Spatial Distribution Characteristics of Educational Institutions in Shanghai---Analysis Based on POI Data

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Abstract. Based on the POI data of Shanghai educational institutions, this paper analyzes the spatial distribution of educational resources in Shanghai and draws the following conclusions. The distribution of educational institutions in Shanghai shows the characteristics of decreasing outward law in the central urban area. The density of educational institutions in the central urban area is much higher than that in other areas, and the spatial distribution is unbalanced.

Introduction

The allocation of educational resources has been affected by various factors for a long time, which has become a widely discussed issue in sociology. The rational allocation of educational resources plays an important role in the stability of society and the effective utilization of talents, and also promotes the mobility among different classes. As one of the first-tier cities in China, Shanghai is rich in educational resources, and its rich educational resources are also an important factor to attract the migrant population to study, work and live in there. But even so, there must be great differences in the spatial distribution of educational resources in Shanghai, so this paper attempts to discuss the characteristics of the spatial distribution of educational resources in Shanghai. At present, with the rise of the era of big data, using big data to analyze spatial pattern has become a hot spot. Poi (point of information), as a simple and representative point data in the new trend of big data, plays an important role in a series of studies such as public facilities layout, service location selection [1]. This paper makes a quantitative analysis of the spatial distribution, concentration, distribution density and influencing factors of the existing educational institutions in Shanghai by using the point data of the educational institutions in the Amap, aiming to summarize the spatial distribution rules and characteristics of the educational institutions in Shanghai and provide a theoretical basis for the development of the educational resources.

At present, how to plan the urban development in the mass big data and high-speed development of social status has become an urgent problem in sociology. The study of spatial layout by western scholars can be traced back to the early 20th century. With the rise of Chicago school, the concept of spatial analysis has been paid more and more attention. In the early research, sociological space issues mainly focused on residential segregation, neighborhood community effect, residential migration and other issues. Due to the lack of spatial data and spatial analysis technology, the domestic social sciences have carried out the relevant issues late. With the wider use of POI data, many domestic scholars have carried out relevant research. Tang mengge and others analyzed the gathering of hot spots of leisure and entertainment in Chengdu by using POI data, and found that tourism and leisure related facilities have a very obvious circle structure, and the distribution density from the center to the surrounding presents a decreasing law [2]. Cao Shuqing used the data of 482 POI of public cultural facilities in Qingdao to analyze the spatial characteristics of regional distribution, concentration and distribution density, and found that the regional distribution of public cultural facilities in Qingdao is quite different and highly concentrated, basically around the city center [3]. Xu use Shanghai overseas tourists POI data, explore the time and space distribution characteristics of Shanghai central city overseas tourists, found that the quantity and the density of Shanghai downtown district very unequal, high-level tourist area large commercial entertainment

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history blocks and other regional agglomeration degree is higher, built-up area city park business entertainment facilities as well as regional intensity is very low [4]. In addition, some scholars use the mobile signaling data to analyze the commuting data and the spatial relationship between occupation and residence of Shanghai residents [5]. In the research of Shanghai education resources, few scholars use spatial data to explore the allocation of resources on the spatial level, so this paper uses ArcGIS to analyze the relevant data based on the POI data of educational institutions.

Spatial Distribution Characteristics of Educational Institutions in Shanghai

This paper obtained the 16 gold map in the Shanghai area about 40000 education institutions of POI data points the POI data not only include the kindergarten, primary and secondary schools and university institutions, also includes all kinds of remedial class library education training institutions, every education institutions to record the specific address and latitude and longitude information, first of all, we according to the POI geographic coordinates information, combined with Shanghai street map, mapping the spatial distribution of POI scatter plot.

