Research on Layout Optimization of Primary Schools in Urban and Rural Of China Based On GIS Spatial Analysis ——Taking Dalian Ganjingzi District Primary School as an Example

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Keywords: Optimization of primary school layout; GIS; buffer analysis; education resources; policy recommendations

Abstract: The purpose of this paper is to optimize the layout and resource allocation of urban primary schools by analyzing the current situation of the distribution of urban primary schools, and put forward feasible optimization and adjustment programs, so as to provide guidance and suggestions for improving the efficiency of regional education resource utilization and improving the school-age students' schooling environment in the region. Taking the primary school in Ganjingzi district of Dalian city as the research object, based on the GIS decision support technology, the buffer zone is used to analyze the layout of urban and rural primary schools and the problems existing in the school service scope, and the network analysis technology based on the road network and the Thiessen polygon technology are used to optimize the primary school service scope. Research shows that with 500 meters as a space of the urban elementary configuration standard is reasonable, because of the complexity of the rural primary school layout and population distribution, to determine the service radius of rural elementary school should have sufficient and reasonable elastic space, to achieve planning is scientific and sustainability, need to long-term population development trend of the study area.

1. Introduction

Since the reform and opening up 40 years ago, with the continuous acceleration of the urbanization process, the disordered flow of rural labor force and school-age population to the city has become more and more common, and the public service function areas in urban and rural areas are in urgent need of re-planning, in order to better regulate the direction of social population flow and serve the society. Under the background of rapid development of national economy and society, primary school, as an important basic education service facility, is bound to put forward higher requirements for it and pose severe challenges to the spatial pattern of primary school. Therefore, in the process of rapid urban expansion and development, it is necessary to study the current spatial layout of primary schools and timely find out the problems and contradictions in the spatial layout of primary schools and the planning of teaching areas, so as to provide a basis for relevant departments to optimize the spatial layout of primary schools and make the layout of primary schools more suitable for the requirements of urbanization.

Up to now, the Internet, newspapers and other media still appear from time to time students and parents questioned the existing school district division scheme or even filed a lawsuit against the news reports. Thus it can be seen that the scientific and reasonable division of school districts has always been a hot topic in the field of education in China. It is of great practical significance to study

how the division of school districts reflects the principle of proximity to the maximum extent and how to determine the appropriate size of primary schools and the best service radius.

This paper will be the school district planning to reflect the principle of proximity, specifically divided into three basic requirements, namely: first, the school district to road network as a boundary, to block as a unit. Second, the spatial distance between the school district and the corresponding school is the closest or closer. Third, the number of students in the school district matches the student capacity of the corresponding school. The spatial location, spatial distribution, spatial morphology and spatial relations of the spatial elements such as roads, blocks, schools and school districts mentioned above are the research objects and advantages of GIS spatial analysis. Regional school layout planning, school district division and educational resource allocation based on GIS spatial analysis technology has become an important research direction.

2. Investigation and Evaluation of Primary School Layout

2.1 The Layout of Regional Primary Schools

Based on the investigation and analysis of primary schools in Ganjingzi district of Dalian city, this paper can basically map out the basic situation of the spatial layout of primary schools in urban and rural areas in China, so as to conduct relevant research. The layout of regional primary schools is determined according to the total population and layout of the region. The district has a registered population of 701923, among which the number of primary school students is 64,444. Ganjingzi district has jurisdiction over 15 streets and a total of 203 communities. According to the existing administrative zoning map, the paper analyzes the optimization of facilities in urban areas, primary schools and rural areas according to different practical conditions and the distribution needs of facilities. There are a total of 73 primary schools in Ganjingzi district. In view of the significant urban-rural differences in the layout of primary schools in Ganjingzi district, it is necessary to divide them into urban areas and rural areas for research. According to the density of population and the distribution of primary schools, urban areas and rural areas were divided. Among them, there are 48 urban primary schools and 25 rural primary schools, all of which are evenly distributed. Primary schools in urban areas are relatively concentrated, while primary schools in rural areas are dispersed. Among them, there are 47 urban primary schools and 26 rural primary schools.

2.2 National standards for primary school layout

The following national standards are used to measure the standard level of the distribution of primary schools in Ganjingzi district of Dalian and to judge whether the service scope of primary schools meets the requirements.

