THE FORECAST OF BEIJING FLOATING POPULATION SOCIO-SPATIAL DIFFERENTIATION

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ABSTRACT

In this paper, 18 districts in Beijing as the basic research unit with the Location Quotients, the spatial distribution of floating population in the year 2015 is forecasted, based on the grey prediction methods. The results indicated that the floating population is spreading to the outer suburban districts, mainly concentrating on the plains region, and the floating population in the center is increasing.

Keywords: Social Space, Grey system theory, Location Quotients, Classification, Data Preprocessing

1 INTRODUCTION

The urban social space is considered as the socio-spatial dialectic, reflecting a continuous two-way process between inhabitants and city. The socio-spatial differentiation refers primarily to the obviously uneven distribution of the social elements. We take the floating population as research object in this paper, predicting the spatial differentiation trend(in this study, mainly refer to uneven distribution of the floating population in Beijing).

Objective world is the world of a material world, as well as an information world too. It contains a large number of known information, and a lot of unknown and uncertain information. Unknown or uncertain information is considered as the 'black' world; the known information is considered as the 'white' world. The Grey system is that contains known and certain information, as well as unknown and non-assured information. Grey means predictable. Grey system theory (GST) advocates to study the system from characteristics (structure and parameters) of the system, allows the existing of grey parameters, and makes full use of the white news to solve problems. Generally, the system is considered as a set of complex multi-level subsystems in point of GST. If one level of subsystems which we can not confirm, the other(internal and external) relatively ensured, we can conclude the unsured level by the other level. However, the other levels are inevitably interactive with this level. So we can this level subsystem in a higher level and the non-observation can be determined. Thus, we can consider a 'grey' variable as 'white' in a higher level; a white variable may be grey in a lower system. In a higher level, the grey information will eventually be white. This is so-called that stand higher, look further. In a word, the process of understanding the world is the process of seeking 'white information' from the chaotic world. GST is based on the idea that grey is universal (It was only through the grey to look white) and predictability (grey can be white), using sequence data to establish the

dynamic model, accumulating a group of discrete, random original data, making them into a new sequence, then weakening the randomness of the original data. Then modeling, finally subtracting to the predict value. GST is single-series prediction, and do not need a lot of data.

2 THE CLASSIFICATION OF THE RESEARCH REGION

The research object in this paper is the city of Beijing, and the smallest basic units are the 18 districts of Beijing. These 18 districts are divided into inner, suburban and exurban zones of the city, in which inner zones refer to the four old districts in the central area of Dongcheng, Xicheng, Chongwen, Xuanwu; suburban zones are districts of Chaoyang, Fengtai, Shijingshan, Haidian; exurban zones are districts of Mentougou, Fangshan, Tongzhou, Shunyi, Changping, Daxing, Pinggu, Huairou, Miyun, Yanqing (Figure 1).

