RESEARCH ON REGIONAL ECONOMICAL LEVEL OF LANCANG RIVER BASIN BASED ON GREY CLUSTER AND GIS

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Abstract

Lancang River is the most important international river in Southeast Asia, it is playing huge role to regional economy in this area. In order to analysis the economy developing level in this special region, then further analyze the influence of Lancang River on regional economy, grey cluster models and GIS tools have been used. In this paper, by using grey cluster models and methods, economy development level for each county in Lancang River Basin in Yunnan Province has been calculated, and 31 counties have been put into five grey class. By GIS tools, 500 meters buffers of residential points in Lancang River and its branches and average slopes of all the counties have been gained. At last important information has been discovered that the influence on regional economy from Lancang River and its branches is very noticeable. Though this influence is different even is limited in different counties for the special geographical conditions. The different influence on each county more or less induces the unbalance of regional economy development. The research conclusions enrich the research contents of Lancang River Basin in its spatial characteristics, emphasis the importance of this river and its branches to local economy, and provide certain decision-making gist for comprehensive evaluation, spatial distribution, and development decision-making of these counties.

Key words grey cluster, GIS, buffer, slope, regional economy level, Lancang River

1. Introduction

Lancing River Basin is located in southwest China. Along with Lancang River flowing from north to south, passes through nearly all natural landscapes and the weather patterns in the world besides Gobi and desert (Gan, 1999). The natural condition is bad, the ecological environment is frail, the geography configuration is complex, the geological disasters are high frequency and the economic society development is slow. As the most important international river in Southeast Asia, Lancang River has been paid much attention in recently years. Plenty researches on water resource in this drainage area have been developed from different aspects. Lancang - Mekong International River has become stanchion of regional economy since 1990s (Sun, 2007), whereas few researches on regional economy in the area in China have been checked in the list of Literatures.

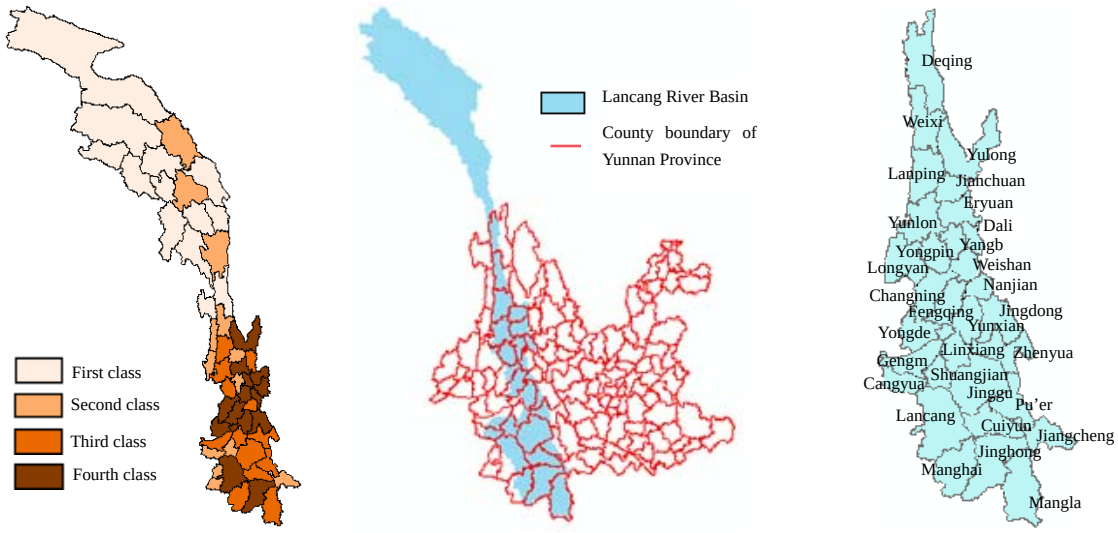
In the late 1970s, early 1980s, Professor Ju-long Deng brought forward Grey system. It is a model and method to address the problem of "less data uncertainty"(Deng, 2002). With more scientific, intuitive and comprehensive grey clustering quantitative research methods increasingly widely used in the field of comprehensive evaluation. Some examples(Niu, 2005; Zhou, 2007; Xiao, 2008; Lin, 2008) show that grey system theory, model and method have been used in analysis on road safety, water environment quality, geological risk, natural resources and so on.

