Study on the Scope of Primary School Service Area in the Old City of Ankang Based on Gis Spatial Analysis

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Abstract. The division of school district has long been an important judgment basis for the rationality of basic education facilities and services, and also the focus of education management. This paper takes primary schools in the old city of Ankang as the research object, Using Argis (Geographic Information System), Based on data such as urban road networks, residential areas, primary schools, land use and demographics, combined with Thison polygon, service coverage, accessibility analysis, population geospatialization and overlay analysis, and according to the school district division published on the official website of the Bureau of Education, the old city of Ankang primary school district is divided. The spatial distribution of primary schools in the old urban area of Ankang City is not balanced, and the coverage of school districts is strongly correlated with the distribution of population. The district area of the central area is small, while the distribution of primary schools in the edge area is small and the district area is large.

Keywords: Geographic information system · Service area analysis · Division of school district

1 Introduction

In the "Compulsory Education Law of the People's Republic of China" passed on April 12, 1986 and the "Implementation Rules of Compulsory Education Law of the People's Republic of China" promulgated on March 14, 1992 [1]. it is clear that the school-age children and adolescents in the nine-year compulsory education stage "go to the nearby school" principle [2]. However, in the process of urbanization development, there are insufficient and unbalanced situations. Based on the differences in education quality and teaching resources, and in accordance with the principle of nearby enrollment, some key primary schools bear more than the limit number of students, and primary schools in remote areas are undernumbered. Therefore, the rationality and scientific nature of the division of school district has been widely concerned by parents and society, and has

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become a hot issue in basic education management and urban regional planning in our country.

In the early 80's of Founding a nation, our country GIS (Geographic Information System) education began prologue, and [3] applied to geography teaching research [4]. With the development and progress of GIS technology, domestic and foreign scholars have used GIS technology and spatial analysis methods to study the division of primary school districts, [5] the layout planning of educational facilities, [6] the allocation of educational resources, [7] accessibility and equity [8]. For example, Hanley et al. investigated primary schools in Iowa, used GIS technology to analyze the relationship between transportation costs and the scope of school district division, and calculated the impact of school district merger on transportation costs [9]. Eddie Parsons and Allan Jones used GIS spatial analysis technology to study the location and zoning boundaries of schools, and used case analysis to conduct in-depth research on the source of students and students' school choice, providing a new idea for the reasonable division of school districts [10]. However, in the research process, the transportation distance cost and accessibility time of students were not taken into account. In 2013, the Third Plenary Session of the 18th Central Committee of the Communist Party of China issued the Decision of the Central Committee of the Communist Party of China on Some Major Issues on Comprehensively Deepening the Reform, which clearly put forward the "trial school district system", indicating that the construction of school districts in China has been in full swing. In 2014, the initiative to strictly follow the "nearest enrolment" of school districts was fully launched. There are few reports on domestic scholars applying GIS to school district division and spatial-temporal accessibility [11]. Commonly used accessibility calculation methods include nearest distance method, autocorrelation analysis, gravity model, [12] two-step mobile search method, etc. [13]. Shuyao Li and Jing Xin analyzed the geographical location accessibility of primary schools based on the nearest distance method and the two-step mobile search method to provide technical reference for the allocation of educational resources in school districts [14]. Ziyi Zhou used GIS technology to analyze the influence of different spatial levels formed by the division of control units and school districts on the supply and demand situation and accessibility level of primary schools, and then explained the influence of the division of school districts on the actual service ability of primary schools [15]. Yunfeng Kong and Jianping Lv adopted GIS technology to optimize the spatial layout of urban primary schools and optimize the spatial accessibility and service radius of primary schools. Therefore, the service scope of urban primary schools not only reflects the rationality and fairness of education resource allocation, but also indirectly reflects the level of school district education development, providing a theoretical basis for urban basic education resource planning.

In order to analyze the reasonableness of the division of school district in the old district of Ankang City, this paper selects the old district primary school of Ankang City as the research object. Firstly, based on the distribution of each primary school, the Tyson polygon space analysis method in Argis is used to determine the coverage area of each primary school. Secondly, based on the service area analysis method of GIS network analysis, the coverage of each primary school considering the road network was analyzed, and then combined with the seventh census data, the population of the

