family tours need to consider such factors as fatigue tolerance, choice preference, travel safety, and suitability for teenagers, visitors tend to choose short-distance and nature destinations for family trips. Thus, flower-viewing tourist attractions have become a popular choice for family weekend visits.

Among factors of regional economic development, the q value of regional GDP is 0.806 (P<0.01), which indicates that the level of regional economic development has a significant impact on the formation of the spatial distribution of flower-viewing tourist attractions. Existing studies have suggested that the number of regional tourist attractions is proportional to the level of regional economic and social development (Jia et al., 2019; Tang et al., 2019). In our

Table 4 Influencing factors and their explanatory strength in the distribution of flower-viewing tourist attractions

1-class indicator	2-class indicator	Evaluation indicator	q value	P value
Customer market potential	Domestic tourist market	Permanent resident population	0.570**	0.007
	Elderly visitor market	Elderly population	0.492	0.070
	Youth visitor market	Youth population (under 14 years of age)	0.432*	0.047
	Female visitor market	Female population	0.584**	0.006
Social economic conditions	Level of economic development	Provincial GDP	0.806**	0.000
		GDP per capita	0.235	0.355
	Level of service sector development	Added value of tertiary sector	0.639**	0.008
		Proportion of tertiary sector	0.06	0.877
	Level of tourism industry development	Tourism income by province	0.493	0.063
Regional traffic conditions	Traffic accessibility	Comprehensive road network density	0.284	0.391

Note: * and ** represent significance at the 5%, and 1% level, respectively.

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study too, we conclude that flower-viewing tourist attractions in China are mainly located in regions with higher economic development. From Fig. 3, we found that the aggregated areas of flower-viewing tourist attractions are mainly located in developed areas, such as the Beijing-Tianjin region, Yangtze River Delta region, and Pearl River Delta region, or have formed around regional central cities, such as Zhengzhou and Chengdu. Furthermore, we found that more than 75% of flower-viewing tourist attractions are located in or around big cities (L), megalopolises (XL), and megacities (XXL), but the proportion drops to only 15.34% for medium cities (M) and 8.41% for small cities (S) [①](Fig. 8). In addition, there are 31 tourist attractions in megalopolises on average, 12 in megacities, five in big cities, three in medium cities, and only two in small cities. Therefore, there is a significant correlation between the spatial distribution pattern of flower-viewing tourist attractions and the urban hierarchy. Residents of regions with a higher development level have higher average income level and stronger capacity for leisure tourism demand and consumption than do residents of regions with a lower social and economic development level, which may provide greater impetus for the construction and development of flower-viewing tourist attractions. Moreover, the infrastructure and special tourism facilities in regions with a higher economic development level are more complete, which can provide better guarantee conditions and potential to develop flower-viewing tourist attractions.

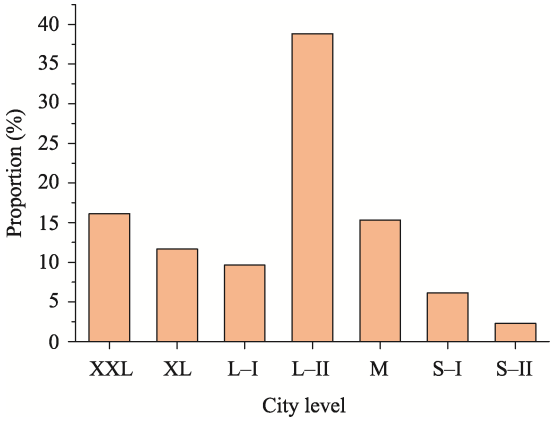


Fig. 8 Proportion of flower-viewing tourist attractions in different level cities

The results for the added value of the tertiary sector (q=0.639, P<0.01) show that the development level of the regional service sector had a strong positive impact on the formation of the spatial distribution of flower-viewing tourist attractions. This result is consistent with the existing literature (Tang et al., 2019). A high development level of the tertiary sector can accelerate the development of regional tourism, improve the development and upgrading of flower-viewing tourist attractions, and promote their agglomeration (Zhu and Sun, 2019).

However, the results for regional GDP per capita and the proportion of tertiary sector are not significant (P>0.1). The most likely explanation is as follows: the results of regional GDP and the added value of the tertiary sector are significant and show that the amount of regional flower-viewing tourist attractions depends on the regional economic size. A large economic size means a large demand. This implies that regional flower-viewing tourism can only develop well when demand is high. However, the regional GDP per capita and the proportion of tertiary sector cannot represent the regional demand. Even if the regional GDP per capita is large, if the economic size is small, the consumer market and demand will still be insufficient. The proportion of tertiary sector represents the economic structure of a region, and a high proportion does not represent a large economic size. Therefore, the impacts of regional GDP per capita and the proportion of tertiary sector on the formation of the spatial distribution of flower-viewing tourist attractions are not significant.

