Measuring the Increase and Loss of the Public Facility Welfare ——A Case of Kunming City

Fan Jun[1] Xu Ning[1]

[1]2013 doctoral students,School of Earth Sciences and Resources , China University of Geosciences, Beijing. Zip code, 100083.

[2]CECEP New Material Investment Co., Ltd. Zip code, 100082.

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ABSTRACT: The welfare of public facilities space is part of residential space welfare. The spatial difference of public facilities causes the difference of public facilities space welfare and the spatial differentiation. In this paper, the establishment of public facilities space welfare maximization model is combined with the Kunming regional characteristics, and then the largest public welfare facilities configuration space is determined.

Introduction

With the development of society, on the one hand there exists social differentiation, and the spatial differentiation emerged on the other hand. In the meanwhile, when spatial differentiation develops to a certain stage, it may lead to spatial mismatch. Spatial mismatch hypothesis, originally proposed by Kain (1968), it discussed that the employment dispersion of American cities contributed to African Americans' low-income and high unemployment phenomenon. The study included Ellwood (1986); Ihlanfeldt and Sjoquist (1990, 1991); Ihlanfeldt (1992), (1993); Holzer ect (1994); Zax and Kain (1996), who focused on living environment and employment of vulnerable groups [1] - [7]; Brueckner (1997) analyzes the equilibrium under the spatial mismatch [8]. In China, the number of researchers were relatively few, they are Zhou Jiangping(2004), Li Chunbin (2006), Qian Yingying (2007), Zheng Siqi (2007) and Ma Guanghong (2008) and so on. The process of urbanization is the process of urban space production and reconstruction, but also the process of spatial differentiation and the process should be consistent with space justice. The space justice influences the spatial variation, adjusting space mismatch and then leading entire urban space to reach equilibrium. Cao Xianqiang (2011) explained the conception of "space justice" from two angles [9]. He Shuwen (2010) proposed the core values of justice of living space, and pointed out four kinds of injustice [10]. Gao Chunhua (2011) explained the connotation of the urban space justice and performance from an ethical perspective, and explored the solution of the loss of the modern urban space justice [11].

City is made up of social space and physical space, urban residents' daily life is made up of family life, work, leisure, entertainment, shopping and other various activities, all kinds of daily life behaviors in the urban environment are called the living environment. The benefits gained by the living space and environment are called living welfare. Public facilities welfare is part of living welfare, space welfare values are the result of effective market configuration, and also the result of the government payment transfer.

Establishment and improvement of the empirical model 1

Model hypotheses: ①Different regions in inner cities are homogeneous. ②Cost of transport is the linear distance between two location. ③The optimal public facilities configuration would not necessarily be in the geographical central , we choose the case of $n=1$ samples to study. ④ Groups' living area is gathered at one point ,and so is public facilities. ⑤Residents are rational, and the choice of public products is rational. ⑥Public goods are configured to discrete distribution.

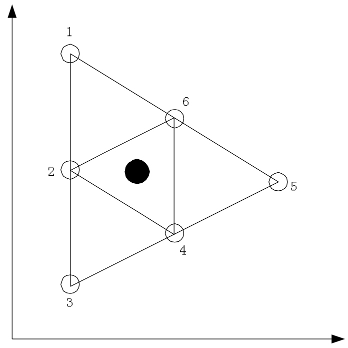

Figure 1 spatial organization and structure characteristics of urban location

In a mono-centric city, 1 - 6 represent the six different areas' centers respectively. Select the appropriate rectangular coordinate system to determine the coordinates of each regional center. Assume that the gathering location of public facilities is at the black spots, the six areas' distances to the black spot are d_1, d_2, d_3, …, d_i, $i=1,2,3,4,5,6$

The corresponding populations are p_1, p_2, …, p_i, i=1,2,3,4,5,6，traffic conditions are b_1, b_2, …, b_n, Revenues are t_1, t_2, … t_i. The welfare of the public products is related to at least four factors: regional population, commuting cost, traffic conditions, regional public expense. Here, commuting costs only consider the linear distance d , public spending is presented by tax t. The ultimate goal of the regional public configuration is to maximize the regional welfare of public facilities. Therefore, the objective function is $\max U = U(a,p,d,t)$. According to experience, assuming that welfare utility is proportional to the public spending while the population and traffic conditions are inversely proportional to the distance.Then the welfare utility function formula is: $\sum_{i=1}^{N}\frac{p_i b_i t_i}{d_i}$. Among them, N is the number of the division for the city. a is the coefficient of the convenience of transportation, equal to the ratio of the level of traffic and the distance. The greater of the a, the better of the traffic conditions and the smaller the value, the worse of traffic conditions(or the distance is further). Through the group sampling, we get the critical value a_0. When $a < a_0$, set the value a to zero, it says the area of public welfare is unavailable, so it should be eliminated in the utility function.