In this paper, five indicators PGDP, DGDP, PTAO, PGIO and PFR have been chosen to indicate economical development. By using grey cluster models and methods, regional economy levels of counties in Lancang River Basin in Yunnan Province have been calculated. To confirm grade of each county from regional economy level, research clue and data foundation will be put forward. On this basis, by applying GIS tools such as buffer and slope, analysis on different influence of Lancang River to these counties and advantage or limitation from the land scale for each county have been done.

2. Topics basis and model adaptation

In this paper, five indicators have been selected to evaluate the regional economical level. They are per capita GDP(PGDP), GDP in each square kilometer (DGDP), per capita total agricultural output(PTAO), per capita gross value of industrial output(PGIO) and per capita financial revenue(PFR). Data come from Yunnan Statistical Yearbook (Yunnan Statistical Bureau, 2005) and China Counties(Cities) Social and Economical Statistical Yearbook(National Bureau of Statistics of China, 2005). It is an indispensable precondition that there are no correlations among these indicators.

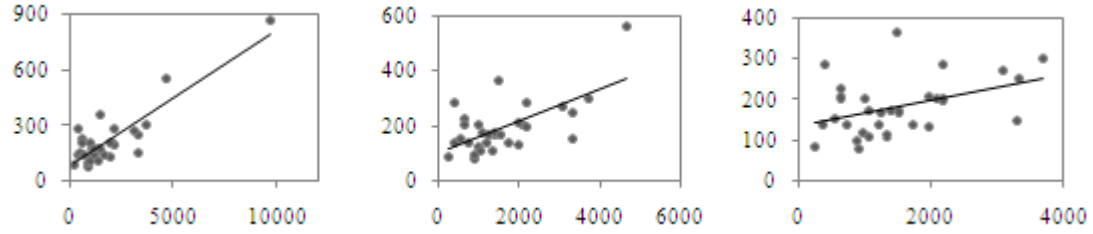
Lancang River flows through Qinghai, Tibet and Yunnan Province in China. The upstream section of the basin mainly belongs to mountain, canyon and glacial landform, the population is sparse, 90 percent above population concentrate in downstream section (Figure 1.a), therefore in this paper the research regions are 31 counties which flows through by Lancang River and its branches in Yunnan Province in China. Figure 1.b and Figure 1.c show it. In this basin agriculture is the most mainly production method, and Lancang River and its branches play very important roles certainly.



a. Quartile chart of population *b. Location in Yunnan Province* *c. Counties the basin covered*

Figure 1. Background of research regions

Pearson correlative coefficients have to be evaluated between every two indicators for 31 counties. Just from the values of correlative coefficients, strong correlations consist some indicators such as PGDP and DGDP(0.749), PGDP and PGIO(0.704), PGDP and PFR(0.826), DGDP and PFR(0.819), PGIO and DGDP(0.825), PGIO and PFR(0.867) etc. and Correlation is significant at the 0.01 level (2-tailed). In fact these are false correlations because of the existence of exceptional values such as Dali city, Cuiyun etc. It is can be find easily from the scatter charts, showed in Figure 2.



a. 31 counties in the basin *b. 30 counties except Dali* *c. 29 counties except Dali and Cuiyun*

Figure 2. Scatter Charts

For example, the strongest correlation is between PGIO and PFR for they have the biggest Pearson correlative coefficient 0.867. But from the scatter chart (Figure 2.a), two exceptional value can be found. They are Dali and Cuiyun. By eliminate Dali, the correlative coefficient drobps to 0.638, and sample values leave off trend line obviously (Figure 2.b). By eliminate Cuiyun, the correlative coefficient drops to 0.437, and there are have no connection between sample values and the trend line(Figure 2.c). Besides Dali city and Cuiyun, Longyuan and Jinggu are special counties in the data serials for they are centers of a bigger region then a normal county, and have more advantages in policy and resource. Through the same operation, the conclusion can be drawn that there are no strong correlations among these five indicators. They can be selected as analysis indicators in models.

3. Evaluation on Economy Standard Based on Grey Cluster Models

In this paper, grey cluster analysis has been done on 31 counties in Lancang River basin in Yunnan Province in 2004. The following is the steps and results.

