

THE METHOD BASE OF GEOGRAPHIC ANALYSIS AND ITS APPLICATION

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ABSTRACT: The geographical analysis method base is a software system in common use which designed by the software technology. It includes the general analysis method on optimization problems and on mathematical programming by both geographers and planners. This paper describes the method base and its applications. Supported by the regional information system, analysis are carried out concerning the land efficiency system, the relevance between human being and land, the effect of Beijing and Tianjin to region or the center city expansion analysis, the population forecast of Beijing, the reasonable analysis of each city industry structure, and the retio degrees of regional industry distribution. The analysis results provide reliable bases for the regional development, the regional land value confirmation and the acknowledge of environment changes caused by the human action and the changes of natural items.

KEY WORDS: Method Base, Geographical, Application

I. INTRODUCTION

The modern geographical analysis technology is now developing swiftly especially in the recent twenty years. Geographical Informtion System(GIS) has focused on the resarch of geographical environmental system and social system and turned them into computer simulation system, The geographical analysis has developed from the qualitative description into the modern science combined by quantitative analysis and qualitative analysis. While some new technologies, such as simulation system and dynamic supervision were also explored.

The geographical analysis method base utilizes the modern computer software techniques. It processes all kinds of these methods, through computer software design, proper

treatment, debugging and execution, into standard and common software system that realizes the information between computer and the user. The software provides reliable technique methods for the comprehensive geographical environment analysis. The software also ensures the computer application at geographic research and regional development.

According to the data sequence, geographic analysis can be divided into two catalogues, distance space and time space. Space and time are the intrinsic existing form of the objective and moving substance. Space is independent of human being's mind and exists objectively. The time-space data analysis supports the dynamic analysis of geographic environment factors, as well as the changing rules of geographic environment variables (GEV) with the time. All these can be calculated and planned. The distance space data supports the analysis of GEV spatial distribution rules, spatial relevance and difference. It helps to carry out the special construction and character analysis on the space system of geographic environment factors. It will serve the searching work of regional space rules and the rational distribution of space.

The geographic analysis basis (GAB) is based upon the MASRA 1.0 edition of the Micro-computer Assisted System of Region Analysis, MASRA. The GAB, geographic analysis software system (MASRA), is especially supported by the computer hardware of PC-AT or PS-2. The system keeps the original function of computer assistant drawing while develop the analysis mode base of geographical space analysis and dynamic data.

II. SOFTWARE SYSTEM STRUCTURE

The software base combined the technique of geographical space analysis with computer assistant drawing. This fundamental geographic research base of multi-user interfaces requires no special target and no particular data pattern. Its software base is designed according to the ordinary steps of space data analysis, including the pre-treatment of data, the analysis of statistical character value, the relevance analysis, regression analysis, lamination analysis, model analysis, as the choice of classification, windows expansion, and conditional control extraction.

The software pieces bricks together. Most analytic bricks and procedure bricks are written in the computer language of FORTRAN -77. The parameter transmission among analytic bricks at the forms of public bricks and partial parameters. Most screen promotions for user dialogues are designed at the first level bricks. It will be convenient for the user to revision and transplant. The upper-level bricks form a tree structure with the lower bricks. The larger middle processing structure is transferred by the form of temporary file to save the memory space and favour the operation in the micro-computer environment.

The first-level software brick is divided into two parts, statistical data bricks and diagram data bricks according to the difference of data sources. (Fig. 1 and 2)