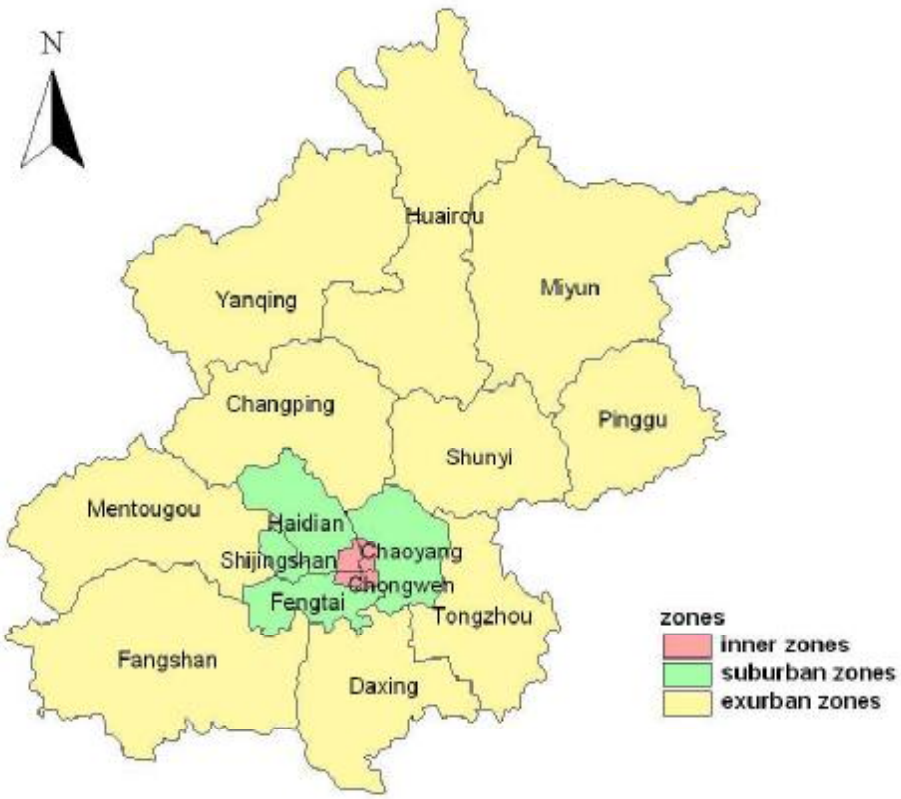


Figure 1. The inner, suburban and exurban zones in Beijing

3 BASIC RESEARCH METHODS

3.1 Data metabolism

In this forecast, we are not only using the traditional grey forecasting methods, but also joining the thought of replacing the old with the new. Under normal circumstances, the longer time it predicts the greater loss it may contain. The thought of data metabolism means keeping the length of the sequence, each time, removing the oldest data, and adding the newly predicted data in to this sequence. It can achieve two objectives: Firstly, to add the new information to the sequence in order to enhance the white information. Secondly, every step of predicting means the more step to improve the model.

3.2 Research ideas

To measure the concentration degree of the floating population in basic research unit, reflect the socio-special situations in the region as a whole, the Location Quotients (LQ) is used. The specific formula of LQ is as follows (R. Alan Walks，2001):

$$LQ_i = \left(O_i / \sum_{i=1}^{n} O_i\right) / \left(P_i / \sum_{i=1}^{n} P_i\right)$$

In this equation i is the basic research unit (which means the 18 districts), O_i is the floating population in the selected basic unit, and Pi is the total population in the selected basic unit. LQ reflects the degree of concentration in the analytic variables. This value ranges from 0 to infinity, when the value is 1, it means the concentration level within the basic research unit is the same as the level in the whole region; when a value greater than or less than 1, it means the concentration level within the basic research unit is greater or less than the whole. With the LQ value, we use matlab software to forecast the differentiation of floating population in 2015. Then, we use the Arcgis software to draw the figure.

4 THE PROCESS OF PREDICTION

4.1 Data

In order to ensure the reliability and consistency of data, we selected the household registration statistics all from the Beijing Statistical Yearbook. Because of the intermittent in the yearbook, the complete and continuous time series is not available. Thus, we have adopted the 1998,2000,2002,2004,2006 data in the Beijing Statistical Yearbook and use the data of 1997, 1999, 2001, 2003, 2005 to calculate LQ value(select floating population as the migrant population, the total population is the sum of resident population and migrant population). Using the LQ value, we predict the year of 2007, 2009, 2011, 2013, and 2015. The data is few and discontinuity, which is suitable for gray forecast. The LQ values of 1997-2005 are as bellows.

Table 1. the LQ value in 1997-2005

	1997	1999	2001	2003	2005
Dongcheng	0.7897	0.882622	0.554993	0.551577	0.831121
Xicheng	0.816938	0.802891	0.671059	0.50158	0.804539
Chongwen	0.724899	0.920405	0.555359	0.441695	0.74732
Xuanwu	0.619831	0.591666	0.604112	0.530446	0.78931
Chaoyang	1.564515	1.084551	1.296636	1.398015	1.223445
Fengtai	1.647816	1.630962	1.460251	1.114831	1.003852
Shijingshan	1.365791	2.178698	1.549839	1.164272	1.1744
Haidian	1.421053	1.458362	1.432979	1.232889	1.176473
Fangshan	0.470346	0.462269	0.512955	0.645479	0.638257
Tongzhou	0.500602	0.394987	0.620348	0.870762	0.982131
Shunyi	0.680791	0.681083	0.966325	1.082991	0.954444
Changping	1.073964	1.341034	1.635224	1.617766	1.160526
Daxing	0.808087	1.088057	1.060946	1.502785	1.178262
Mentougou	0.807331	0.791941	0.62001	0.729797	0.683914
Huairou	0.553116	0.95549	0.800999	0.545356	0.749704
Pinggu	0.214149	0.305243	0.227946	0.236698	0.290658
Miyun	0.200261	0.27955	0.300981	0.29017	0.391683
Yanqing	0.2117	0.339107	0.371892	0.320318	0.353634