3.1 Establishing Grey Cluster Appraisal Indicator System

Grey cluster is a classification method. Based on the production of whitening function, manage the whitening number of cluster objects to different cluster indicators according to grey classes, to judge the cluster object belongs to which grey class, then classification is achieved. The first step is to determine cluster objects, cluster indicators and grey cluster classes.

In this paper, the classification objects are 31 counties in Lancang River Basin in Yunnan Province, then cluster objects n=31. Five economical indicators such as PGDP, DGDP, PTAO, PGIO, PFR will be used to evaluating the regional economical levels, then cluster indicators m=5. Five classes such as very strong, strong, middle, weak, very weak will be put in for these counties, then cluster grey classe k=5. Then grey cluster

appraisal indicator system is established.

3.2 Building Sample Matrix

Sample matrix is the data foundation. In this paper, it is a matrix of 5*31 dimensional. Table 1 shows it. For these five indicators, they are all positive indicators to regional economy. In other words, they are positive correlated to economy level. Then the step of unification to the sample polarity can be overstepped. In order to ensure the accuracy of analysis results and improve the precision of analysis results, indicator values standardization is essential, achieves the effect of zero dimension. There are many methods to standardization. The following formula has been used (Wang, 1999),

$$x_{ij}^{*} = x_{ij} / s_j, \quad and \quad s_j^2 = \frac{1}{n}\sum_{i=1}^{n}(x_{ij} - \bar{x}_j)^2$$

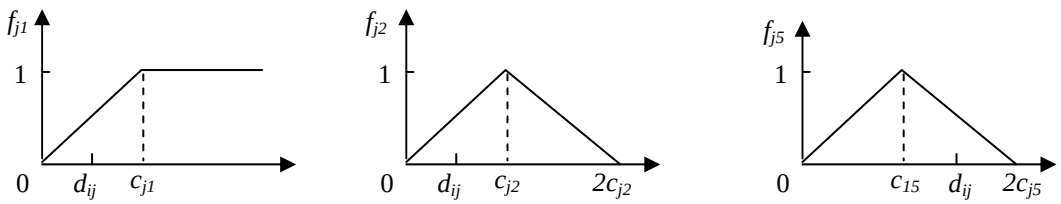
	Indicator 1	Indicator 2	…	Indicator 5
County 1	Value(1,1)	Value(1,2)	…	Value(1,5)
County 2	Value(2,1)	Value(2,2)	…	Value(2,5)
…	…	…	…	…
County 31	Value(31,1)	Value(31,2)	…	Value(31,5)

Table 1. Sample matrix

3.3 Determining Whitening Functions

This is a key process for grey cluster. In order to determine whitening function, gate threshold values have to be determined at first. Gate threshold value C_{jk} is namely gate threshold value of indicator j to k grey class. Here four quartiles have been used to determine the gate threshold value.

For first grey(very strong grey), the function is figured just as Figure *3.a*.



a. Very strong *b. Strong* *c. Very weak*

Figure 3. Grey whitening weight functions

And the following is the formula.

$$f_{j1}(d_{ij}) = \begin{cases} \dfrac{d_{ij}}{c_{j1}} & 0 < d_{ij} < c_{j1} \\ 1 & d_{ij} \geq c_{j1} \end{cases}$$

For second, third and four grey class (strong, middle and weak), the function is figured just as Figure *3.b*, and the following is the formula.

$$f_{j2}(d_{ij}) = \begin{cases} \dfrac{d_{ij}}{c_{j1}} & 0 < d_{ij} < c_{j2} \\ \dfrac{2c_{j2} - d_{ij}}{c_{j2}} & c_{j2} \leq d_{ij} < 2c_{j2} \\ 0 & d_{ij} \geq c_{j2} \end{cases}$$

Third and four grey have the same whitening function with second grey, just change c_{j2} to c_{j3} or $c_{j4.}$

For five grey class (very weak), the function is figured just as Figure *3.c*, and the following is the formula.

$$f_{j5}(d_{ij}) = \begin{cases} 1 & d_{ij} \leq c_{j5} \\ \dfrac{2c_{j5} - d_{ij}}{c_{j5}} & c_{j5} \leq d_{ij} < 2c_{j5} \\ 0 & d_{ij} \geq c_{j5} \end{cases}$$