At the same time, this model also considers other external factors that interfere with public facilities configuration, such as public policy, the natural environment and other factors. Through the comprehensive evaluation, we get a comprehensive value R according to the different nature and utility of public goods, welfare accessibility and objective factors, by giving them different weights to get the final utility function: $\max U = U(a,p,d,t) = w_1\sum_{i=1}^{N}\frac{p_i b_i t_i}{d_i} + w_2 R$ $w_1 + w_2 = 1$ and $w_1, w_2 \geq 0$. R is a function of the external objective factors. Based on the different properties of different public facilities, requirement of the objective external environment also has big differences, here we only select some universal factors constructor to construct the R . (i) E natural environment factors,(ii) r Economic strength,(iii) b^* Local traffic,(iv) L political laws,(V) m Negative impact index. These factors can be regarded as public facility location function, $R = R(E(x,y), r(x,y), b^*(x,y), L(x,y), m(x,y))$. These different factors have different weights, we need the actual investigation, comprehensive analysis and experience to adjust, w_E , w_r , w_{b^*} , w_L , w_m , meeting $w_E + w_r + w_{b^*} + w_L + w_m = 1$, and $w_E, w_r, w_{b^*}, w_L, w_m \geq 0$ then,

$$R = w_E \bullet E(x,y) + w_r \bullet r(x,y) + w_{b^*}(x,y) + w_L \bullet L(x,Y) + w_m \bullet m(x,y).$$

Due to different location of samples and public facility, distance and the traffic conditions will be different, the distance is about the function of location of the public facility(x,y), and traffic can also be expressed by (x,y). Finally select (x,y) to maximize $w_1 \sum_{i=1}^{N} \frac{p_i b_i t_i}{d_i} + w_2 R$ that is to maximize ,

$$\max w_1 \sum_{i=1}^{N} \frac{p_i b_i t_i}{d_i} + w_2 R.$$

Choose three areas in the city, we establish right angle coordinate system according to their own characteristics. A, B, C represent three locations in the city, and their coordinates are $A(x_A, y_A)$, $B(x_B, y_B)$, $C(x_C, y_C)$. Black dot represents with quasi selected location of the public facilities,marked by (x,y). In order to simplify the calculation, each function related to (x,y) is regarded as a linear function. Assume three areas' population of the city are respectively p_1, p_2, p_3, and traffic b_1, b_2,…, b_n,then R is shown by the following functions:

$$R = w_E \times E(x,y) + w_r \times r(x,y) + w_{b^*} b^*(x,y) + w_L \times L(x,y) + w_m \times m(x,y),$$

$$= (w_E b_E + w_r b_r + w_{b^*} b_{b^*} + w_L b_L + w_m b_m)x + (w_E g_E + w_r g_r + w_{b^*} g_{b^*} + w_L g_L + w_m g_m)y$$

$= hx + xy$, among them, $h = w_E b_E + w_r b_r + w_{b^*} b_{b^*} + w_L b_L + w_m b_m$,

$x = w_E g_E + w_r g_r + w_{b^*} g_{b^*} + w_L g_L + w_m g_m$,

Then the objective function $\max U = U(a,p,d,t) = w_1 \sum_{i=1}^{N} \frac{p_i b_i t_i}{d_i} + w_2 R$ change to:

$$U = w_1 \left[\frac{p_A \times b_A \times t_A}{\sqrt{(x - x_A)^2 + (y - y_A)^2}} + \frac{p_B \times b_B \times t_B}{\sqrt{(x - x_B)^2 + (y - y_B)^2}} + \frac{p_c \times b_c \times t_C}{\sqrt{(x - x_c)^2 + (y - y_c)^2}} \right] + w_2(h_x + x_y)$$

If the location area is of continuity, the partial derivative of x,y is to zero respectively, we get the equations after solving them : $\frac{\partial U}{\partial x}=0$, $\frac{\partial U}{\partial y}=0$, Then we get the maximization of benefits of the public facilities configuration .If the location area is discrete, we can obtain utility value depending on the utility function, choose the largest utility is to choose the location to maximize the public facilities welfare.

Model correction and space value

Kunming city consists of wuhua district, xishan district, guandu district and panlong district. In the urban area, geographical landscape and state of the economy are basically homogeneous. Take the provincial government of yunnan province as the origin of coordinates, and establish the right angle coordinate system, chose one sample from each administrative region as a group gathering. Choose the xishan district government from the xishan district, choose wujing road between the minhang road and chuncheng road from guandu district, zhuoyue SOHO junyuan in beijing road from panlong district, jinxingyuan which near the intersection of yuandianxi overpass, west road of second ring and xuefu road as a group gathering, as shown in figure 3.3. Selection of sample points considers the location, transport, residential density, comprehensive factors such as economic environment, policies and regulations, and try to eliminate the interference due to the large differences.

