

# Study on the Spatial Pattern of Central Place in Yanqing District, Beijing Based on POI Data

Xiang Pan

Beijing Normal University

201911039040@mail.bnu.edu.cn

**Abstract.** This paper studies the spatial pattern of the central place in Yanqing District of Beijing, where scholars pay less attention. Based on the Point of Interest (POI) data, the kernel density analysis was used to identify the spatial distribution of the center place and obtain the characteristics of its agglomeration distribution. The Hierarchical Cluster Analysis and the centrality index are applied to identify the hierarchical system of the central place of Yanqing District combined with the multi-source image. The influence on the central place distribution of multiple factors which includes topography as a main factor is discussed. Based on the analysis results, the possible central place additional suggestions is put forward.

**Keywords:** Central Place theory; hierarchical system; POI; Yanqing

## 1. Foreword

### 1.1 Summary of Previous Studies

Yang[1] applied the Central Place theory to comb out the historical background of the formation of the commercial and service industry in Beijing, and predicted the commercial and service center also sub-center in the next century in Beijing. Based on the Point of Interest (POI) data, Lin and other scholars[2] identifies the distribution of Central Place hierarchy system of retail commerce within the sixth Ring Road in Beijing, and analyzes the impact of its formation from many perspectives. Guo Jie[3] and other scholars have mainly studied the spatial structure of Beijing's service industry based on POI.

For other cities outside Beijing, many scholars conduct research on urban commercial distribution based on POI, including the agglomeration status of retail commercial centers[4], the identification of urban functional centers[5] and the spatially and temporally distributing characteristics of commercial centers[6].

### 1.2 Research Significance and Topic Selection

Analysis methods based on POI data are more accurate and efficient than traditional methods[5]. With the help of the geographic data provided by the POI data, the central place spatial distribution pattern of the research site can be quickly obtained, which is also convenient for further in-depth analysis through the geographic information system.

Previous research in Beijing focuses on retail or service industry, and the research scope is limited within the sixth Ring Road. Lack of attention to multiple industries, as well as to the suburbs. And the central place formation mechanism of Beijing urban area is more complex. One of the typical manifestations is that the central pattern of  $K=3$  and  $K=4$  are staggered and superimposed[2].

Based on the reason above Yanqing District is selected as the case site of this study. Yanqing District is located in the northwest of Beijing, the main part of is is located in the Yanhuai Basin, and the mountains isolate it from Beijing. Yanqing district has a relatively broad and flat area, this part can meet the assumption of the Central Place theory. The relatively moderate size of the Yanqing District decides the magnitude of the data for the analysis is feasible, so various industries can be included in the analysis.

## 2. Data and Methods and Results

### 2.1 The POI Data Source and Pre-processing

This data is from the the poi58(poi58.com) website (one-tenth of the total data, and the limitations of it will be discussed later). According to the data provider: the data comes from the POI data of 2021 in various source such as Tencent Map and Baidu Map.

Given that POI data often duplicates, the data is cleaned: the same data is removed and improved. Based on the data itself and previous studies[2], a classification standards is developed (see Table 1 and Table 2) and the data were reclassified. Finally, the data includes 779 items in total.

The data which represents commercial site are classified into categories as: primary or senior, necessary or unnecessary. Primary and senior class are a relative concept between different functional subcategories under a functional category. For example, under the retail category, convenience stores are primary class, and supermarkets and comprehensive shopping malls are senior class. For the necessary and unnecessary functions: the former is the functions that meet the basic needs of the citizens or have irreplaceable services, such as convenience stores, grain and oil, fruits and vegetables, meat, poultry, eggs, milk and aquatic products, snacks and halal (restaurants), etc. Unnecessary functions are to provide cultural, sporting goods retail, motor vehicles and other retail services.