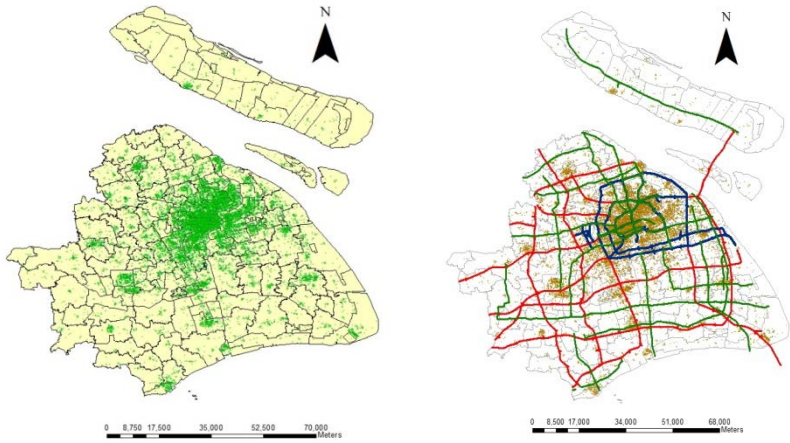

Fig.1 Distribution of educational institutions in Shanghai

As shown in Figure 1, we can see more intuitively that most of the educational institutions are located in the area within the ring road of Shanghai, that is, the central urban area we refer to, and the density of educational institutions outside the ring road is greatly reduced. However, we can also find that the educational institutions near the ring road are more concentrated than those in remote areas.

The article goes into analysis of main roads in Shanghai after the circuit diagram, the spatial distribution characteristics of the more significant within circle region distribution intensity, the largest outside loop near downtown area distribution is relatively concentrated, the more far away from the city center, the mechanism of distribution density is smaller in the far away from the downtown area, education institutions are mainly distributed near the road route, chongming island region, for example, education institutions are mainly distributed in the provincial road on both sides.However, Shanghai metro line map was not used in this paper. Whether some relatively concentrated small areas are distributed near subway lines and subway stations was not discussed in this paper. Therefore, some features of local areas need further consideration.

After that, the kernel density estimation (KDE) is used to measure the spatial agglomeration degree of geographical point elements, and the spatial distribution and agglomeration characteristics of educational institutions in Shanghai are analyzed. The kernel density analysis of point elements is used to calculate the density of point elements around each output grid pixel. Conceptually, each point is covered with a smooth surface. The surface value is the highest at the location of the point. With the increase of the distance from the point, the surface value decreases gradually. The surface value is zero at the location where the distance from the point is equal to the search radius. The volume of the space enclosed by the surface and the plane below is equal to the entry field value of this point. If the field value is specified as empty, the volume is 1. The density of each output grid

pixel is the sum of the values of all the core surfaces superimposed on the center of the grid pixel. Generally, the POI core density of urban commercial formats centered on P point is:

$$P_X = \frac{}{nh} \sum_{n=i}^{n} \left\{ K\left[\frac{X \; X_i}{h} \right] \right\} \tag{1}$$

n is the number of educational institutions included in the range of distance scale, P (x) is the kernel density function, h is the distance threshold, that is, the scale of kernel density estimation method, D (x, x_i) is the Euclidean distance between two points [6]. From the density analysis, we can clearly understand the agglomeration and spatial distribution of Shanghai's educational institutions, so as to judge the distribution characteristics and existing problems of Shanghai's educational institutions. The mathematical form of kernel function and distance threshold are the main factors that affect KDE. Using the KDE analysis tool in ArcGIS and the natural breakpoint method, the core density distribution map (left figure) is obtained. At the same time, using the same analysis tool in ArcGIS, the point density distribution map (right figure) is obtained.