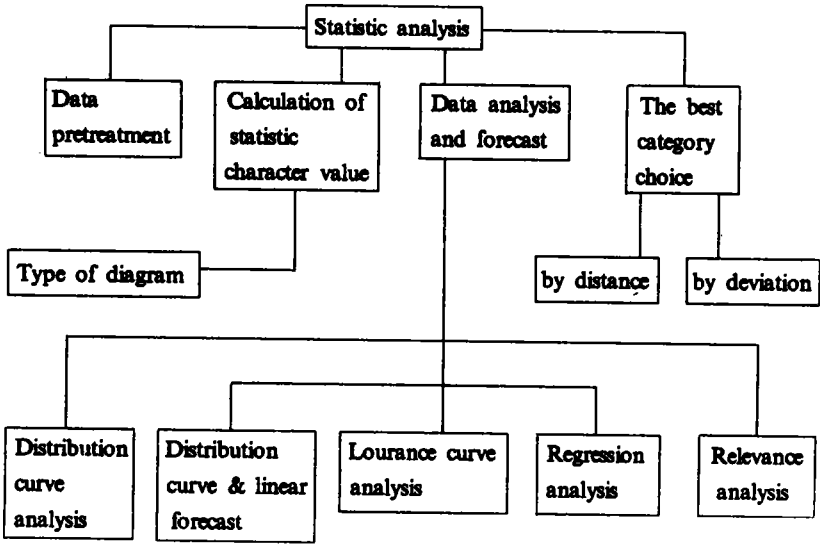


Fig.1 The software structure for statistical analysis brick

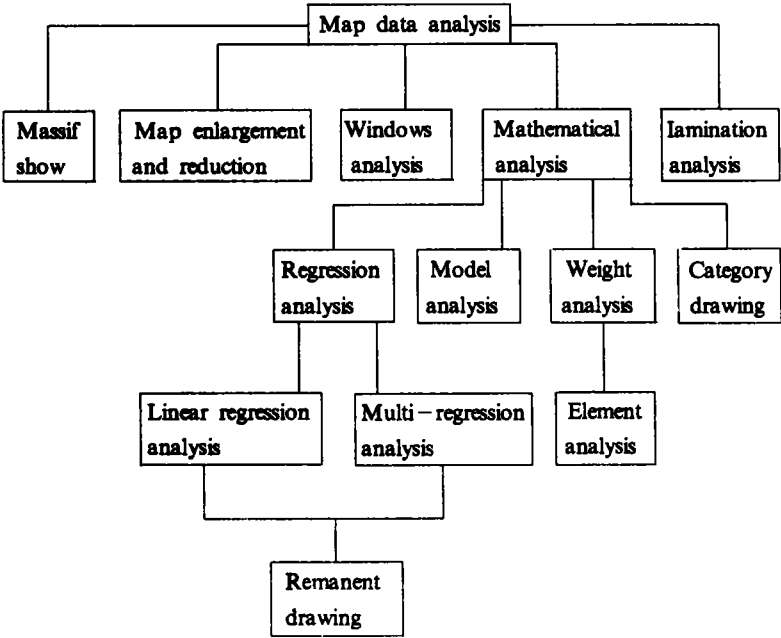


Fig.2 The software structure for mapping analysis brick

Some middle—results and the final result are processed by the form of files during the data processing because the data are too large for the limited micro—computer memory.

The software process takes changeable data recording during the direct communication between the user and the software design because different users may take different data recording layout. Thus, all kinds of user data files can be received by the system

The user order system presents triple—level . Each level combines data form list with dialogue order because it can provide better interface for different users. The bricks are designed in the form of block assembly which provides of tools for the further exploration and application of the users.

III. APPLICATION RESEARCH

This application research, based upon the regional information system of Jing—Jin—Tang (Beijing, Tianjin, Tangshan), is carried out upon the original research work. The region is one of the main developed areas of industry and agriculture. The region includes Beijing, center of Chinese politics, culture and education; Tianjin, economic and trade center of North China; Qin Huangdao, the biggest coal export harbor of China and the summer political center; Tangshan, main energy and raw material source for Beijing and Tianjin; and Langfang, the newly developed grocery and food processing basis. The total area is 5,5000 km^{2[1]}. Supported by the regional information system, analyses are carried out concerning the land efficiency system, the relevance between human being and land , the effect of Beijing and Tianjin on region or the center city expansion analysis, the population forecast of Beijing, the reasonable analysis of each city industry structure, and the rational degrees of regional industry distribution. The analysis results provide reliable bases for the regional development, the regional land value confirmation and the acknowledge of environment changes caused by the human action and the changes of natural items.