Table 1 Classification types and quantity proportion of retail sites in Yanqing District, Beijing

| Category                                                               | Subcategory                                                                                                                                                                                    | quantity | proportion |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|
| Other retail                                                           | Flowers and birds sale, fish and insects, fire equipment, unmarked, agricultural accessories, scenic spot gifts                                                                                | 32       | 4.11%      |
| Textile, clothing and daily necessities specialized in retail          | Cosmetics, bicycle monopoly, clocks, glasses, clothing, shoes and bags, mother and children's supplies                                                                                         | 111      | 14.25%     |
| Home decoration retail                                                 | Paint, Doors and Windows, Building Materials, Tile Flooring, Furniture, Home furnishing *                                                                                                      | 92       | 11.81%     |
| Culture, sporting goods and equipment specialized in retail            | Jewelry, arts and crafts and collectibles, cultural supplies, books, audio and video, sports and outdoor                                                                                       | 37       | 4.75%      |
| Comprehensive retail                                                   | Comprehensive shopping malls, convenience stores, supermarkets                                                                                                                                 | 103      | 13.22%     |
| Food, beverage, tobacco, alcohol and alcohol are specialized in retail | Tobacco and alcohol monopoly, bread and dessert, cold drinks, grain and oil, fruits and vegetables, meat, poultry, eggs and milk and aquatic products, nutrition and health care products, tea | 64       | 8.22%      |
| Home appliances and electronics products specializing in retail        | Digital home appliances, mobility scooter, other electronic products, communication equipment, household appliances, home audio-visual equipment, computers                                    | 34       | 4.36%      |
| Motor vehicle retail                                                   | Used car trading, gas stations, auto parts sales, car sales                                                                                                                                    | 14       | 1.80%      |

Table 2 Classification types and quantity proportion of service sites in Yanqing District, Beijing

| Category                                   | Subcategory                                                                                                                                                        | quantity | proportion |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|
| Motor vehicle service industry             | Car Maintenance,                                                                                                                                                   | 32       | 4.11%      |
| neighborhood services                      | Beauty salon, tattoos, fitness regimen                                                                                                                             | 54       | 6.93%      |
| Leisure and catering industry and commerce | Farm food, seafood, hot pot, Halal, Japanese and Korean dishes, barbecue, special Chinese food, western food<br>Eat fast food, Chinese restaurants, and other food | 206      | 26.44%     |

## 2.2 Analytic Procedure

### 2.2.1 Kernel Density Analysis

The resulting 779 POI data are imported into the Arcgis for Kernel Density Analysis (performed in geographic coordinates) to identify the spatial distribution of the commercial network and their influence. Specific parameters are: 6E-04 output pixel radius, 1.75405E-02 search radius, the boundary Yanqing district administrative division (source: [http://datav.aliyun.com/portal/school/atlas/area\\_selector](http://datav.aliyun.com/portal/school/atlas/area_selector)) is the processing range. The value domain of Kernel Density Analysis is obtained as [0,804097.3873]. The results of the analysis are classified using Quantile and set the number of categories to 12. Export the analysis results as shown in the figure below:

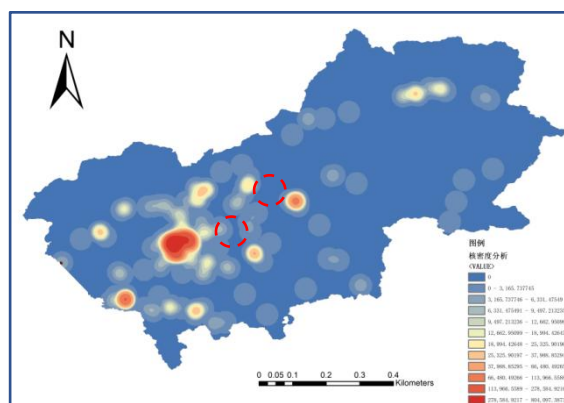


Figure 1. Results of the nuclear-density analysis

The boundary of each color block in the figure can be regarded as a contour line, and the range of a single-layer or two-layer color block (contour line) is taken as the center ground. Ignore separate color blocks (for example, those in two red dashed circles in the figure above). Because these color blocks are only the influence range of a single POI data under the Kernel Density Analysis and therefore should not be identified as a central place. Finally, 25 central places are found, all of which are shown in the figure below:

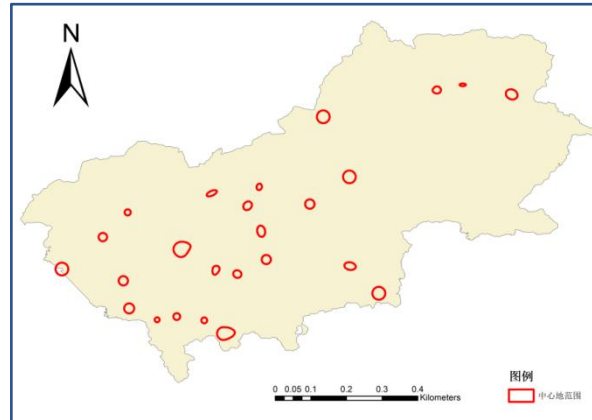


Figure 2. Scope of each center site

The POI point data of each center place was extracted. According to the data characteristics: the number of the functions, primary or senior functions, necessary or unnecessary functions, total number of sites, and the number of supermarket is calculated. The specific indicators of each place center are shown in the following table. Since there are only 4 supermarkets in the research area, which are all in the Yanqing Downtown, the columns of supermarkets is not shown in the table below.