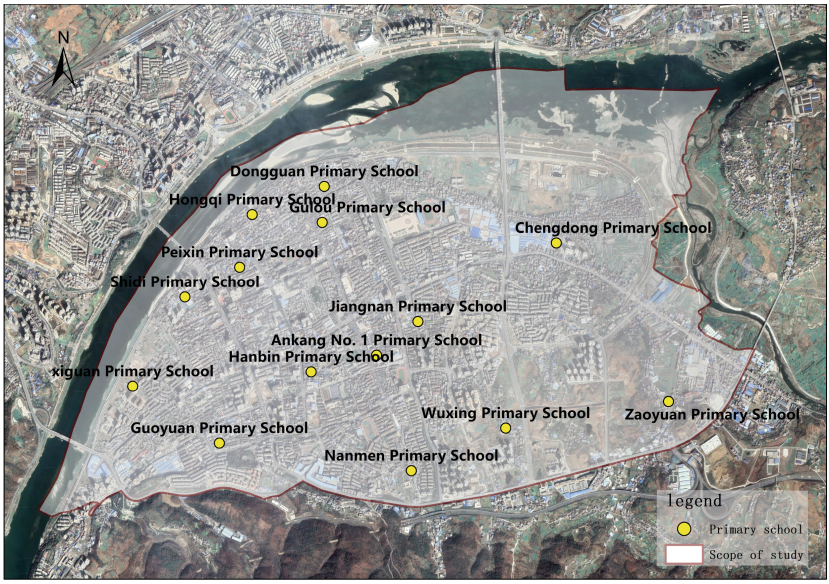

Fig. 1. Distribution map of primary schools in the old city of Ankang

old city was spatialized. Finally, based on the division of primary school districts and the distribution of road network and construction land published on the official website of the Education Bureau, the scope of primary school service area in the old urban area of Ankang City is obtained by using the superposition analysis method, which provides optimization ideas for the reasonable division of school districts.

2 Study Area and Data

2.1 Profile of the Study Area

This paper selects the old urban area of Ankang City as the research area, with a total area of about 150,000 square meters and a population of about 240,000. There are 2 sub-district offices and 33 communities (villages) under its jurisdiction, including: West Street Community and Peixin Street Community, Xing'an Road Community, Dabei Street Community, Wuxing Street Community, Dongguan Community, Gulou Community, etc. By 2022, there are 14 primary schools in the old urban area, and the distribution of primary schools is shown in Fig. 1.

2.2 Data Source

The basic traffic network vector data, primary school POI data, residential POI data, land use data and other data of the old city of Ankang are derived from network acquisition and related planning. The data on the size and structure of students in 14 primary schools came from the statistical report of Ankang Education Bureau in 2020. The population data of every street and community in the city in 2020 are from the main data bulletin of the 7th National Population Census of Ankang Bureau of Statistics.

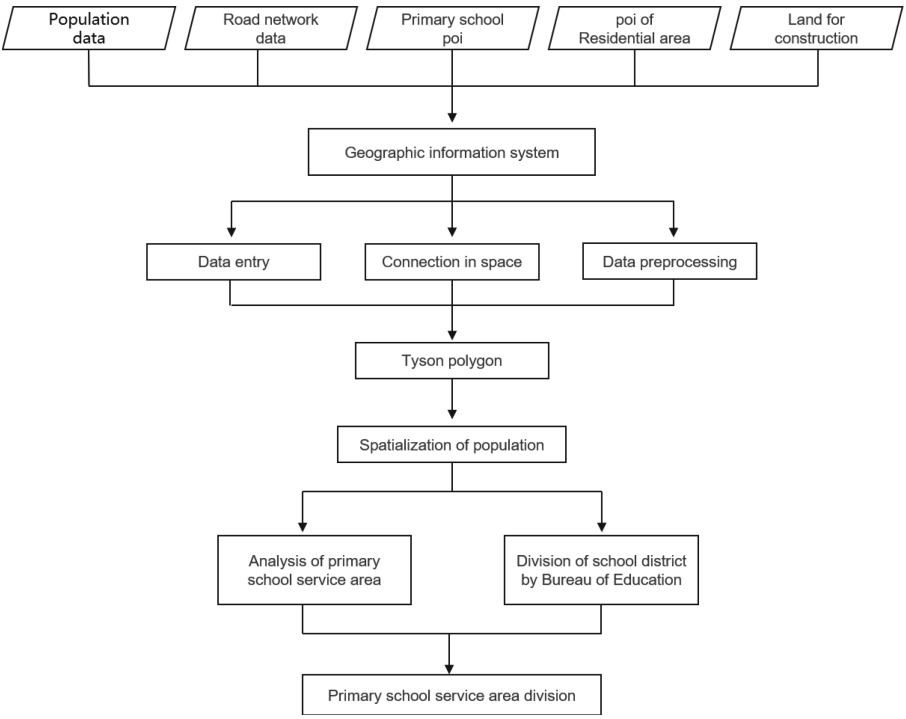

Fig. 2. Technical route

3 Technical Route and Research Method

3.1 Technical Route

Based on the principle of "uniform distribution", [16] the technical route takes primary schools in the old urban area of Ankang City as the research object, analyzes the service scope of primary schools. The technical route is shown in Fig. 2.