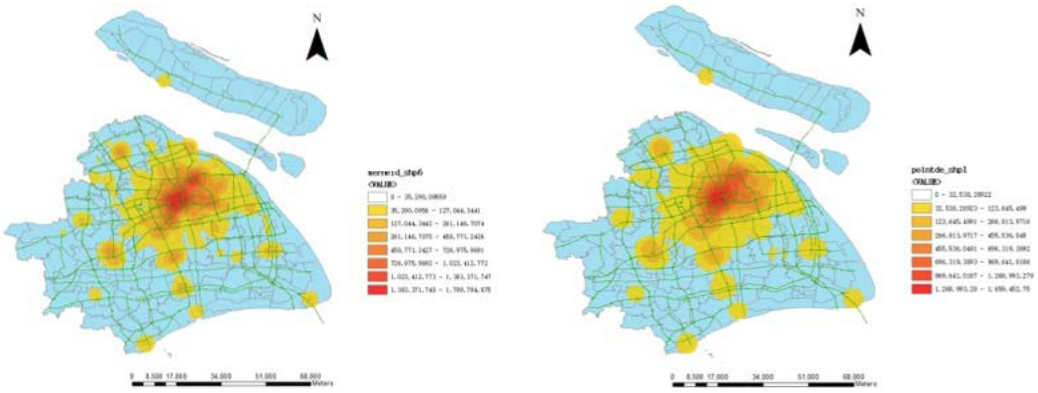

Fig.2 Nuclear density map and Density map of Shanghai Educational Institutions

The analysis results of the two maps are basically the same, as shown in Figure 2, the density of the central urban area is higher than that of other urban areas, the urban center density is the highest, and the density decreases outwards. It can also be seen from the figure that there are several small areas with concentrated density in the outer ring area. These areas are not only affected by the traffic lines, but also may be related to other factors such as the population density of the area. It can be seen from the figure that the unbalanced spatial distribution of education resources in the whole Shanghai area is very serious. Most of the resources are concentrated in the central urban area, and gradually decrease outwards. The education resources in remote areas and Chongming Island are very limited.

Next, the paper considers the influencing factors mechanism of the number of educational institutions. As it is difficult to obtain the street level data, only the data of the permanent population of each street in Shanghai from the sixth census are obtained for analysis, as shown in the figure:

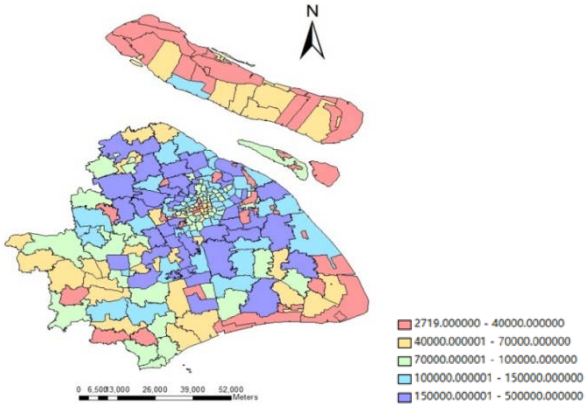

Fig.3 Population distribution of Shanghai

Figure 3 shows that the distribution of population in each street of Shanghai. It can be seen that the area with the largest population distribution is mainly the area close to the loop line, rather than the central area with the most intensive distribution of educational resources. The housing price in this area is lower than that in the central urban area, and the distance from the central business district is moderate, which may cause a large number of non-Shanghai immigrants to settle here. For these people, because they are close to the central city, their children's access to educational resources is relatively convenient. At the same time, a large number of people are logically distributed around the city center, which will not lead to excessive population density in the city center, resulting in extremely crowded situation. In addition, we can also find that some street areas with a large number of people in the ring road are also the corresponding areas with concentrated educational resources in the density map, and the two almost coincide. This means that the population of these areas is relatively concentrated, and the surrounding education resources are also relatively concentrated, which is more convenient to achieve education in time. Chongming Island, the southeast of Shanghai and some areas in the West are the main street areas with less population distribution, which is also the area with the lowest concentration of educational institutions. However, this paper can not further analyze the causal mechanism, and how the causal relationship between the two is still not discussed.

On the whole, we can find that the distribution of educational institutions is closely related to the population distribution. Educational institutions are mainly distributed in the central urban area, and decrease outwards regularly, and the areas with dense institutions are close to the location with convenient transportation. In addition, we found that the streets with a large population are mainly located near the outer ring road. These areas are moderately far from the urban area, which is convenient to enter the central urban area. The central urban area is small, which can not allow a large number of people to live in. However, education resources can be concentrated here, so that a large number of people around can get resources from it. So this distribution mechanism is more reasonable.

District Distribution of Educational Institutions in Shanghai

Due to the difficulty in obtaining streeter-level data, this paper then investigated the distribution of educational institutions in 16 districts and counties of Shanghai according to the existing data. Firstly, the number of educational institutions in each district and county was statistically obtained, and the density distribution of educational institutions was analyzed according to the actual area of the corresponding districts and counties.