Table 3. Central place index values of ten of the largest central place

| No. | Name                                                                   | Central<br>functio<br>n | The<br>proportio<br>n of<br>primary<br>sites | The<br>proportio<br>n of<br>advanced<br>sites | The portion<br>of<br>nonessentia<br>l functions | The<br>proportio<br>n of<br>necessary<br>functions | Total<br>numb<br>er of<br>sites |
|-----|------------------------------------------------------------------------|-------------------------|----------------------------------------------|-----------------------------------------------|-------------------------------------------------|----------------------------------------------------|---------------------------------|
|     |                                                                        |                         | %                                            |                                               | %                                               |                                                    |                                 |
| 1   | Yanqing Downtown                                                       | 52                      | 20%                                          | 80%                                           | 73%                                             | 27%                                                | 337                             |
| 2   | Zhangshanying<br>Town, Guandi<br>Temple                                | 9                       | 56%                                          | 44%                                           | 67%                                             | 33%                                                | 9                               |
| 3   | Yuhuangmiao<br>Village,<br>Zhangshanying Town<br>(Yushu Mountain)      | 2                       | 0%                                           | 100%                                          | 100%                                            | 0%                                                 | 5                               |
| 4   | Conzhuang town                                                         | 19                      | 30%                                          | 70%                                           | 70%                                             | 30%                                                | 40                              |
| 5   | Badaling town and<br>town government<br>around                         | 4                       | 40%                                          | 60%                                           | 80%                                             | 20%                                                | 5                               |
| 6   | Jeme Tianyou<br>Memorial Hall and<br>the Great Wall of<br>China Museum | 5                       | 56%                                          | 44%                                           | 44%                                             | 56%                                                | 9                               |
| 7   | LiuGou ancient city                                                    | 8                       | 23%                                          | 77%                                           | 77%                                             | 23%                                                | 13                              |
| 8   | Yongning ancient city                                                  | 17                      | 43%                                          | 57%                                           | 71%                                             | 29%                                                | 28                              |
| 9   | Artillery Village,<br>Badaling Town                                    | 2                       | 0%                                           | 100%                                          | 100%                                            | 0%                                                 | 2                               |
| 10  | Liu Haoying Village,<br>Kangzhuang Town                                | 2                       | 33%                                          | 67%                                           | 0%                                              | 100%                                               | 3                               |

### 2.2.2 Central Place classification method

System Clustering: uses SPSS software for the clustering of the above 25 center places. First, the data at each center were standardized for variance, as follows:

$$X_s = \frac{X - X_{Avg}}{S}$$

Where X is a central place index,  $X_{Avg}$  is the mean of that central index, S is the sample standard deviation.  $X_s$  is the standardized central place index.

After standardization, the indexes above are selected for case clustering. The nearest neighbor element as clustering was used to measure intervals using Euclidean distance. Previous studies have pointed out that the smaller the reference line setting value, the more reasonable the classification possibility is[2]. In this study, the reference line of clustering was set as bounded by 3, and the clustering results are shown in the following table:

| Class | Central Places             | Overall<br>function<br>number | The<br>proporti<br>on of<br>primary<br>sites | The<br>proportio<br>n of<br>advanced<br>sites | The portion<br>of<br>unnecessary<br>functions | The<br>proportion<br>of<br>necessary<br>functions | Total<br>number<br>of sites |
|-------|----------------------------|-------------------------------|----------------------------------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------------------------|-----------------------------|
|       |                            |                               | %                                            |                                               | %                                             |                                                   |                             |
| 1     | 1                          | 52                            | 20%                                          | 80%                                           | 73%                                           | 27%                                               | 337                         |
| 2     | 4、8                        | 26                            | 35%                                          | 65%                                           | 71%                                           | 29%                                               | 9                           |
| 3     | 12、20、6、<br>18、11、14、<br>5 | 14                            | 50%                                          | 50%                                           | 56%                                           | 44%                                               | 5                           |
| 4     | 7、23、22                    | 10                            | 22%                                          | 78%                                           | 81%                                           | 19%                                               | 40                          |
| 5     | 19、25、9、<br>21、3、15、<br>13 | 7                             | 0%                                           | 100%                                          | 100%                                          | 0%                                                | 5                           |
| 6     | 2                          | 5                             | 56%                                          | 44%                                           | 67%                                           | 33%                                               | 9                           |
| 7     | 16                         | 3                             | 67%                                          | 33%                                           | 100%                                          | 0%                                                | 13                          |
| 8     | 17                         | 2                             | 50%                                          | 50%                                           | 0%                                            | 100%                                              | 28                          |
| 9     | 10                         | 2                             | 33%                                          | 67%                                           | 0%                                            | 100%                                              | 2                           |
| 10    | 24                         | 2                             | 0%                                           | 100%                                          | 50%                                           | 50%                                               | 3                           |

Table 4: Clustering results

Centrality Calculation: Based on the previous research[7], and the centrality calculation formula applied in this study is put out as:

$$K = \left( \prod_{n=1}^6 k_n \right)^{\frac{1}{6}} (\text{Type 2})$$

where k1-6 are six indicators used except the number of supermarket. To eliminate the influence of minus numbers, each index is standardized by the maximum method here. Arrange the calculation results in descending order to obtain the following table:

Table 5 Centrality index and ranking of each center site

| Rank | Name                                                          | Central Place Index | Rank | Name                                                                          | Central Place Index |
|------|---------------------------------------------------------------|---------------------|------|-------------------------------------------------------------------------------|---------------------|
| 1    | Yanqing District                                              | 0.600881225         | 14   | Liu Binbao township                                                           | 0.166483805         |
| 2    | Conzhuang town                                                | 0.376637902         | 15   | Yuhuangmiao Village, Zhangshanying Town (Yushu Mountain)                      | 0                   |
| 3    | Yongning ancient city                                         | 0.356300496         | 16   | Artillery Village, Badaling Town                                              | 0                   |
| 4    | Zhangshanying Town, Guandi Temple                             | 0.26863818          | 17   | Liu Haoying Village, Kangzhuang Town                                          | 0                   |
| 5    | Old county town                                               | 0.255462433         | 18   | Jingzhuang Town, West Hongshan Village                                        | 0                   |
| 6    | LiuGou ancient city                                           | 0.255442841         | 19   | Old county town ancient city village                                          | 0                   |
| 7    | Jeme Tianyou Memorial Hall and the Great Wall of China Museum | 0.248007213         | 20   | Old County Town big bai old village                                           | 0                   |
| 8    | Big elm town                                                  | 0.22289949          | 21   | Shenjiaying Town Xiangcun Ying Village and Jingzhuang Town Aiguanying Village | 0                   |
| 9    | Badaling town and town government around                      | 0.200728418         | 22   | Xiestone village and East Sancha village                                      | 0                   |
| 10   | Qianjiadian Town 1                                            | 0.200201537         | 23   | Xiangying Township Baihebao Reservoir                                         | 0                   |
| 11   | Qianjiadian Town 2                                            | 0.19472064          | 24   | Qianadian town Xiawan village                                                 | 0                   |
| 12   | Shuiguan Great Wall Scenic Spot                               | 0.182930164         | 25   | The camp village                                                              | 0                   |
| 13   | Dazhuangke Township                                           | 0.166483805         |      |                                                                               |                     |

The main reason that the central place index of ranking 15 and later is zero, is that the amount of data is too small, or the function is too simple, resulting in the zero value existing in the calculation index. After the confirmation of satellite remote sensing images and panoramic maps, the author believes that the centrality index of 0 does not affect the description ability of the centrality index constructed in this paper: these centrality are indeed lower than the top centers. And from the perspective of the selected central indicators, the difference between these central indicators is relatively small, and it can be uniformly expressed by the 0 value.

