DEFINING THE SERVICE AREA FOR EACH SCHOOL IN CHANGCHUN METROPOLITAN AREA BASED ON GIS TECHNOLOGY

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Abstract:

Education in china or other countries is a big problem to families and society. Especially, the PRC leaders and education officials emphasized the education rights should be commonly shared in 2005, this issue had been becoming an urgent problem which was waiting for being solved (Chuanyou Bao, 2007). However, this issue has not been solved successfully. In the early study, the researchers put more attentions on the regime of the education and seldom spent much time on studying how to define the service area for each school. To define the service area for each school properly, there are two aspects which should be considered: one is the school's ability of enrolling students and the other is how many students that the district can produce. As the primary study phase for this issue, this paper just takes Chaoyang district as an example. In the research, the Manhattan distance is used to measure the distance between students and schools. Then use the supply-demand model from operational research theory to define the relationship between students and schools. The result shows that this method is very useful to define the school's service area. The students in the service area have the equal opportunity to go to school. Besides, this method changes the conventional way to define school service area.

1 INTRODUCTION

It is a long time since the regime of going to school abiding to the school's service area in primary schools and middle schools was put in practice. Generally speaking, this regime maintains the education regime's implementing. Hence, whether the regime can be implemented successfully or not is an issue which we concern earnestly. And the basis for implementing the regime of going to school abiding the school's service area is defining the school's service area properly.

If a school enrolls students much more than its enrollment ability, a series results maybe occur. The results maybe: the campus is too congested; the class size is too big and furthermore cause the decline of education quality. Contrariwise, if the students in a school are much less than its enrollment ability, it is a waste of the educational resources. Hence, it is urgent to balance the educational resources and set up a suit of regimes for defining school service area (Yuan Zhao and Jia Zhu, 2008). However there are few materials which can be used to solve this issue. Therefore, this paper tries to use GIS as a tool to solve the issue. To solve this issue, there are two constrains should be considered: one is the school's ability to enroll students and the other is minimizing the sum distance between students and schools. According these constrains, this paper set up a process to define the school service area. Then the results will be more rational and get rid of the arbitrary decisions and uncertainties. On all accounts, it is a useful way to assign the educational resources properly and upgrade the teaching quality steadily.

There are two definitions about the regime of school service area in our country. One is for administration by educational organizations; and the other is the area for a school to enroll students. This paper emphasizes on how to define area for a school to enroll students (Yi Li, 2006).
The primary school education and the middle school education are consistent. And the primary school education is the basis of the middle school education. Furthermore, the results of the primary school's service area have important influences on defining the middle school's service area. So the results of defining the primary school's area are rational or not may impact the propriety of defining the middle school's service area. Hence, this paper just takes the primary schools in Chaoyang district ,Changchuan, China as an example.

2 STUDY AREA

The study area, Chaoyang District (or Precinct) is a district of southern Changchun, China. Chaoyang District includes nine blocks, Chongqing, Yongchang, Qinghe, Hongqi, Guilin, Huxi, Nanhu, Nanzhan, Fufeng, and also includes fifty-five communities, two towns, twenty-five villages and a provincial level development zone. The district covers 248 km^2 and has population of 688,000. It has a moderate continental monsoon climate, with clearly divided four seasons. The district offers fertile soil, picturesque cultural landscapes, and pretty residential environment; in addition it has a large number of business buildings, hotels, apartment houses and auxiliary structures, and fairly completes municipal administrative, transports and communication facilities.

Chaoyang serves as a center of government, economy, and culture in Changchun municipality. It has huge development potentials with many department stores, financial institutions and office buildings and features highly developed culture and education. The district has registered many primary and secondary schools and boasts rich basic education resources.

3 DATA SOURCE AND DATA PROCESSING

3.1 Data source

The planning institute of Changchun purposes doing the detail

planning of education for Changchun municipality, so investigates and researches the residential area and the schools involving the type, area, the location and the size of every school, the transportation information, etc. This paper uses the data provided by the planning institute of Changchun municipality and processes some data in a way according to the practice in the process of study. The data includes the location, the size and the population density of each residential area, the position and the size of every school as well as the capability of schools and so on.