Table 1 Statistics of educational institutions and areas of 16 districts in Shanghai

District	Number of educational institutions	Area / Km^2	Institutional density / Km^2	District	Number of educational institutions	Area/ Km^2	Institutional density / Km^2
Xuhui	4150	55	75.45	Pudong	8205	1210	6.78
Yangpu	3113	61	51.03	Minhang	3622	371	9.76
Jing'an	2767	37	74.78	Songjiang	2202	606	3.63
Huangpu	2264	20	113.20	Baoshan	2093	271	7.72
Putuo	2120	55	38.55	Jiading	1790	464	3.86
Changning	1957	38	51.50	Fengxian	1158	687	1.69
Hongkou	1504	23	65.39	Qingpu	953	670	1.42
				Jinshan	661	586	1.13
				Chongming	497	1185	0.42
Total	17875	289	69.91	Total	21181	6050	36.41

We put the statistics of seven districts in the center of the city in the left half of the table, and compare the statistics of other districts and counties in the right half of the table. It can be seen from table 1 that the total number of educational institutions in seven districts in the central area is basically the same as that in nine other districts and counties, but the area difference between the two parts is very obvious, and the density of educational institutions in the central urban area is almost twice that in other areas. It can be seen that there is a significant imbalance in the distribution of educational resources between the two. Next, we calculate this imbalance index, and analyze it with reference to Gini coefficient, an important index used to investigate the difference of income distribution among residents in the world. Gini coefficient is introduced to reflect the gathering and scattering degree of public cultural facilities in the research area. The numerical range is 0-1, and the calculation formula is as follows:

$$G = \sum \left| X_i - x \right| / \left[\sum X_i + (N - 2)x \right] \quad (2)$$

G is the Gini coefficient, x_i is the average density of educational institutions in the ith regional unit; X is the average density of educational institutions in the whole regional unit; n is the total number of regional units in the study area [7]. According to the formula, G = 0.772. The closer the value of G is to 1, the more significant the unbalanced distribution is, so we can think that the unbalanced distribution of educational resources in Shanghai is more prominent.

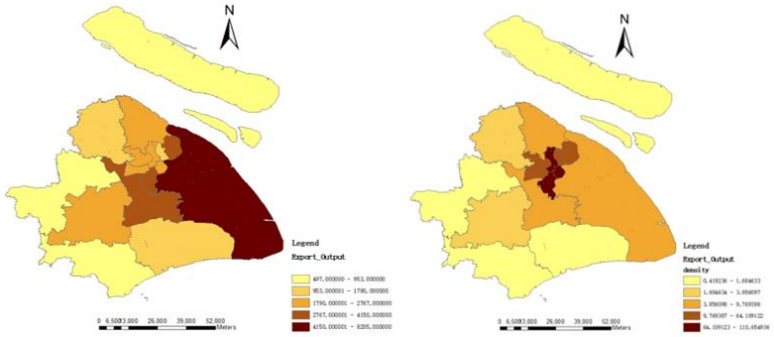

Fig 4. Distribution and Density of educational institutions in districts of Shanghai

From Figure 4, we can also get the corresponding conclusion. Although considering the quantity, the gap between the central urban area and other districts and counties is not obvious, the resource concentration advantage of the central urban area can be clearly reflected by discussing the density of educational institutions after joining the regional area.

Conclusions and Suggestions

Based on the existing data, this paper analyzes the spatial distribution of educational resources in Shanghai, and finds that the distribution of educational resources in Shanghai is characterized by high central urban area, low surrounding area, and decreasing from the central area to the outside. At the same time, it is found that there are serious imbalances in resource allocation between the central urban area and other areas. It can not be denied that the main concentration of educational resources in the central area will bring certain positive effects, such as conducive to the mutual use of educational resources, saving unnecessary cost waste caused by distance. However, we should also be aware that with the agglomeration of population and the further development of economic level in the surrounding areas, we should appropriately increase the investment in other areas, especially in remote areas. If we simply develop the level and scale of education in the central urban area, it will inevitably lead to the unfairness of education recipients in other regions and bring greater differences between regions. Therefore, the government should increase education in other urban areas to ensure that the same educational resources can be obtained by the educated in different regions.

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