3.4 Calculating Conversion Coefficients and Evaluation Value

The conversion coefficients are namely cluster weights. The formula is $\eta_{jk} = c_{jk} / \sum_{j=1}^{m} c_{jk}$, m means the number of indicators, c_{jk} is gate threshold values which have been gained in 3.3. The evaluation value of grey cluster is calculated by the formula

$\sigma_{ik} = \sum_{j=1}^{m} f_{jk}(d_{ij})\eta_{jk}$. If $\sigma_{ik} = max(\sigma_{i1}, \sigma_{ik}, \ldots, \sigma_{ik})$, then object *i* belongs to grey *k*.

Then, 31 counties in Lancang River Basin in Yunnan Province have been put into five classes, Table 2 shows it. There are 4 counties are most developed, 12 counties are second developed, 7 counties are middle developed, 7 counties are less developed, and Lancang County is least developed.

Grey class	amount	County name
Very strong	4	Cuiyun, Dali, Jinghong, Mangla
strong	12	Pu'er, Jinggu, Jiangcheng, Manghai, Yangbi, Nanjian, Eryuan, Jianchuan, Longyang, Lanping, Yunxian, Genma,
middle	7	Shuangjiang, Cangyuan, Linxang, Yongping, Yunlong, Changing, Weishan
weak	7	Jingdong, Zhenyuan, Yulong, Deqin, Weixi, Fengqing, Yongde
Very weak	1	Lancang

Table 2. Evaluation Value and Results of Grey Cluster

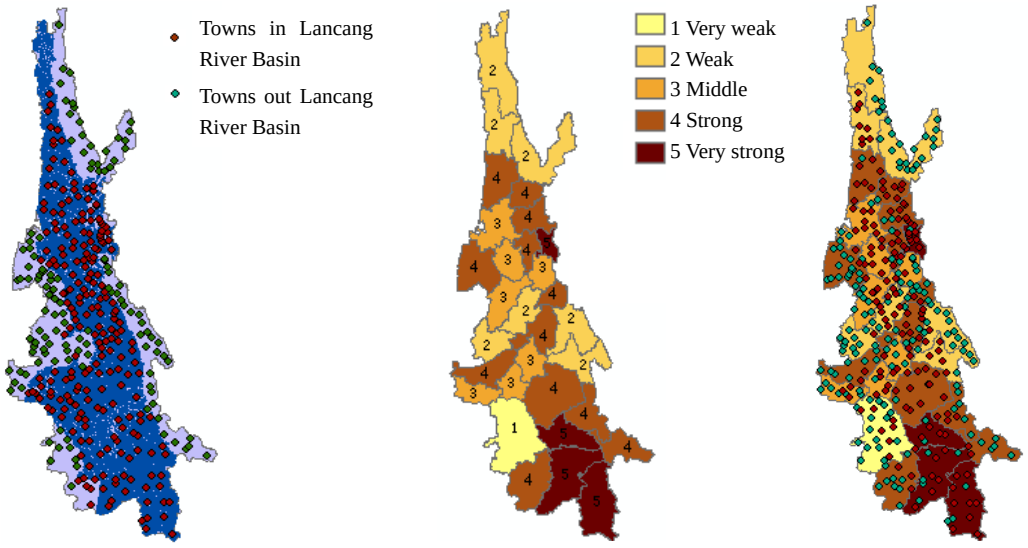
4. Analysis on Influence from Lancang River based on GIS

These counties analysis in this paper are all agricultural counties expect Dali city. In other words, agriculture is the pillar industry in these counties. It is well know that water resource is a key factor for agricultural production. Then Lancang River and its branches will make definite positive influence to these regions, though the effects are different. In order to analysis the influence of Lancang River on these counties in regional economy, buffer tools and slope analysis of GIS have been applied.

4.1. Buffer Analysis

People are living in cities, towns or villages, thus localities are considered as residential areas in geography and figured as residential points in spatial database. There are 12788 residential points in the 31 counties, but the distance of each residential point to Lancang River and its branches is different. We know that the distance is an important factor to induce different effect of the river on people's lives. Then 500 meters buffers have been done for all of the residential points in the 31 counties to Lancang River and its branches. There are 4953 residential points in the buffers, takes 38.7 percent. More than 50 percent of residential points in 500m buffers for all of the four counties in strong grey class, the value even reach 81 percent for Dali city.