Figure 1 The distribution of primary schools

Figure 2 Population density of Chaoyang district

3.2 Principles for defining school's service area

1)   Comprehensive principle
Basic education in China contains pre-school education, primary education and regular secondary education. The primary and junior secondary education belongs to the nine-year compulsory education. Hence, the primary and junior secondary education has high demand and takes an important part in the education in China. It relates with development of successors in morality, intelligence and physique, the development of educational undertakings, the construction of socialist modernization. In order to guarantee that each student can obtain fair education opportunity and convenient study environment, the definition of school's service area is very important (Hongchao Wu, 2007).

2)   Simple and clear principle
The students will refer to the definition of school's service area and confirm which school to study in. If the programming result is blurry or complicated that is difficult to understand, it will cause disputation among the educational departments, the schools and the students' paterfamilias. Therefore, it must have a strict and compendious principle for specifying the service area of schools.

3)   Optimize and shorten the distance between students and schools
The purpose of programming schools' service area is convenient for students, in this way, each student can take least cost to go to school, if the programming result is authentic, and it can help students choose their best school. The distance between students and school is one aspect of the concerned cost. For realizing the shortest distance, the following problems must be resolved.

- The service area of every school can't be very large due to the limit of distance and time between students and schools.
- The school must locate at the center or the proper position of its service area.
- The service area of each school should be integrated, compact and have a regular shape.

4)   Equitable principle
The demand of the primary education is homogeneous in space, which means it can't change with the spatial distance or time changing. However, the distance between different students and different schools is different so the common establishments (schools) use is uneven for different students, which will result in descending with distance, namely the same demand may bring different attainability. Hence, it isn't equitable. Thereby this problem must be considered.

3.3 Study Methods

3.3.1 Compute Distance
In practice, the Manhattan distance, the Time distance and the Euclidean distance are usually used to describe the distance between the entities in the real world. The three modes have their own signification in depicting distance. The Euclidean distance represents the linear distance between two points in the same plane, its equation can be formulated as,

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad (1)$$

The Manhattan distance (or the taxicab metric) emphasizes the distance between two points measured along axes at right angles. In a plane with p1 at (x1, y1) and p2 at (x2, y2), it is as,

$$d = |x_2 - x_1| + |y_2 - y_1| \qquad (2)$$

The Time distance expresses the time cost by passing the two points, it can be formulated as the third equation, in addition it need two parameters, one is the distance between two points, the other is the speed.

$$t = \frac{d}{v} \tag{3}$$

Note: For the above equations, (x_1, y_1), (x_2, y_2) represent the coordinates of the random two points in Cartesian coordinate system; d is the distance between two points; v is the speed; t is the time cost by passing the distance between the two points.

Because this paper will study the distance between the students and schools, that is how far a student go to his/her school, consequently the Menhaden distance can apply to the study topic. The papaer use the distance between the center of the residential area and the school to substitute the distance between every student in the residential area and the school.

3.3.2 Compute the number of students

Currently the data about the area of the residential region and the population density is ready, thus the number of the population can be calculated by the equation as,

$$P = Int(A \times dns) \tag{4}$$

Like Eq.(4), P represents the population number; Int is the function for getting the integer; A is the area of the residential region; dns is the population density.