5.2.3 Regional traffic conditions

In this research, we found no significant correlation between the spatial distribution of flower-viewing tourist attractions and the comprehensive road network, the indicator we use to represent regional traffic conditions (q=0.284, P=0.391). This result is related to the characteristics of flower-viewing tourist attractions. Ornamental flowers are the main tourist resources of flower-viewing tourist attractions. Different from other natural tourism resources, ornamental flowers can be cultivated and transplanted to different places. Therefore, the location of flower-viewing tourist attractions can be based on other considerations than the location of resources or regional traffic conditions, such as distance from domestic tourism markets. Statistics on the number of flower-viewing tourist attractions in built-up areas (Kuang et al., 2021) and their 10-km buffer zones in China's cities in 2018, the proportion of flower-viewing tourist attractions in the built-up areas of cities is 20.85%, while the proportion of flower-viewing tourist attractions within the 10-km buffer zones is 75.7%. This result shows that most flower-viewing tourist attractions are located in cities or their suburbs, where are close to domestic tourism markets. However, with the increasing role of tourism development in targeted poverty alleviation and rural revitalization, many rural areas are vigorously developing flower-viewing tourism plans based on their forest and fruit resources. Accordingly, the number of flower-viewing tourist attractions in rural areas has increased rapidly in recent years. Meanwhile, with the popularity of family cars and the rise of rural tourism, rural areas far from cities have become popular choices

① The classification of city levels is based on the notice of the state council on Adjusting the Standards for Classifying City Sizes (Guofa [2014] No. 51) issued by The State Council in 2014.

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for urban residents to visit. With the increase of flower-viewing tourist attractions in rural areas and the expansion of travel distance, the impact of regional comprehensive traffic conditions on the formation of spatial distribution of flower-viewing tourist attractions is likely to become increasingly significant.

6 Discussion and conclusions

6.1 Discussion

(1) Influencing factors of spatial distribution characteristics of flower-viewing tourist attractions

The results show that the development of flower-viewing tourism presents significant spatial–temporal differentiation characteristics in China, which is closely related to such factors as flowering duration of different ornamental flowers and the level of regional economic development. This conclusion is consistent with the results of existing studies (Ding and Lu, 2006; Tao et al., 2015). The formation of the spatial distribution pattern of flower-viewing tourist attractions, in addition to being influenced by natural and socio-economic factors, is also influenced by regional cultural factors, but this study does not discuss these factors. In fact, regional culture has a significant impact on the spatial pattern of flower-viewing tourist attractions. For example, the peony culture began in Luoyang during the Tang dynasty, peaked during the Song dynasty, and has continued to the present. It is one of the characteristic cultures of Henan Province, which has the most flower-viewing tourist attractions for peony in China. Therefore, future research should consider nature, social economy, culture, and other factors for a systematic analysis using qualitative and quantitative methods.

(2) Future development vision of flower-viewing tourism

The spatial distribution of flower-viewing development in China is unbalanced at present, with most flower-viewing tourist attractions located in the eastern and central regions of China, and only a few located in the western region. As people's living standards improve, the demand for flower-viewing tourism in China's western region is increasing. The development of flower-viewing tourist attractions needs not only a tourism market but also sufficient capital investment, good infrastructure guarantee, and high-quality tourism service supply. Therefore, the Chinese government should formulate a special plan for the development of flower-viewing tourism, strengthen infrastructure construction, provide financial and talent support, and guide and promote the coordinated development of regional flower-viewing tourism from all aspects. Meanwhile, flower-viewing tourism destinations should build alliances with surrounding major tourist attractions to further transfer and expand the tourism market, and should cooperate with other types of tourism organizations for coordinated development. The COVID-19 pandemic during the Spring Festival of 2020 had a significant adverse impact on the development of the tourism industry in China, as it did throughout the world. As a popular tourist attraction in spring, flower-viewing has been greatly affected by the pandemic. To reduce the adverse impact, flower-viewing tourism destinations should further reduce ticket dependence; prolong the flowering period; extend the industrial supply chain, innovate the product development mode; and speed up the integration of flower-viewing tourism with ecological healthcare, leisure vacation, mountain outdoor, car camping, research travel, and other tourism formats. In this way, flower-viewing tourism in China could become more resilient and achieve sustainable development post-pandemic.