For a county in west Yunnan Province, towns plays mainly role in economical level, they are selected from all of the residential points so that the problems bring from too many sample amount can be avoided. Figure 4 shows it. The number of towns in 500 meters buffers in Dali, Cuiyun, Jinghong and Mangla (very strong grey class) are over 50 percent. Dali reaches 89 percent. On the contrary, the percentage of Lancang County (very weak grey class) is only 32 percent. Lancang River and its branches do make important influence on local economical development.



a. Towns in the basin *b. Results of grey cluster* *c. Towns in 500m buffers*

Figure 4. Towns in Lancang River Basin, results of grey cluster and 500m buffers

4.2. Slope Analysis

From physiognomy scale, the type of mountainous region takes up the most status in all of the 31 counties, though certain difference exists, the percentages of mountainous region to the whole area are range from 47%(Nanjian) to 100%(Deqin). Except Nanjian County, over half of the areas are mountainous region in the rest 30 counties. In Deqin etc. three counties all of the areas are mountainous region. For this mountainous region in Yunnan Province, plain blocks with sunshine are very important for inhabitation, agricultural and industrial activities. Then slope is an important index to evaluate the geographical conditions propitious to economical level. Figure 5 shows the average slope values in 31 counties.

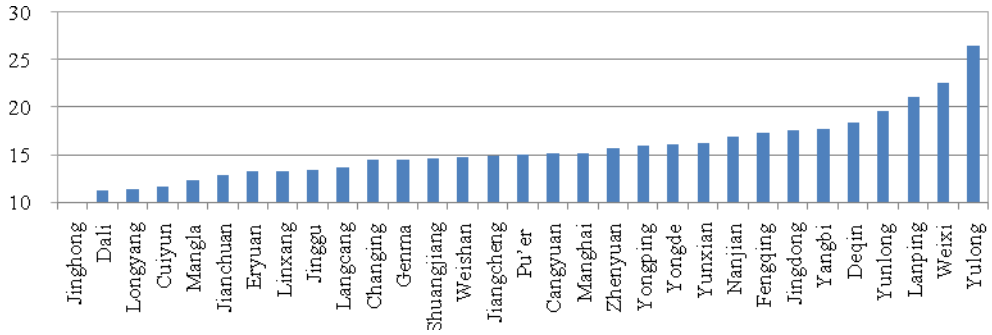


Figure 5. The average slope values for each county

It is obvious in Figure 5 that average slope values of four counties in very strong grey class are smaller than other counties. What needs to point out is Longyang County, though there are few towns in 500m buffers (only 10 percent), besides taking advantages of regional center, more areas smooth ground is another important factor. For some counties such as Weixi and Yulong, there are bigger proportions (89 and 73 percent) of towns in 500m buffer, but nearly all of the areas are mountainous region, they are in weak grey class.

5. Discussion and Conclusion

There are 31 counties have been taken as research objects in this paper for Lancang River or its branches flow through them. The economical level is imbalance in these counties. In order to evaluate the imbalance more reasonable and scientific, five indicators without correlation have been chosen, grey cluster models and methods have been applied to evaluate the economical level for all the counties and then they have been assorted into five grey classes. Based on the results, by using GIS tools, 500 meters buffers of residential points in every county, in Lancang River and its branches have been obtained. And considering the physiognomy characteristics, average slopes for each county have been calculated. From the results and further analysis, the conclusion can be draw that Lancang River does play important roles on local economy.

The research area locates in west Yunnan Province, belongs to multinational and depressed region in China. According to statistical materials, among 31 counties there are 22 counties (71 percent) are in the list of Development-oriented Poverty Reduction Counties in China. This means that the most important task is to raise the economic development level to eliminate poverty in the region. Considering the natural condition, Lancang River and its branches are the most important natural resource. How to take advantage of the water resource of Lancang River Basin is a very important problem for the decision-making departments. Then the work have been done in this paper is just

thus attempt to this goal, and it will be beneficial exploration to comprehensive analysis and planning research on this region, but it is very superficial and many works have to been done.

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