### 3. Central Ground Level Classification and Analysis

#### 3.1 Combined with the Street View

For example, Group 1 includes only 1 central site, located in the urban area of Yanqing District. The center is located in large shopping centers such as Global New Innovation Department Store, Zhongta Plaza, Yanqing People's Shopping Mall and Yanqing Wanda Plaza. All the supermarket in the data are located in this center. The center has complete functions, clothing, shoes and bags,

tobacco and alcohol sales, jewelry, beauty and hairdressing and others are leading functions. Combined with the clustering results and the centrality index overall, the center area is undoubtedly located in the highest position in the central area hierarchy system of Yanqing District.



Figure 3 Typical commercial sites in Yanqing Urban District

Based on the street view combination, which is shown like the example above above, the final classification results are shown in Figure 4 and Table 6 below:

Table 6 Central centers and their total number

| Levels | Central Places                         | Number |
|--------|----------------------------------------|--------|
| 1      | 1                                      | 1      |
| 2      | 4、8                                    | 2      |
| 3      | 2、6、7、15                               | 4      |
| 4      | 3、5、9、11、12、13、14、18、19、20、21、22、23、25 | 18     |

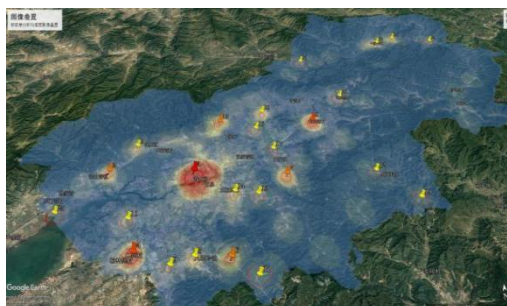


Figure 4 Location of the central areas of all levels

The scope in the picture is the administrative boundary of Yanqing District. The center is marked by using the Google Earth. Level 1 central places has 1.4 sized mark and RGB (255,0,0), colored mark; level 2 central places has 1.3 sized and RGB (255,75,75) colored mark, level 3 central places has 1.2 sized and RGB (255,130,130) colored mark, level 4 central places has 1.1 sized and the default RGB (255,255,0) colored mark. The marks next to the icon are consistent with Table 2.

### 3.2 Analysis of Structure of the Central Places

From the perspective of the proportion of all levels, the central place distribution of Yanqing District of Beijing is closest to the system of  $K=3$ . It shows that the market has played a relatively large role in the formation of the case center.

I draw lines and shapes with high accuracy through the AutoCAD. The kernel density analysis results into the AutoCAD, with the largest case of the No. 1 central place of Yanqing city as the first reference point, No. 4 and 8 central place respectively of the second and third largest hexagonal center and a vertex position), to determine the Figure 5.

In general, the distribution of central areas at all levels in Yanqing District, Beijing, especially at higher level centers (also with relatively sufficient data), is in line with the central areas system of Chris Taylor K=3.

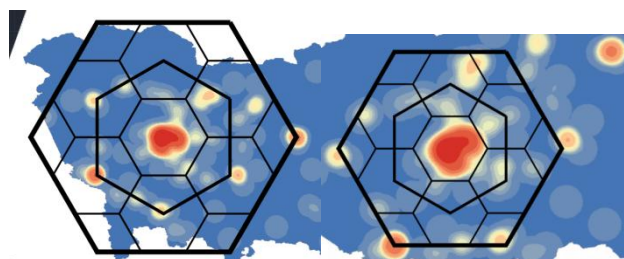


Figure 5 Network stacked core density analysis

The figure on the left shows central place No. 1 and 4 as the reference points, and the figure on the right takes central place No. 1 and 8 as the reference points. Given the applicability of the centrality theory, the centrality networks are only drawn in the plain area.

### 3.2.1 The "Dislocation" of the Level 2 Central Places

As shown, drawing in either way. One of the second level of central places always produces a "dislocation" phenomenon. In the left figure, the range of influence of the highest level function of the level 1 level central place is determined as the reference point, so that the central place level 4 of the level 2 central place (larger than the 8 level central place) is located in the geographical location of the level 3 central place. If the central places 1 and 4 are the reference points in the right figure, all the level 3 central places should be located in the level 2 central places. central place 8 is approximately in the geographical location of another level 1 central place. Considering that the central place site 8 is already close to the mountain area, it obviously does not have the location conditions to become a level 1 central place site.