(3) Advices of coordinated and sustainable development of flower-viewing tourism in China

The results of this study show that the flower resources and the development characteristics of flower-viewing tourism are different among the various regions of China. The regional coordinated and sustainable development of flower-viewing tourism can be increased by strengthening the regional cooperation, developing industrial integration, and creating differentiated functional zones. First, based on the existing traffic and infrastructure networks, regional cooperation can be heightened by integrating flower-viewing tourism resources along the line organically. Second, to achieve sustainable development, regional flower-viewing tourism should create "flowering-viewing tourism plus" characteristic products by integrating it with agriculture, culture, creative industry, and other tourism sectors. Third, it is necessary to build differentiated flower-viewing tourism functional zones based on the type differences, viewing-time differences of regional ornamental flower resources, and the differences of regional landscapes and cultural resources.

6.2 Conclusions

(1) About 95% of China's flower-viewing tourist attractions are located southeast of the Hu Line. The spatial attribution pattern of flower-viewing tourism in China is overall aggregated with some differences among provinces and cities. At present, two high-density aggregated areas, three medium-density aggregated areas, and one general-density aggregated area have formed. In addition, the Pearl River Delta region is gradually developing into a high-density agglomeration area. Specific to the tourist attractions with five main ornamental flowers (peach blossom, cherry blossoms, peony, rhododendron, and lavender), several aggregated areas of these tourist attractions have also formed. Two high-density aggregated areas of peony tourist

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attractions have formed; and one high-density aggregated area of peach blossom tourist attractions and lavender tourist attractions has formed. No agglomeration area of tourist attractions with rhododendron or cherry blossoms has formed.

(2) The flower-viewing period in China usually begins in February and ends in October each year, lasting about eight months. In different regions, the flower-viewing period times differ. The flower-viewing date starts earliest in eastern China, and ends earliest in western China. The overall flower-viewing period in eastern China lasts the longest, while that in northeastern China lasts the shortest. From the posting number of Weibo messages, the average viewing period of peach blossoms in China is 20.27 days, and the peak of Weibo posts for viewing peach blossoms is in late March. The average viewing period of lavender in China is 36.48 days, and the peak of Weibo posts is in late June. The average viewing period of peony is about 9.12 days, and the peak of Weibo posts is concentrated in late March and late April. The average viewing period of cherry blossoms in China is 23.47 days, and the peak of Weibo posts is in early April. The rhododendron blooming period is about 20 days, and the peak of Weibo posts is in late April.

(3) From the perspective of influencing factors, the temporal distribution pattern of flower-viewing tourism is mainly affected by ornamental flower phenology, legal holiday arrangements, and the date of blossom festivals. The spatial distribution pattern of flower-viewing tourism is mainly affected by geographical distribution of ornamental flower resources, customer market potential, and social economic conditions. There is strong consistency between the agglomerated areas of flower-viewing tourist attractions and the spatial distribution of the corresponding ornamental flower resources. Provincial GDP, added value of the tertiary sector, regional permanent resident population, female population, and youth population have strong impacts on the formation of spatial distribution of flower-viewing tourist attractions. Regional traffic conditions do not significantly influence the spatial distribution pattern of flower-viewing tourist attractions.

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中国赏花旅游发展时空分异特征及其影响因素

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摘 要：近年来我国赏花旅游快速发展，但目前尚未见有研究对我国赏花旅游发展进行系统梳理。鉴于此，本文基于赏花旅游景区位置数据、观赏花卉物候期数据、赏花游客微博发帖数据、社会经济统计数据等，采用空间统计方法与地理探测器方法，对我国赏花旅游的时空分异特征进行分析，并在此基础上，探讨影响我国赏花旅游时空分异格局的主要因素。研究结果表明：（1）我国赏花旅游发展总体呈现空间集聚特征，目前已形成 2 个高密度集聚区、3 个中密度集聚区和 1 个一般密度集聚区；5 类主要赏花旅游景区也已形成若干集聚区；（2）从总体赏花时段看，我国的花卉观赏期约从每年 2 月开始，至 10 月结束，持续约 8 个月，各地区与不同观赏花卉的赏花期与花期不同；（3）观赏花卉物候期、赏花资源空间分布特征、区域常住人口数、青少年人口数、女性人口数、地区 GDP、和第三产业增加值等因素对赏花旅游发展时空分异格局的形成具有显著影响。上述结论基本厘清了我国赏花旅游发展的时空分布格局及其影响因素，可为促进赏花旅游区域协同与可持续发展提供科学依据与有益借鉴。

关键词：赏花旅游；时空分异特征；影响因素；旅游景区

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