Note：The total population is the sum of resident population and migrant population. Because of the lack of immigrant data in 2003, we replace it with the non-resident data. Sources: Beijing Statistical Yearbook 1998, 2000, 2002, 2004, 2006

4.2 Data preprocessing

In the process, we adopt a five-dimensional time series to forecast, in order to reduce the volatility of the original data; we firstly smooth the data with a three-point smoothing method.

The equation:

$$X^{(0)}(t) = \left\{ X^{(0)}(t-1) + 2X^{(0)}(t) + X^{(0)}(t+1) \right\} / 4$$

The endpoint: $X^{(0)}(1) = \left\{ 3X^{(0)}(1) + X^{(0)}(2) \right\} / 4$

$$X^{(0)}(n) = \left\{ X^{(0)}(n-1) + 3X^{(0)}(n) \right\} / 4$$

4.3 The process of prediction

- Prepare the original sequence data:

$$X^{(0)} = \left[X^{(0)}(1), X^{(0)}(2), X^{(0)}(3), \cdots \cdots, X^{(0)}(n) \right]$$

- Totting up（use superscript (1) to show subsequence）

$$X^{(1)}(k) = \sum_{i=1}^{k} X^{(0)}(i)$$

$$(\mathrm{k} = 1, 2, \cdots, \mathrm{n})$$

- build GM (1, 1) model:

$$dx^{(1)}/d_t + ax^{(1)} = u$$

- least square method:

$$a' = \begin{vmatrix} a \\ u \end{vmatrix} = \left[B^T B \right]^{-1} B^T Y_n$$

- Determine B, Yn:

$$B = \begin{vmatrix} -1/2\left(X^{(1)}(2) + X^{(1)}(1)\right), 1 \\ -1/2\left(X^{(1)}(3) + X^{(1)}(2)\right), 1 \\ \cdots \cdots \\ -1/2\left(X^{(1)}(\mathrm{K}) + X^{(1)}(\mathrm{K}\text{-}1)\right), 1 \end{vmatrix}$$

$$\mathrm{Y}_n = \left[X^{(0)}(2), X^{(0)}(3), X^{(0)}(4), \cdots \cdots, X^{(0)}(n) \right]$$

- Solve Equations

$$X^{(1)}(K+1) = \left(X^{(0)}(1) - u/a \right) e^{-ak} + u/a$$

- The actual value

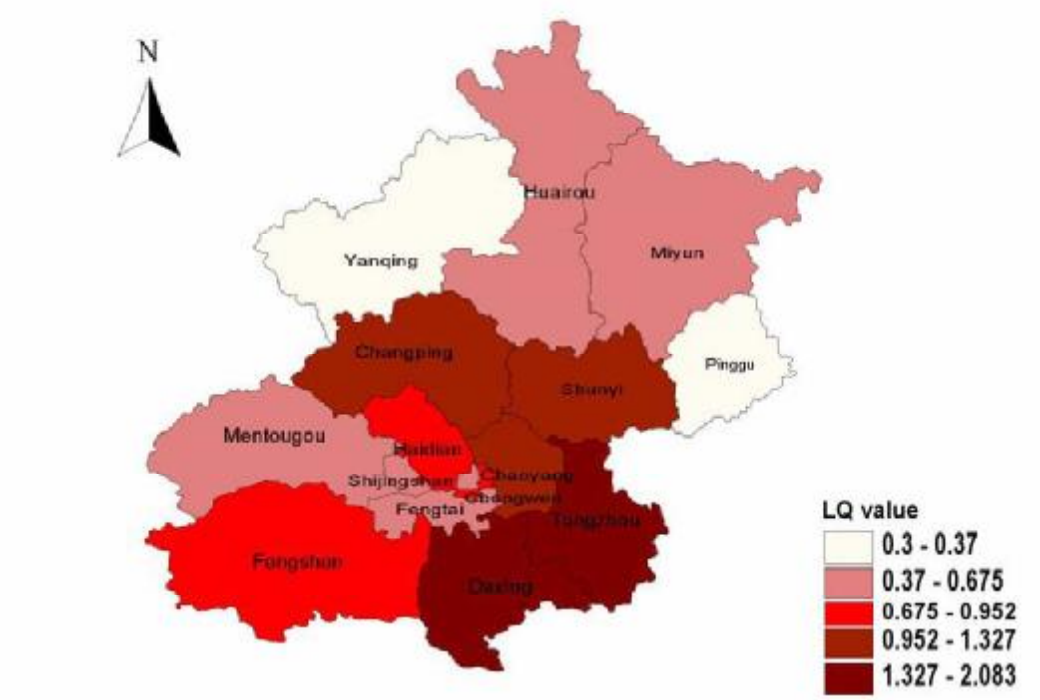
$$X^{(0)}(K+1) = X^{(1)}(K+1) - X^{(1)}(K)$$