3.2 Research Methods

Tyson polygon [17] first proposed by Dutch meteorologist A-H Thiessen, is A method to calculate average rainfall based on discrete distribution of rainfall at weather stations. Later, it was extended to many other fields and became a common analytical tool for measuring surface data with the help of point data. Schools are distributed in dense areas, the area of Tyson polygon is small; In areas with sparse distribution of schools, the actual service area undertaken by a school is large, and the area of Tyson polygon is large. Therefore, the size of the primary service range within the polygon area can be inferred by the size of the Tyson polygon area (Fig. 3).

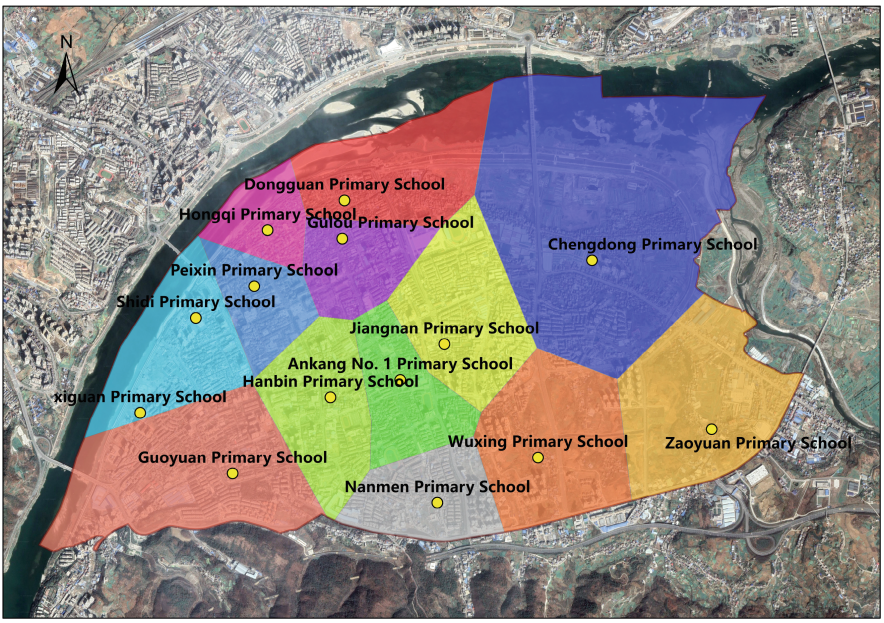

Fig. 3. Schematic diagram of Tyson polygon in primary school

Spatialization of population. With POI density, night light brightness, land use type proportion, road network density and other variables as independent variables, and population density as dependent variable, a random forest model was constructed to simulate the spatial distribution of 300*300m grid population in the old urban area of Ankang City. Then, Formula (1) is used to decompose the total population of the old city into each grid by taking the estimated value obtained from the random forest as the weight.

$$POP_i = POP_t \times W_i / W_t \tag{1}$$

where: POPi is the population of grid i; Wi is the weight of population distribution in this grid. Wt is the sum of weight of population distribution of all grids in the region where the grid is located. POPt is the total population of the towns in which the grid is located (Fig. 4).

4 Results and Analysis

4.1 Primary School Service Area Analysis

With the help of GIS service area network analysis tool, the time cost was set as 10 min, 20 min and 30 min respectively for analysis, and the service area scope of 14 primary schools in the old urban area of Ankang City was further analyzed, as shown in Fig. 5. As can be seen from the Fig. 5, the actual service area of primary schools based on network analysis is an irregular polygon. On the whole, the service area of primary schools in the old urban area of Ankang is unbalanced. The central area absorbs most of the students,

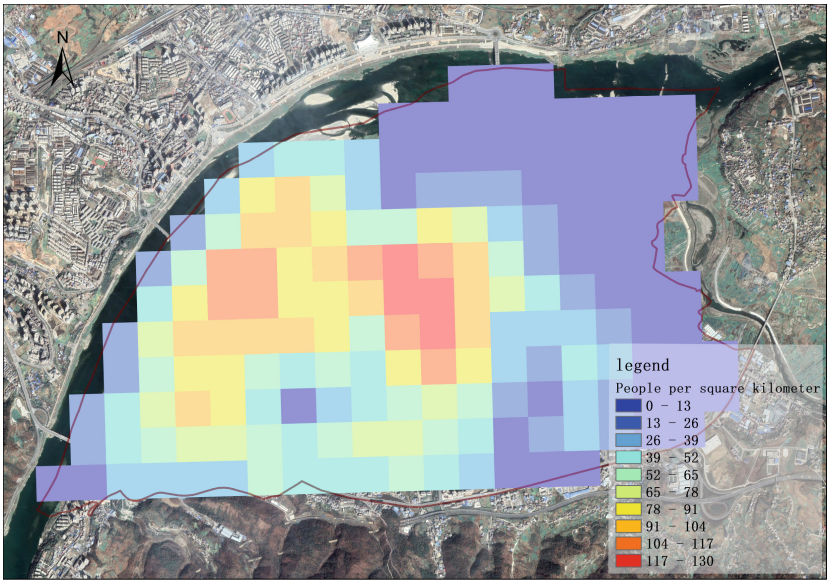

Fig. 4. Spatial distribution of population in the old city of Ankang City

and the degree carrying capacity is overloaded. Will have an impact on primary school pupils.

