Division of Township Grade System and Scope of Influence: A Case Study of Dafang County

Xiaozhu CHEN *

School of Information, Guizhou University of Finance & Economics, Guiyang 550002, China

Abstract At the township level, combining Voronoi diagram and breaking point theory, this paper divides township grade system and its scope of influence in Dafang County of Guizhou Province, and discusses the grade system from small scale perspective. Results show that Dafang County takes Dafang Town as the center, Dashi Town in the north and Shachang Township in the east as auxiliary part, Sanyuan Township, Zhuyuan Township, Babao Township, Pudi Township, Lihua Township, and Dingxin Township as cooperative part, to drive development of 36 townships in Dafang County. Thus, it basically reflects township grade of Dafang County, accords with current development situation, provides certain reference value for system planning and economic zoning of small scale regions, and it is able to improve the accuracy of scope division by completing attribute data and revision of many methods.

Key words Township grade system, Scope of influence, Voronoi diagram, Dafang County

1 Introduction

Urbanization can invigorate rural market, propel domestic demand, spur economic growth, break urban and rural dual socio-economic structure, narrow urban and rural divide, and promote coordinated development of urbanization and industrialization, thus, it is inexorable trend of China's socio-economic development[1]. Correct division of urban grade system and its scope of influence will be favorable for distribution of capital, labor and land resources in the drive of urbanization, and can provide scientific reference for national or regional economic strategic plan[2]. Voronoi diagram, as a method for determining scope of space influence of economic object, is widely applied in recent years for dividing urban grade and its influence scope, and provides new working foundation and technical support for researches on regional influence scope. However, most scholars focus on analysis above city level[3-5], and lack analysis of urban level. The grade system at township level is closer to facts. Especially for western special geographic environment and social conditions, it is more helpful for researches on current situations and trend. This study takes researches on existing urban grade system and space influence as the support, bases on Voronoi diagram technology, combines breaking point theory in urban geography, analyzes influence scope of townships in Dadang County, makes division and determines corresponding grade system, and discusses methods and technologies for researches on small scale grade system.

2 Data and methods

2.1 Data source This study adopts administrative map of Dafang County provided by Guizhou University as base map, and the population data are selected from *Statistical Yearbook of Dafang County* in 2009.

2.2 Research methods

2.2.1 Voronoi diagram (as shown in Fig. 1)[6], also called Dirichlet tessellation, is a practical method for dividing influence of point-type economic object. It is widely applied in qualitative analysis, statistical analysis and proximity analysis of meteorological, geological, surveying and mapping, archaeological and computer science fields. Voronoi diagram has two definitions: (1) Euclidean distance between arbitrary point p and q is dist (p, q) in the context of a plane.

$$dist(p,q) = \sqrt{(p_x - q_x)^2 + (p_y - q_y)^2} \quad (1)$$

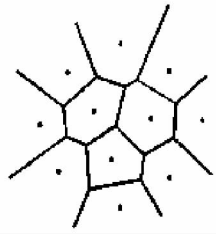

Fig. 1 Ordinary Voronoi diagram

(2) Suppose $p = \{p_1, p_2, p_3, \cdots, p_n\}$ is n different points on the plane. Any 2 points are not in common position, any 4 points are not in the same circle, and Voronoi diagram of any point pi is defined as:

$$T^i = \{x : dist(x,p^i) < dist(x,p^j) \mid p^i, p^j \in P, p^i \neq p^j\} \quad (2)$$

Based on the essential feature that the value of any unknown point in the space of Voronoi diagram plane can be replaced by the known point (sampling point) closest to it[7], combining the principle of people's preference for closest distance, shortest time or minimum cost when choosing final space in behavioral geography, we assume central point of towns as center of social economic object, and the generated Voronoi convex polygon is deemed as

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* Corresponding author. E-mail: chwbwx@163.com

scope of space influence of the corresponding township.

2.2.2 Breaking point theory. The breaking point theory is one of the most important theories in urban geography, and has been widely applied in determining urban attraction scope and dividing urban economic zones. This theory defines the point at which the attraction of two adjacent cities reaches the balance as breaking point, and gives the calculation formula[8]:

$$d_A = D_{AB}/(1 + \sqrt{P_B/P_A}) \quad (3)$$

$$d_B = D_{AB}/(1 + \sqrt{P_A/P_B}) \quad (4)$$

where d_A and d_B are respectively the distance from breaking point to city A and city B, DAB is the straight line distance between two cities, and P_A and P_B are population of city A and city B separately. Theories have shown that the influence of a town upon surrounding areas is directly proportional to the scale of the town[9], while the scale of the town is generally based on population size. Based on this, through defining townships with population larger or equal to Voronoi polygon adjacent regions as local central point, according to analogy of step upward analysis, Voronoi diagram in the local center of (k - 1)th level is adopted to define the local center of the k - th level[10], then to divide township grade system of Dafang County and determine scope of influence of townships.

3 Division of township grade system and determination of its scope of influence

With the aid of ARCGIS 9.3 software platform, administrative map of Dafang County is used as base map. 36 towns and townships in Dafang County are the lowest level local central point in Voronoi processing. Finally, primary Voronoi diagram of Dafang County is obtained (as shown in Fig. 2). The derived diagram shows scope of space influence of towns. With reference to population size of townships in Dafang County, it is able to compare population of adjacent towns among 36 towns. For towns with larger population, according to the breaking point theory, the influence power upon surrounding areas is greater. Take it as the central point of higher level, *i. e.* the growth core of new level. From this, select 9 second level local central townships, including Dafang Town, Changshi Town, Shachang Township, Sanyuan Township, Zhuyuan Township, Babao Township, Pudi Township, Lihua Township, and Dingxin Township. On the basis of this, Voronoi processing is carried out, and secondary Voronoi diagram of townships in Dafang County is obtained (as shown in Fig. 3). Through comparing population size of 9 townships, Dafang Town, Changshi Town and Shachang Township are determined as third-level local center. On the basis of this, Voronoi processing and calculation comparison are conducted, and it is determined that Dafang Town is the highest level central township of Dafang County.