4.4 Predict results

Table 2. Location quotients for floating population in 2007-2015

	2007	2009	2011	2013	2015
Dongcheng	0.7461	0.7708	0.8331	0.8882	0.937
Xicheng	0.6834	0.6753	0.6954	0.706	0.7096
Chongwen	0.5765	0.5307	0.5232	0.5041	0.4765
Xuanwu	0.8203	0.9523	1.1186	1.3011	1.5028
Chaoyang	1.3017	1.3058	1.3007	1.3033	1.3081
Fengtai	0.7396	0.5359	0.3835	0.2667	0.1822
Shijingshan	0.8027	0.5718	0.4118	0.2832	0.1883
Haidian	1.0294	0.8958	0.7739	0.6642	0.5688
Fangshan	0.7817	0.93	1.0957	1.2889	1.51
Tongzhou	1.4549	2.0833	2.8941	3.9512	5.2976
Shunyi	1.1669	1.3265	1.4744	1.6464	1.8415
Changping	1.2248	1.1391	1.007	0.8959	0.8083
Daxing	1.4636	1.6333	1.7891	1.9709	2.175
Mentougou	0.6673	0.6406	0.6229	0.6054	0.5863
Huairou	0.5898	0.5252	0.4765	0.4236	0.3732
Pinggu	0.2845	0.3003	0.3224	0.3436	0.3646
Miyun	0.4462	0.5465	0.6661	0.8044	0.9645
Yanqing	0.3558	0.3697	0.3799	0.3896	0.4004

The spatial results are as follows.



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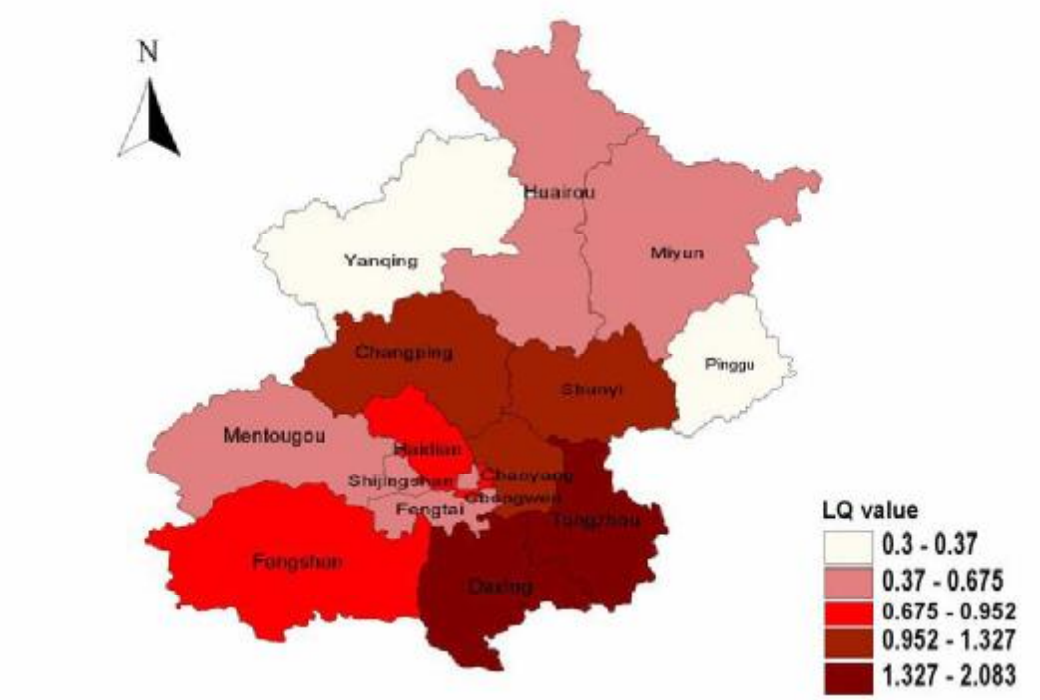