(1) Service radius of urban primary schools: The primary school service scope cannot be more than 500 meters, according to the actual situation, allowing appropriate adjustments (Code of urban Residential Areas Planning & Design, GB 50180—93(2002)).

(2) Rural primary school service radius: for rural compulsory education schools, there is no national standard, but through the comprehensive analysis of various provinces and local policies, it is generally recognized that the service radius of rural primary schools is 2000 meters (Code of urban Residential Areas Planning & Design, GB 50180—93(2002)).

A buffer is an area of a certain width around a geospatial object. This width is called the buffer distance. Buffer analysis is distance analysis based on topological relation of spatial objects. Buffer analysis is mainly based on point, line and surface. According to the requirements of primary school service radius, the suitable service range for urban primary schools is 500 meters, and that for rural primary schools is 2000 meters. The buffer zone analysis in ArcGIS was used to establish the buffer zone with the primary school as the center and the service radius of 500 meters and 2000 meters respectively, and the service scope map of urban and rural primary schools was obtained.

3. Primary school layout optimization based on road network

3.1 Data collection and analysis

Road is the most basic connection bridge between facility points and residential points. The collection of all kinds of roads into a basic network data set is conducive to the research on facility points and population distribution. Roads are interrelated and cannot be interrupted. Therefore, when building road network data set, all kinds of roads should be considered. Before setting up the data set, it is necessary to consider whether all intersections are opened to ensure that the road data is a fully connected intersecting network, so as to prepare for building the data set. Establish the database of school layout points, study the correlation between school layout points and residential areas, use remote sensing images to obtain school layout data and statistical data of Dalian education bureau, including school size and the number of students that can be contained, etc.

Part of the data in table 1 is selected for analysis. It can be seen that, with 1500m as the service radius, rural primary schools with a suitable scale generally go to school beyond the distance due to its wide coverage and sparse enrollment. Generally, urban primary schools take 500 meters as the service radius, but it can be seen from the data that even with 1500 meters as the service radius, there is a certain situation that primary school students go to school beyond the distance in urban areas.

Table.1. (part) network analysis conclusions based on road network

coding	School name	Admission capacity/person	1500m service radius corresponds to the number of students	(Network analysis 1500m ideal student source/enrollment capacity) *100%	Over the distance to school
1	A	343	93	27.11%	72.89%
2	B	1375	292	21.24%	78.76%
3	C	580	94	16.21%	83.79%
4	D	226	59	26.11%	73.89%
5	E	300	206	68.67%	31.33%
6	F	500	110	22.00%	78.00%
7	G	970	655	67.53%	32.47%
8	H	1600	1096	68.50%	31.50%
9	I	843	938	111.27%	0.00%
10	J	1050	1006	95.81%	4.19%

3.2 School District Optimization Based on Thiessen Polygons

This study optimizes the school district without adding new schools, mainly using the Thiessen polygon technology. Thiessen polygon also called Voronoi diagram, is based on the existing point to plane segmentation of the designated area, a central point will correspond to a polygon, can cover the whole surface will not appear again divided into overlapping area, each area one and only one center (here refers to the primary school), contains all the points are area, and area of any point to point distance (school) in the region is outside any point distance is smaller than the area, area border points to two points in the region is equal distance. Using voronoi diagram to divide the educational service area, the optimal service scope of each school can be divided from the perspective of the nearest space. According to the principle of "entrance" to the nearest primary school students should go to the nearest seat of registered permanent residence, on the other hand, is a primary school in service of all residential areas and only arrived at the school are from the nearest, and the whole city center within each district corresponds to a school, there is no service blind area and no one residential areas by delimit more school districts. In combination with the requirements of the school district optimization, the network space analysis and the establishment of Voronoi diagram can be well realized. Research shows that will be a complete administrative area is divided into the same as the number of schools and continuous cover several area, and need to meet each point to the corresponding school district distance closer than the distance to the other school request, i.e. draw best service scope of each school, it in computational geometry theory belongs to the typical Voronoi diagram of the problem, can use of neighborhood analysis technology Voronoi diagram to construct function to implement, as shown in figure 1.