According to 4 grades, the map of space grade system of towns in Dafang County is plotted (as shown in Fig. 4). From Fig. 4, it can be known that space grade and influence scope of towns in Dafang County centers on Dafang Town, takes Dashi Town in the north and Shachang Township in the east as auxiliary part, Sanyuan Township, Zhuyuan Township, Babao Township,

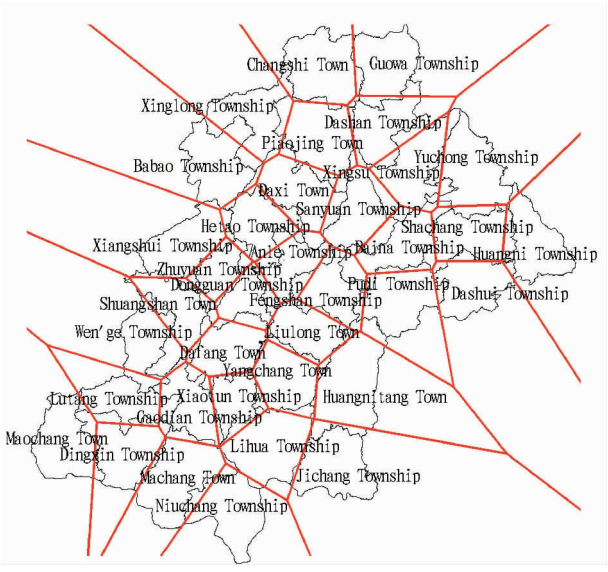

Fig. 2 Primary Voronoi diagram of towns in Dafang County

Pudi Township, Lihua Township, and Dingxin Township as cooperative part, to drive development of 36 townships in Dafang County. Analysis results basically reflect space grade system of distribution of towns in Dafang County and conform to overall planning of land use of Dafang County. Thus, it is feasible to preliminarily divide township grade system and determine its scope of influence based on Voronoi diagram and combining the breaking point theory.

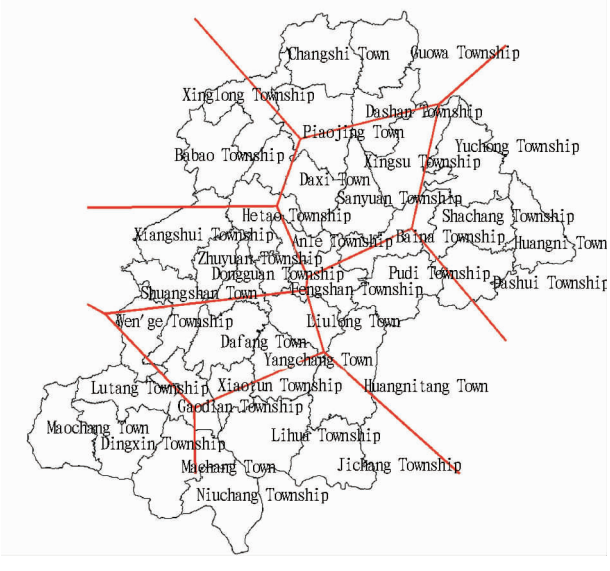

Fig. 3 Secondary Voronoi diagram of towns in Dafang County

4 Conclusions

From the perspective of small scale, it is feasible to preliminarily divide township grade system and determine its scope of influence based on Voronoi diagram and combining the breaking point theory. Results indicate that Dafang County takes Dafang Town as the center, Dashi Town in the north and Shachang Township in the east as auxiliary part, Sanyuan Township, Zhuyuan Township,

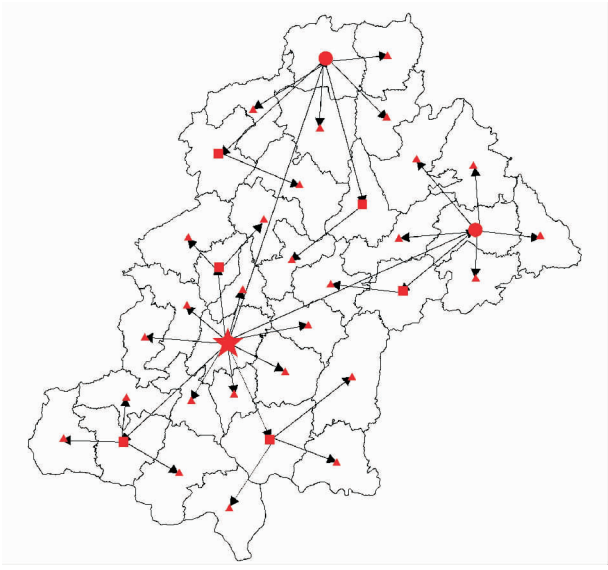

Fig. 4 Township grade system of Dafang County

Babao Township, Pudi Township, Lihua Township, and Dingxin Township as cooperative part, to drive development of 36 townships in Dafang County. Thus, it basically reflects township grade of Dafang County, accords with current development situation, provides certain reference value for system planning and economic zoning of small scale regions, and it is able to improve the accuracy of scope division by completing attribute data and revision of many methods. China is vast in territory and varied in topography. Scope of influence of towns is not only limited by natural conditions, but also related to social environment. Improving space data and comprehensively considering influence factors, and making further revision by field intensity analysis method and shortest distance method are helpful for improving science and accuracy of division of township grade system and determination of scope of influence.

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