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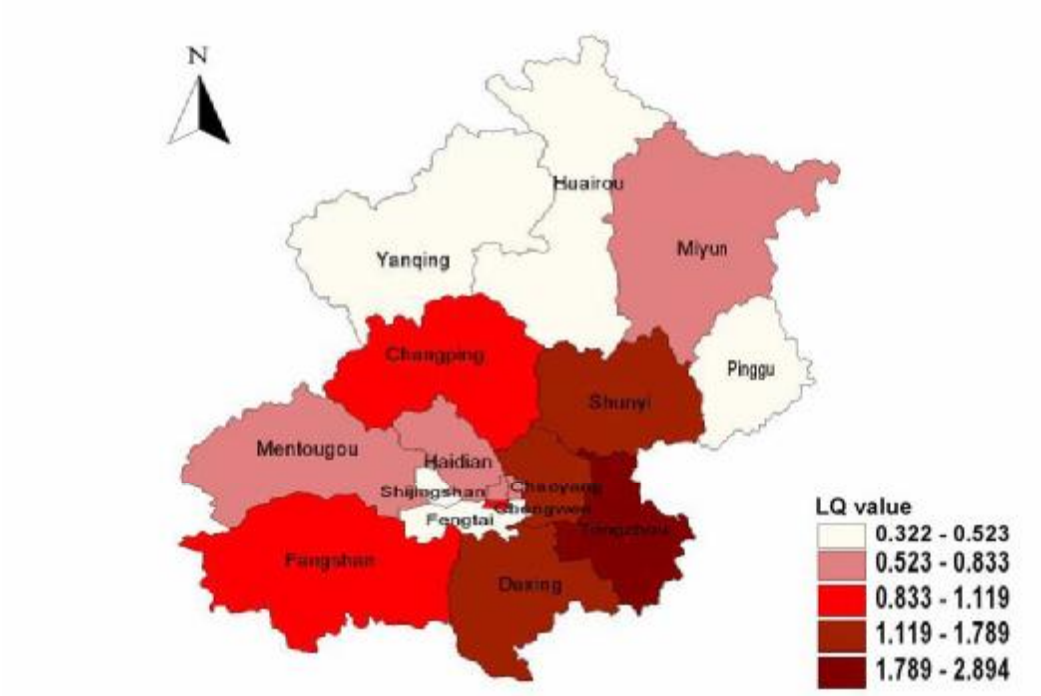