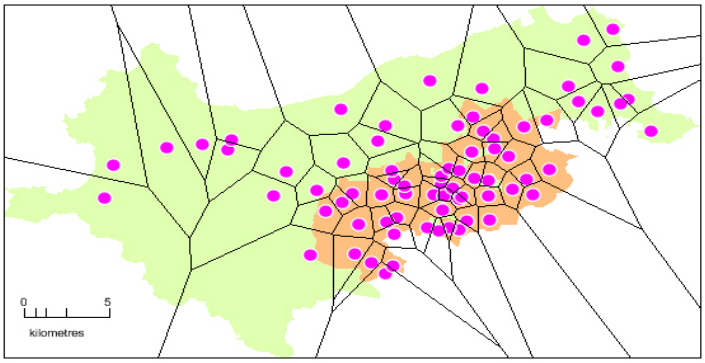

Figure 1. Division of Thiessen polygonal school district

4. Primary school layout optimization based on road network

On the premise of not adding more schools, this study optimizes the existing basic education resources to provide short-term solutions for the layout of primary schools. Therefore, for most school districts, optimizing the spatial layout through tyson polygon can make the service scope of the school district more appropriate and improve the situation that the students in the school district go to school beyond the distance. Through the optimization of the new school district division program. According to the optimization plan, the rural school district is relatively stable. This is because the setting of rural primary schools is generally based on natural villages. The differentiation between rural primary schools and other rural primary schools is obvious, so it is relatively stable. And urban school districts adjustment space is large, this is because the city primary school to the street or village as the district division, reflected in the school district layout, has certain irrationality, in addition, the city students, despite intensive primary layout, but embrace resources possession is uneven, this shows that under the condition of existing resources, the actual needs of the students go to school with the contradiction between the limited resources still exist, it is through long-term planning is needed to be fundamentally solved. As shown in table 2:

Table.2. (part) Thiessen polygonal school district data

coding	School name	Admission capacity/person	Services to students	Ideal student source/(enrollment capacity)*100%	School district (yes/no) changes
1	Qianmu primary school (agriculture)	505	668	132.28%	No
2	Lancheng primary school (agriculture)	703	563	80.09%	No
3	Bosi primary school (agriculture)	481	439	91.27%	No
4	Aolin primary school (agriculture)	1590	1916	120.50%	yes
5	Attached primary school of no.14 middle school (agriculture)	580	628	108.28%	yes
6	Yingchengzi town central primary school (agriculture)	1014	1343	132.45%	yes
7	Nanguanlin primary school	2132	1700	79.74%	yes
8	Xinhua department of 80 middle school affiliated primary school	1404	1041	74.15%	yes
9	New Ganjingzi primary school	1217	1643	135.10%	yes
10	Furong primary school	868	405	46.66%	yes

5. Conclusion

Based on the service radius of 500 meters in the city and 2000 meters in the countryside, this study determined the elastic space rate of 20% in the city and 25% in the countryside. Through above analysis, we can judge to 500 m as the city primary configuration space standard is reasonable, according to the urban population density and the density of the spatial distribution of primary school, combining urban elastic space rate calculation, to reach 100 meters elastic space, that is to say, the city primary school service scope in the range of 400-600 - m is feasible, when less than 400 meters, to consider the school distribution is too close and waste of resources, and targeted to solve; Over 600 meters, consider district optimization or modest school expansion. In order to realize the scientificity and sustainability of the planning, it is necessary to make a long-term investigation of the population development and change trend in the research area, timely monitor the change of its development situation, timely adjust and improve the planning, and realize the relative balance and effectiveness of social resources. The analysis of this study is based on the real-time data of the education bureau of Ganjingzi district for the 2016-2017 school year. There is no statistical analysis on the number of school sources five years ago, and the evolution trend five years later cannot be predicted. Therefore, there are certain limitations on the guiding significance of school district planning.

Acknowledgements

This work was supported by 2018 national social science fund project: research on resources allocation of compulsory education based on school-age population flow trend prediction (Grants No.18BRK037), as well as general topic of the "13th five-year" education science planning of Liaoning province in 2018: research on the allocation of compulsory education resources based on the prediction of school-age population mobility trend in our province" (Grants No.JG18CB390).

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