Table 1 Kunming city sample data list

Disrict	population	p_i	G_i	coordinates
Wuhua district	855521	0.26	0.36	(-1.8，4.4)
Guandu district	853371	0.26	0.30	(2.1，-2.7)
Xishan disrtict	753813	0.23	0.14	(-0.815，-4.6)
Panlong district	809881	0.25	0.20	(1.3，1.9)

Gathering point do not gather the geometry center as the center, trying to give a true picture of the location of residential groups according to the facts as far as possible. Due to limiting to the second ring area, it will be conducive to rule out policies and regulations, geographical landscape, natural environment, economic strength and other external interference factors. Therefore, $w_2(h_x+x_y)$ is regarded as zero, $w_1=1$, $w_2=0$. All the Gathered sample points are selected in the convenient traffic near the main road, near the second ring,here $b_i=1$. p_i, value refers to Kunming's sixth census criteria, permanent population in wuhua district is 855521, guandu district is 53371, xishan district is 753813, panlong district is 809881, weights are shown in table 3.1. Because the value of district tax revenues is not easy to obtain, here we replace t_i with per capita GDP weight G_i , as shown in the table 1. The model is revised to:

$$U=\frac{p_A\times G_A}{\sqrt{(x-x_A)^2+(y-y_A)^2}}+\frac{p_B\times G_B}{\sqrt{(x-x_B)^2+(y-y_B)^2}}+\frac{p_C\times G_C}{\sqrt{(x-x_C)^2+(y-y_C)^2}}$$

KUNMING MAIN CITY'S MAXIMIZATION OF PUBLIC FACILITIES WELFARE

Set in the empirical analysis: N=3, n=3 in this paper, namely, three groups point and a public facilities configuration points, as local concentration distribution. When N=3, combination one: select three group gathering points A,B,C in wuhua, guandu, xishan district; Combination two: A,B,D in wuhua, guandu, panlong district; Combination three: select A,C,D in wuhua, xishan, panlong district.

Combination one, two, three turn to:

$$U=\frac{0.0936}{\sqrt{(x+1.8)^2+(y-4.4)^2}}+\frac{0.078}{\sqrt{(x-2.1)^2+(y+2.7)^2}}+\frac{0.032}{\sqrt{(x+0.815)^2+(y+4.6)^2}}$$

$$U=\frac{0.26\times0.36}{\sqrt{(x+1.8)^2+(y-4.4)^2}}+\frac{0.26\times\ 0.30}{\sqrt{(x-2.1)^2+(y+2.7)^2}}+\frac{0.25\times0.20}{\sqrt{(x-1.3)^2+(y-1.9)^2}}$$

$$U=\frac{0.26\times0.36}{\sqrt{(x+1.8)^2+(y-4.4)^2}}+\frac{0.23\times\ 0.14}{\sqrt{(x+0.815)^2+(y+4.6)^2}}+\frac{0.25\times0.20}{\sqrt{(x-1.3)^2+(y-1.8)^2}}$$

Table 2 kunming city's welfare maximization of public facilities space list

Area	x	y	maxU
wuhua, guandu, xishan district	-0.14	0.27	0.043
wuhua, guandu, panlong district	0.27	1.34	0.074
wuhua, xishan, panlong district	-0.73	2.05	0.087

According to the theoretical analysis, KunMing urban area is divided into different research areas in this study, as shown in the table above, public facilities gathering point is 1, the residents gathering area is 3. In order to maximize the space welfare utility, in their respective areas, there forms the corresponding optimal public welfare facilities space coordinate. Under the action of commuting costs, spending of the public products, population and so on, the optimal point of public welfare facilities welfare is not in the geometric center, the location of public facilities has played a decisive role in welfare utility. Different area combinations have different utility, combination location of public facilities space welfare of wuhua, the xishan, panlong 's maximum utility is 0.087, significantly higher than the wuhua, guandu, and xishan combination's maximum welfare utility 0.043. To obtain the $\max\sum U_i$, the optimal regional combination should be selected to achieve the real space welfare maximization of public facilities.

Within the urban area, the location of public facilities configuration will lead to the difference of the welfare utility, group selection in the area and the welfare utility influence each other. The area with big public facilities space welfare utility would attract higher income groups, and higher income group can increase the spending on local public goods, and then raise the local welfare utility. Under the interaction with each other, the local welfare utility will be further increased. However, for the area with lower public facilities welfare utility and lower income groups, in the case of the two in combination, the welfare of the public facilities configuration area utility compared to high income group welfare utility area, its amplitude is less than or far less than the high income group's welfare utility. In the long term, it would form the city space differentiation, a more severe case, spatial segregation. High-income groups live in the public welfare facilities space with greater and sustained increase utility for a long time, pushing up house prices, the welfare utility of peripheral location under the action of house prices continues to increase at the same time; while lower income groups live in the public welfare facilities space with lower and sustained decrease utility for a long time, the interaction with house prices are not as obvious as the former, the spatial differentiation would be strengthened.

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