Figure 3. Spatial differentiation status for floating population in 2011

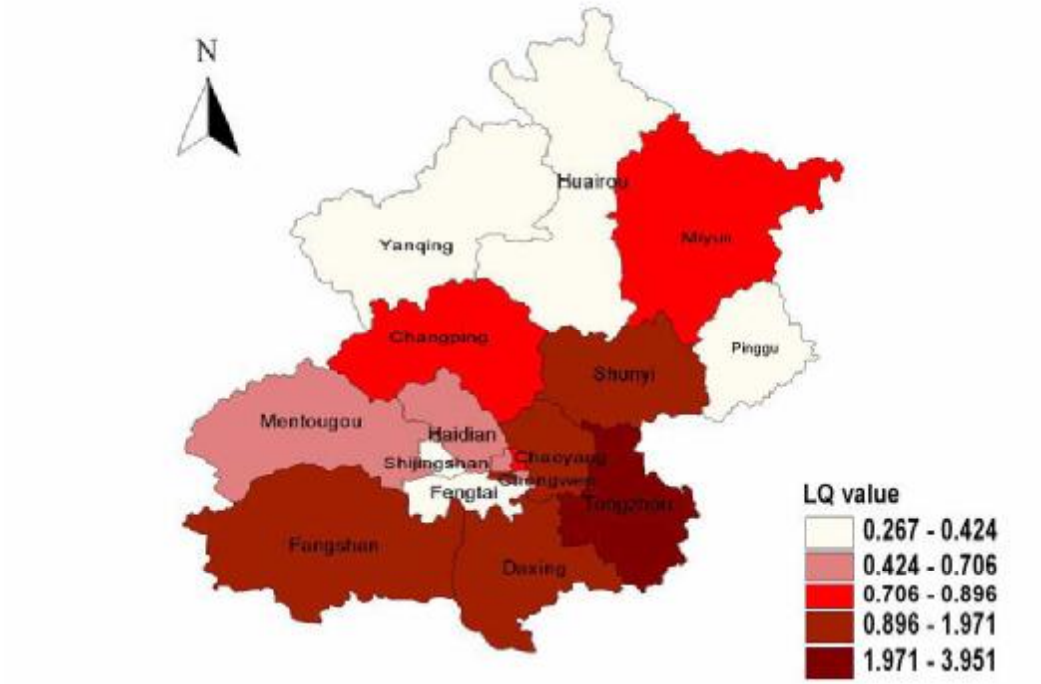

Figure 4. Spatial differentiation status for floating population in 2013

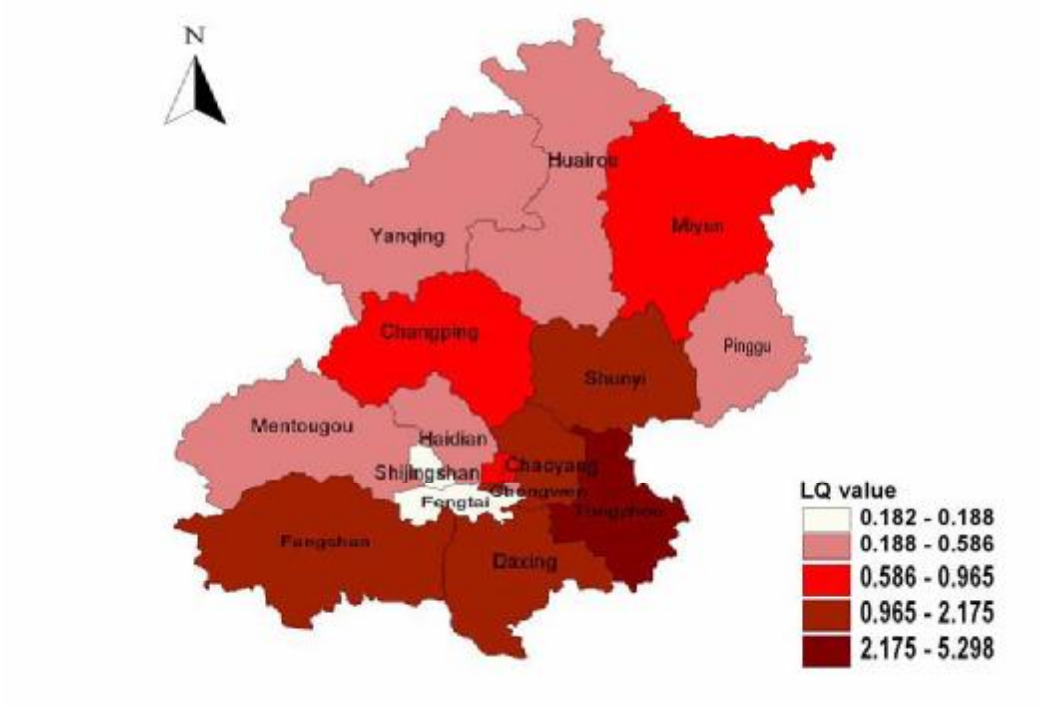

Figure 5. Spatial differentiation status for floating population in 2015

Compared with the year 2005 below.