The author believes that the reason for this "dislocation" is mainly the result of the joint action of transportation, administration, terrain and history. Assuming that in determining the location of the central places 1 and 8, the location of Kangzhuang town 4 should be located in the central land system, then it needs to migrate to the west side relative to the current site. In terms of traffic, this will make it deviate from the existing advantageous traffic location at the intersection of provincial road, national road and railway (with railway station); from the administrative general will bring it into the jurisdiction of Huailai County, Hebei Province (the blue dotted line in Figure 6 is yanqing and Huailai boundary); in terms of terrain, there are also official hall reservoir, wetland park and so on to prevent it from moving westward. Therefore, the current position of Kangzhuang Town is almost the optimal choice under the restriction of various factors.



Figure 6 Location and surrounding environment of Kangzhuang Town

Another possibility, if assume first determine the 1 and 4 central place, namely the yanqing city and Kangzhuang town location, if migration 8 central place to its location in the system, should not only make it away from the national highway provincial interchange advantage of traffic location, and the ancient city of yongning as a cultural site migration does not allow such behavior.



To sum up, the current location of yanqing level 2 central place is an almost optimal scheme under a variety of limiting factors.

### 3.2.2 Internal differences in the Level 2 Central Places

Also as the level 2 central place, the number of commercial sites in Kangzhuang Town is 42.9% more than that of Yongning Ancient City, among which the proportion of senior sites and non-essential functions is also higher, and it also has a small advantage in the number of functions. Compared to the ancient city of Yongning, Kangzhuang town is closer to the Yanqing city. In the framework of Chris Taylor's central theory, in general, the closer to the higher central place, the lower the hierarchy in the whole system, and the lower the function in theory. But Kangzhuang town in this case is a realistic case contrary to the above thought experiment. The main reason may be the influence of terrain and traffic factors.

Kangzhuang town is located at the intersection of provincial road, national road and railway, and the traffic location is extremely superior. And its surrounding area is a vast plain area. By contrast, the ancient city of Yongning is only located at the junction of provincial roads and national roads, and is surrounded by many mountains. Therefore, in general, Kangzhuang Town has more advantages in traffic flow and actual service scope and population. This should be the main reason why the overall scale and functional structure of Kangzhuang Town are obviously greater than and better than Yongning Ancient City.

### 3.2.3 Other deviations from the ideal patterns

The number of level 3 central places in this study (4) differs from the number in the ideal mode (6). The author believes that there are two main reasons, that is, (1) the "dislocation" of the high-level central place "occupies" the position of the low central place under the complex factors, and (2) the topographic factors affect the development of the central place. But ultimately, the root cause is the impression of the terrain.

The reason (1) The reason for the "dislocation" of the middle and high level central place has been discussed, so it will not be repeated. The "dislocation" of Kangzhuang town led to the position of a low-level central place to be "occupied". But is that really true? In fact, there is another possibility, that is, Kangzhuang Town should be in this position, and the above article also fully demonstrated the superiority of the current position of Kangzhuang town. Based on this point, deep thinking: ideally, the four central places originally for the third level central place should be "upgraded" to the second level central place. This seems very different from the status situation. But in fact, this hypothesis has its rationality, because the four level 3 central places in the classification scheme of this study may be "level 2 central places severely restricted by mountain terrain factors". At this point, if these four central places are counted as category 2, there is still a proper level 2 central place left vacant. This central area, which is "completely limited (100%) by the mountain terrain factor, is the central area (it should be located in the mountain area)".

Assuming that the negative effects of mountain factors are completely removed, the four level 3 hubs are highly likely to develop as the level 2 hubs in the present classification criteria. The ancient city of Yongning may be close to the central place of the level 1. However, the author believes that the greater possibility is: Yongning Ancient City is still the level 2 central place, but the function and scale are better than the current situation; Kangzhuang Town is downgraded to the level 3 central place; the level 3 central place in the other four current classification systems maintains its rank status unchanged, but the function and scale have been developed.