According to the statistical data on the representative residential area, the proportion of the primary students is 6%, the number of the primary students can be formulated as,

$$Ps = Int(P \times 6\%) \tag{5}$$

3.3.3 Build the relationship between the residential area and school

Based on the theory of operational research (Ying-ai Gan et al., 2005), the relation between students and schools can be regarded as the relation of supply and demand, namely the model describing the relation of supply and demand is able to build the relation of schools and students in the process of study in this paper. Hypothetically, the number of the residential area (Here use R_i ($i = 1, 2, 3, ..., m$) as the code of the residential area. The number of primary students in relevant residential area is R_{Si} ($i = 1, 2, 3, ..., m$). The number of schools is n, here use S_j ($j = 1, 2, 3, ..., n$) as the code of the school. Each school has capability, S_{Nj} ($j = 1, 2, 3, ..., n$). d_{ij} is the distance between schools and the residential area. Therefore the relation between the residential area and school can described as,

School / Residential area	S_1	S_2	…	S_n	Number of students
R_1	d_{11}	d_{12}	…	d_{1n}	R_{S1}
R_2	d_{21}	d_{22}	…	d_{2n}	R_{S2}
⋮	⋮	⋮	⋱	⋮	⋮
R_m	d_{m1}	d_{m2}	…	d_{mn}	R_{Sm}
Capability of schools	S_{N1}	S_{N2}	…	S_{Nn}	

When using x_{ij} as the number of students distributed from R_i to S_j and supposing the total of primary students equals to the capability of all schools, which is an ideal condition, in this way, if requiring the distance between schools and the residential area is the shortest, use the following model to get the analysis result.

$$\min z = \sum_{i=1}^{m} \sum_{j=1}^{n} d_{ij} x_{ij} \tag{6}$$

$$\sum_{i=1}^{m} x_{ij} = S_{Nj}, j = 1, 2, 3, ..., n \tag{7}$$

$$\sum_{j=1}^{n} x_{ij} = R_{Si}, i = 1, 2, 3, ..., m \tag{8}$$

$$x_{ij} \geq 0 \tag{9}$$

Eq. (7) (8) (9) are the restriction conditions; Eq. (6) is the objective function. Then use the smallest element method and Vogel methods to compute. In fact, the above ideal condition is an especial instance; mostly the number of students doesn't equal to the capability of school and may exceed the capability, so this article changes this unequal state into equal state through rectifying the capability of schools. The rectification scheme is multiplying the primary capability of schools by a factor. The factor, f can be formulated as,

$$f = \frac{\sum_{i=1}^{m} R_{Si}}{\sum_{j=1}^{n} S_{Nj}} (i = 1, 2, 3, ..., m; j = 1, 2, 3, ..., n) \tag{10}$$

After rectifying, the final capability of the school is S_{FNj} that can be formulated as,

$$S_{FNj} = S_{Nj} \times f \tag{11}$$

3.4 Rectify the results

The result computed by the Vogel method is that the students of the residential area R_i are distributed to the number, k ($k \geq 1$) of schools. However, the simple, clear principle of programming the service area of schools must be considered and it's necessary to assure the one student can be only distributed to one school. In order to solve this problem this article imports the proportion priority method, namely use

Eq. （12） to specify the final relation between the residential area and schools.

$$Max(\frac{x_{ij}}{R_{Si}})(j = 1,2,3,...,n) \qquad (12)$$

4 CASE STUDY

Through the model and computing flow above, it is applied to the programming service area of schools in Chaoyang District in Changchun municipality, the process result is as Figure. 3.

Figure 3 The result of defining service area

The result indicates that this model for programming the service area of schools is reasonable, clear and applied

5 DISCUSSION AND CONCLUSIONS

The paper is based on the theory of operational research (Ying-ai Gan et al, 2005) and considers the relation between the residential area and schools in practice in the study of programming the service area of each school, this study is a helpful test. However, the study of this paper is in a underway phase, in the course of programming it only considers one factor, i.e., the distance between the students and schools must be the shortest and seldom concern other factors such as:

1) Avoid the natural obstacles such as rivers, the valleys, etc and other man-made obstruction like railways, highways. In this way, the traffic safety can be guaranteed.
2) Assure the public security.
3) Assure expedite and convenient transportation and vehicle.

Therefore, in the future study for the service area of schools it's necessary to consider more factors in order to make the result more reasonable.

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