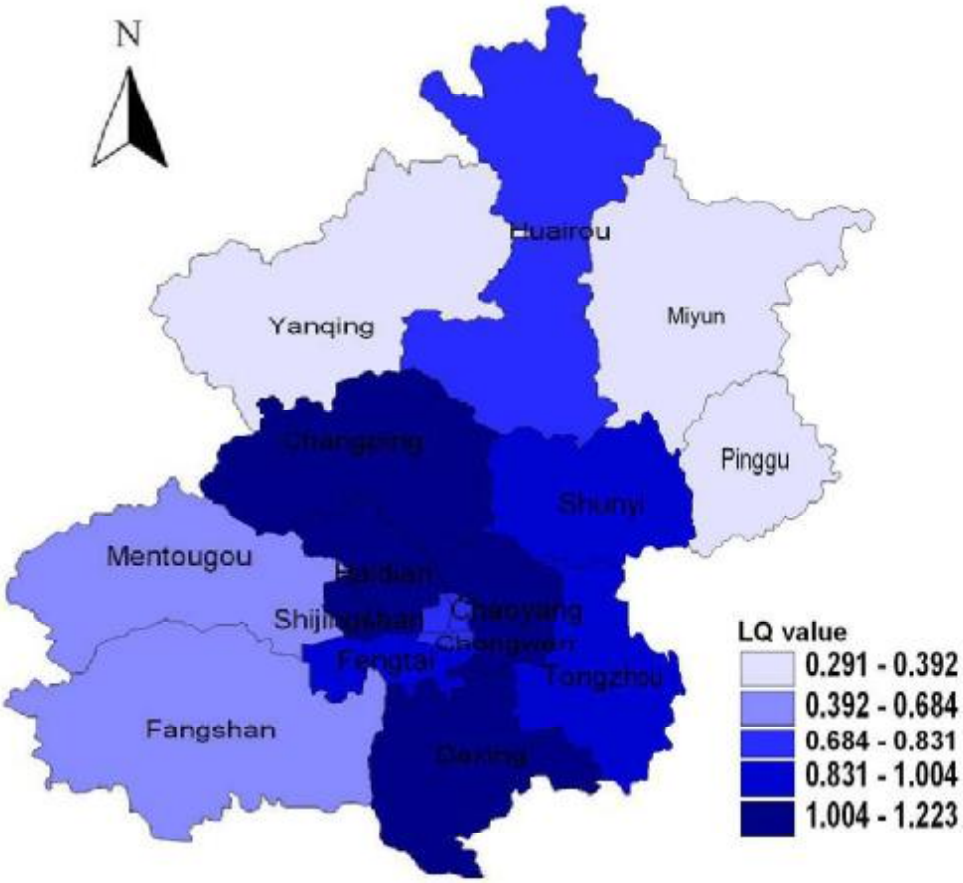

Figure 6. Spatial differentiation status for floating population in 2005

5 ANALYSIS OF THE RESULTS

From this paper, we can conclude the results:

- Floating population spread to exurban zones further. Starting from 2004, the investment emphasis of Beijing government transfers from the urban area to the exurban zones, comparing with the proportion of investments from 8:2(urban areas to exurban areas) in 2003, 6:4 in 2004, and 5:5 in 2005. Under this circumstances, the infrastructure, social and public service facilities, industry support, water conservation and ecological construction will be a great development in exurban areas. With the more and more employment supplied by the exurban areas, this area will be more attractive.
- The concentration of floating population in central area begins to rise. The central areas, in particular Xuanwu District, have a high degree of concentration. This is mainly that the recession in the central area. Because of the aging of municipal facilities, the high concentration of population, and the degraded of the quality of the environment, the urban population, especially those middle class with certain assets have moved to the suburbs, which is similar to the west countries. Accordingly, the underclass who can not afford the cost of resettlement, have to gather in the central area, in search of livelihood occupation. As a result, the floating population concentrated in the central area increasingly.
- From the forecast, we can see that in 2015 the flow of population distribution mainly concentrate in the exurban zones, the basic unit of which is closely related to the terrain. Judging from the overall situation, Beijing is high in northwest, and low in southeast. Northwest mainly contains mountains, and the southeastern mainly contains plains. In the predicted map, the future movement of population mainly concentrated in the plains, and therefore, floating population concentrate mainly in the southeast, and the northwest is relatively small. In the southeast, Pinggu District contains more mountains than plains; therefore, the floating population in this region is relatively small.

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