## 4. Conclusion and Discussion

### 4.1 Conclusion and Suggestion for Improvement

Based on the previous analysis, the author believes that it is more reasonable to represent the central place of Yanqing District by using the central ideal system mode shown in the left figure of

Figure 5. Combined with the terrain analysis, after excluding the mountainous area, it is found that the coverage of the central place is poor at the four hexagonal corners in the southwest side, as shown in Figure 7 below:

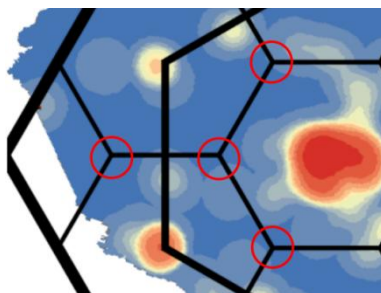


Figure 7 centrally covers the poor four corner points

The suggestions given in this study are: carefully add central areas. There are three main reasons: (1) proximity to Guanting reservoir and wetland park, poor development suitability; (2) large farmland, close to the water source and not; (3) the existing road conditions are poor and new roads will have a large expense, and considering the first two factors, these four locations are not suitable for road construction, thus lacking the central development.

The above improvement proposal is the only suggestion that the author can put forward from a relatively macro perspective. For more constructive advice, more observation and detailed field research is necessary.

## 4.2 Discussion

### 4.2.1 Optimization of the system clustering

The indicators selected in the system clustering are the proportion of primary sites and senior sites, the proportion of non-essential functions and essential functions can only account for indicators. In fact, the two metrics in each pair of metrics describe the same central properties, which are actually repetitive. This leads to the clustering process, the indicators describing the network level and function type are more "advantageous" compared to other indicators. That is, the clustering process actually puts more emphasis on the central network and functional structure. This may be an important reason why the four low-level central places, which have few functions, are each independent in the clustering results. Two repeated metrics were removed and clustered again using the same method to give the following table 7:

| Class | Central Places               |
|-------|------------------------------|
| 1     | 1                            |
| 2     | 16                           |
| 3     | 24                           |
| 4     | 4、8                          |
| 5     | 7、10                         |
| 6     | 3、9、13、15、19、21、25           |
| 7     | 2、5、6、7、11、12、14、18、20、22、23 |

Table 7 shows the clustering results using the new indicators

It can be seen that the previous classification of the scattered situation has been improved to some extent.

Besides this, there is still room for improvement in the selection of cluster indicators in the present study. For example, the composition of central place 2 and central place 6 is not exactly the same. Central place 2 has more home decoration retail, home appliances and specialized retail of

electronic products, while central place 6 is a typical scenic spot, with the former. Although the two are relatively different, under the current index selection, the distance between the two central clusters is 0, that is, they are considered exactly the same in the clustering model, which is obviously quite different from the current situation. Therefore, the selection of cluster indicators still needs to be improved.

#### 4.2.2 Few Samples

The impact of fewer samples has been discussed earlier, but only summarized here: Less sample size makes the accuracy of identifying network and functional structures with lower-level and middle-level central places in this study need to be tested. The benefit of less sample is a significant improvement in the time feasibility of this study.

## Reference

- [1] Lin Qing, Sun Fang, Wang Xiaomin, Liao Cong, Zhang Wenxin. Research on Local Classification System of Beijing Commercial Center Based on POI Data [J]. Journal of Beijing Normal University (Natural Science Edition), 2019,55(03):415-424.DOI:10.16360/j.cnki.jbnuns.2019.03.018.
- [2] Yang Wuyang. The Past, Present and Future of Retail Business and Service Centers and sites in Beijing [J]. Journal of Geography, 1994 (01): 9-17.
- [3] Guo Jie, Lu Yongqiang, Shen Tiyan. Research on Urban Spatial Structure Based on Point Mode Analysis —— takes the Beijing metropolitan area as an example [J]. Economic Geography, 2015,35(08):68-74+97.DOI:10.15957/j.cnki.jjdl.2015.08.010.
- [4] Chen Weishan, Liu Lin, Liang Yuhe-fill. Hot spot identification and business form cluster characteristic analysis of Guangzhou Retail Business Center based on POI data [J]. Geographic Research, 2016,35 (04): 703-716.
- [5] Duan Yaming, Liu Yong, Liu Xiuhua, Wang Honglei. Multi-center identification of the main Chongqing city based on POI big data [J]. Journal of Natural Resources, 2018,33 (05): 788-800.
- [6] Li Yang, Chen Xiaohong. Study on Spatiotemporal Evolution and Space Agglomeration Characteristics of Harbin Commercial Center [J]. Geographic Research, 2017,36 (07): 1377-1385.
- [7] Yu Yongjun, Lu Yuqi. Centrality study in provincial capitals [J]. Economic Geography, 2005 (03): 352-357.