1. Regional Center Gravitational Field Analysis

Affected by Beijing and Tianjin, the area of Jing—Jin—Tang possesses two centers. The first one is Beijing, center of politics, economy, culture and technology. The second one is Tianjin, center of economy and trade. The massifs(geographical unit 1' × 1') within this area are attracted by both centers. This phenomenon seldom happens both in China and other countries. On the basis character, simulated analysis of regional center gravitational field is carried out by model analysis. The analytic model of gravitational field is composed by the attainment between the center and each point within the massif. The double—center gravitational strength to each point is the product of each gravitational strength. The model

follows:

$$Mi = Bi \cdot Ti$$

Where Mi is the regional center gravitation intensity of point i . Bi is the gravitation(attainment) of point i by Beijing. Ti is the gravitation of point i by Tanjin. The modulation analysis result is categorized and drawn after computer simulation analysis. The analysis results are shown in Table 1.

Table 1 The classification system

Classification Number	Value	Ratio
1	6.00— 18.67	17.63
2	18.68— 31.33	18.75
3	31.34— 44.00	13.718
4	44.01— 56.67	10.295
5	56.68— 69.33	4.084
6	69.34— 82.00	10.134
7	82.01— 94.67	5.6578
8	94.68—107.33	2.929
9	107.34—120.00	4.4
10	120.01—132.67	3.212
11	132.68—145.33	1.665
12	145.34—158.00	1.132
13	158.01—170.67	1.311
14	170.68—183.33	0.835
15	183.34—196.00	4.212

In the Table 1, 2, 3, ..., 15 are the intensity categories of the gravitation field. The field one is the highest intensity by the double-center gravitation field, and so on and so forth, The 15th is the weakest intensity area by the double-center gravitation field. The double-center gravitation field looks like a dumbbell. One end is Beijing, the other end is Tianjin. The middle is area along the Beijing-Tianjin railway and highway. Affected by the

Beijing—Shanhaiguan and Beijing—Qinhuangdou railway, a high gravitation belt is formed from the double—center to Tangshan and a sub—gravitation field is formed. Tangshan is the third center following Beijing and Tianjin. Limited by the mountain conditions, the gravitation intensity of Northwest Beijing decreases progressively from the plain to mountain area. The city economy affects the mountain area weakly. The focus of economy is agriculture and forestry.

2. Land Efficiency Analysis

The land utilization is the concrete demonstration of people’s exploration and utilization of land. Effected by natural conditions (such as terrain, land, geology, climate, precipitation), the regional land is exploited and used differently. Effected by human being’s action and renovation, the ratio of land input and output is different. So the land use efficiency has changed. For Jing—Jin—Tang, a medium—sized area, the main natural factor that effects the land utilization is terrain, that is concluded from the analysis of the regional natural conditions^[2]. For example, the distribution of land has close relation with terrain condition. Swamp, meadow and saline soil are always located at the sea coastal depression less than 5 meters high. The brown soil is always distributed among mountains and alluvial fan at the front of the mountains. The terrain is chosen to be the factor in the land efficiency analysis. The population density (when the density unit can demonstrate the environment changes of country and city) shows the progressively transition from the city cone to the periphery of the city and countryside. The economy efficiency of per unit land is usually in direct ratio to population desity at the city cone and periphery, as well as the countryside residence area. The population density decreases progressively from the city cone to its periphery, the outer suburbs. The efficiency of land per unit area also possesses this rule. The population density is chosen as the main factor. The land utilization is one of the demonstration of land efficiency, such as city, town, industrial and mining land, country side residence area, farm land, garden plot, grass land and the uncultivated land. All these kinds of lands show the difference of land utilization efficiency. During the land efficiency analysis of Jing Jin—Tang area, three basic factors are located, the land utilization condition, population density and terrain. Systematic analysis is carried out by the way of model analysis. These three basic factors affect the land efficiency at the same level. Since each one represents one aspect, the common weight coefficient is used. Its analytic model is:

$$Y_i=a_1x_1+a_2x_2+a_3x_3$$

where Y_i is the land efficiency target of the i th unit (standard geographic net unit $1' \cdot 1'$). $i = 1, 2, 3 \cdots i \cdots n$; X_i is the land utilization condition of the i th unit. X_{i2} is the population density category value of the i th unit. X_{i3} is the ratio of the terrain condion at

the i th unit. A_1, a_2, a_3 is the weight coefficient, For results, please see Table 2. Calculate the efficient target value of each massif (analytic unit), and divide it into five categories by arithmetic ratio. The category limit is:

First Category	3.0–8.2
Second Category	8.21–13.40
Third Category	13.41–18.60
Fourth Category	18.16–23.80
Fifth Chtegory	23.81–29.00