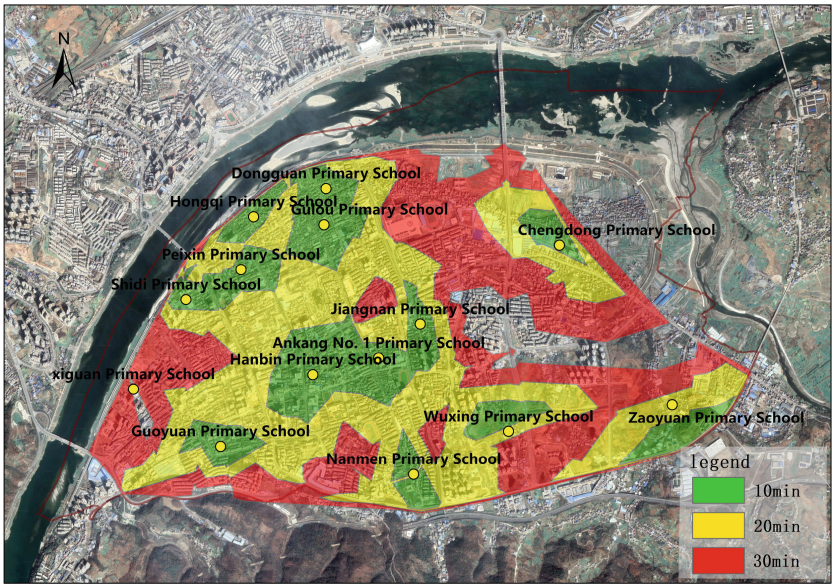

Fig. 5. Scope of primary school services based on time cost

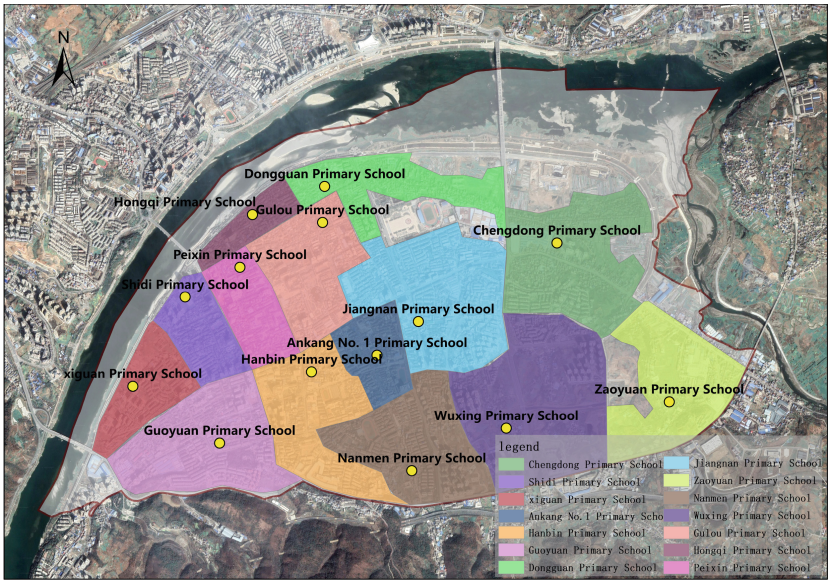

Fig. 6. Ankang City old town primary school district service scope

4.2 The Division of School District Under the Analysis of Service Area

The above analysis results were superimposed and combined with the distribution of primary school districts and construction land published by the Education Bureau. Combined with manual interpretation, the property of residential land belongs to the primary school is adjusted. The adjustment principle is: considering the obstruction caused by the main roads in the city, the residential district is classified into the primary school according to the population distribution. Finally, the service scope of Ankang Old Town Primary School District is obtained, as shown in Fig. 6.

5 Conclusion

In view of the unreasonable division of primary school districts, which is widely concerned by the society at present, this paper uses GIS spatial analysis methods, including Tyson polygon, service area analysis, service coverage, accessibility analysis, population geospatial and overlay analysis to optimize the division of primary school districts published by the Bureau of Education, and draws the following conclusions: The division of primary school districts in the old urban area of Ankang City has a high consistency with population distribution. The central area of the old urban area has a large population density and a small range of school districts. Taking it as the core, the service range of the school district is gradually enlarged. The number of students accommodated by the division of each primary school district is more balanced, which has a certain optimization effect, and can provide research ideas for the division of primary school districts in other similar areas.

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