Table 2 The land evaluation table

Population		City Land	Countryside Residence Land	Farm Land	Garden Plot	Forest	Grass Land	Uncultivated Land
		1	2	3	4	5	6	7
> 20000	1	3	5	7	9	11	13	15
10001–20000	2	4	6	8	10	12	14	16
5001–10000	3	5	7	9	11	13	15	17
2501–5000	4	6	8	10	12	14	16	18
2001–2500	5	7	9	11	13	15	17	19
1751–2000	6	8	10	12	14	16	18	20
1501–1750	7	9	11	13	15	17	19	21
1251–1500	8	10	12	14	16	18	20	22
1001–1250	9	11	13	15	17	19	21	23
801–1000	10	12	14	16	18	20	22	24
601–800	11	13	15	17	19	21	23	25
401–600	12	14	16	18	20	22	24	26
201–400	13	15	17	19	21	23	25	27
1–200	14	16	18	20	22	24	26	28
0	15	17	19	21	23	25	27	29
Elevation		1	2	3	4	5	6	7
		10–60m	5–10m	60–100m	< 5m	100–200m	200–500m	> 500m

The system exports results by different colors and marks automatically and types out the classification category according to the statiscs. As it is shown in the table, the first catalogue takes 1.149% of the total regional area, and has the highest efficiency within this region. There are mainlycities and towns. The second one totals 3.796%, and is situated in the periphery of the cities and large countryside markets. Such kind of area can achieve rela-

tively high land efficiency. The third one occupies 40.09% of the total regional land, there are mainly the countryside residence area and farm land with an elevation from 5 m to 100 m. Such kind of plain, key basis of goods and grocery within this area, holds medium-level land efficiency. The fourth category holds 27.40%, which is the main garden plot of this region with worse terrain, sparse population, and low land efficiency. The fifth one, forest, meadow and uncultivated land, occupies 27.217%. These mountains and seacoast depression are seldom resided and get the lowest land efficiency.

3.The Relevance Analysis of Geographical Factors

During the comprehensive multi-factor analysis, we must confirm whether there do exist relevance among the factors or not. If not we should switch the angle to the geographical experience and find the relevance among them. If there do exist some relevance, we should highlight the classification, distribution rules and characteristics. For example, during the relevance analysis of terrain belt and population density, a list of terrain belt should be arranged from the most convenient place for human being's residence to the most worse area. At Jing-Jin-Tang area, the depression below 5 m is densely populated, especially at Tianjin city and its periphery area. This is one of the exceptions, because Tianjin develops swiftly and the modern science and technology makes it possible for people to lead an easy life at such depression area. This kind of peculiarity is the key for relevance analysis.

The above is the land efficiency analysis. To study the relevance of these three analytic factors, population, land utilization condition, and terrain, we apply the system to carry out the relevance analysis. Its regression equation is as follows:

$$Y=0.622+0.15X+0.334X$$

Y is the land utilization condition. X is the population density. X is the terrain. The coefficient $R=0.60111$. The value of R is smaller because the peculiarity of Tianjin and its periphery has not been discounted. This can fully prove that three factors are related. Based upon the regression equation and tendency analysis, there comes:

$$Y_{iRes}=Y_i-y_i'$$

Y_{iRes} , the surplus, is the difference of expectation value (Y_i) and the actual value (Y_i'). When the absolute value of Y_{iRes} surpasses the ordinary value, the unit (the i th terrain) takes out peculiarity effected by some natural factors or human being's factors. It provides a reliable technique for the analysis of regional development peculiarity and the nature condition's specialty.

IV. CONCLUSION

The expansion and application of geographical method base prove the computer technology forwards at the geographical analysis and application. It will help to realize the renovation of geographic analysis method, and the geographical analysis transmission from qualitative description into quantitative analysis. The expansion degree of the geographical analysis base lies in the friendliness of the user's interfaces. We should provide different interfaces to different users. For example, most geographers, lack of computer technology, hopes the order and operation system simple and the user's interface friendliness. Some geographers who master certain computer technology require both exploration and application service. The application depth lies in the participation of geographers' experience, expert knowledge, geographical analysis logic and the regulations. It is essential problem during the transmission from the method base to expert system. It is also the crux of deepening the application.

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