CHINESE GEOGRAPHICAL SCIENCE
Volume 13, Number 1, pp. 2 - 8, 2003
Science Press, Beijing, China

ANALYSIS OF CAPITAL FLOW WITH GIS
— Two Approaches for Regional Investment in China

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ABSTRACT: GIS technology has been mostly concerned with handling physical data and modeling physical environment. However, the requirements of GIS for handling socio-economic information in many cases are different from those concerning phenomena in the physical environment. Analysis of capital flow among regions requires the transitions both from economic values to physical landscape and from physical surface to economic explanation. Rapid growth of Chinese economy comes mainly from investment. There are two main ways for obtaining high growth of investment. One is government expenditure which usually invests in regional facility and amenity block, which is regarded as stimulus for attracting investment. The other is the creation of investing center and corresponding capital source areas, both of which need the central city with the highest growth rate of investment among regions. This paper presents the cluster areas of both government revenue and total investment, the potential situation of capital flow between central city Shanghai and its neighbor provinces by using "Classification" and "Interpolation" functions of ArcView GIS.

KEY WORDS: capital flow; Geographic Information System(GIS); regional investment; Cluster Analysis

CLC number: F127 Document code: A Article ID: 1002-0063(2003)01-0002-07

1 INTRODUCTION

Investment has been one of main forces for driving high economic growth since implementing the open door policy in China. During 1981 - 1999, the average annual growth rate of total investment was 24.25%. Owing to the spatial differentiation of resources, policy and competitive advantages among regions, there is one kind of discrimination of investment among different provinces in China(YAO, 2001). This discrimination resulted in the spatial inequality of regional investment. Apart from the central government investment, there are two basic approaches that affected regional investment. One is the block of regional facility and amenity that is the stimulus for attracting investment. The other is regional capital flow among neighbor areas which determined capital source for investing in a specific region (ARMSTRONG AND TAYLOR, 1985).

The emphasis on natural science applications in the development of Geographic Information System (GIS) technology has led to a situation in which many presently available systems are not well suited to the modeling of socio-economic phenomena(MARTIN, 1991). But with the broad implementation of these technology, the extension of GIS application into socio-economic reality shows the important domain with. With time going on, more and more sophisticated analytical functions have been employed to do regional analysis. This paper presents cluster areas according to levels of both government revenue and regional investment, analyzes capital flow around Shanghai which is the highest investment city in China with the help of classifying and interpolating functions of ArcView (GIS software)(YAO, 2001).

2 REGIONAL INVESTMENT ON STIMULI SIDE

One kind of basic factors for attracting regional investment is the block of regional facility and amenity, which is determined by the level of regional government expenditure and based on government revenue and, in turn, affects the regional comparative advantages for

Received date: 2002-09-29
Foundation item: Granted by Swiss Federal Institute of Technology.
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investing. This expenditure comes mainly from local government. Thus, government expenditure that is based on local government revenue is the stimulus for investing. With cluster analysis, two series of clusters according to the values of both per capita government revenue and per capita investment will be obtained respectively. If some areas are in the same level of the two classifications that means conformity between the distributions of the two indicators, they can be called a cluster area of both government revenue and total investment (Fig. 1). On the contrary, if there is a gap between the two indicators, it means that the total investment has not been mainly stimulated by government revenue (which will not be discussed in this paper).

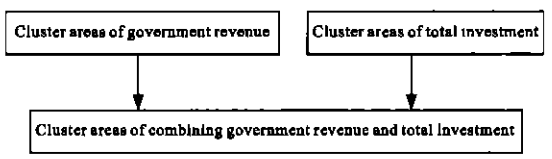

Fig. 1 Framework of Cluster Analysis

Supposing that total investment is affected by government revenue with time delay. For example, there is one year time delay. Consequently, the value of government revenue in 1997 affected the total investment in 1998. Values of the two indicators in 1997 and 1998 will be adopted for clustering their regional distributions respectively in this paper.

2.1 Classify Areas by Government Revenue

Values of provincial government revenue in 1997 will be classified by "equal interval" into nine classes. Equal interval method is better to describe spatial clusters of values in this paper than "equal area", "natural breaks", "quantile" and "standard deviation" in ArcView. Because the same difference among each class level is derived from "equal interval", which can keep clusters equality. During this process, both shape and grid files have been employed. With a shape file (vector) and relational tables, a list of classification is provided, with which class definition of values, areas and unit numbers among different classes are indicated. With a grid file (raster) and relational tables, a cartographic presentation is produced, in which empty classes are omitted. The same methods are also applied for the following classifications. In this case here, classes 5, 7 and 8 are empty. Fig. 2(from the grid file) and Table 1 (from the shape file) show the number and names of the provinces in each class. They indicate that the majority of provinces have lower values of government revenue.

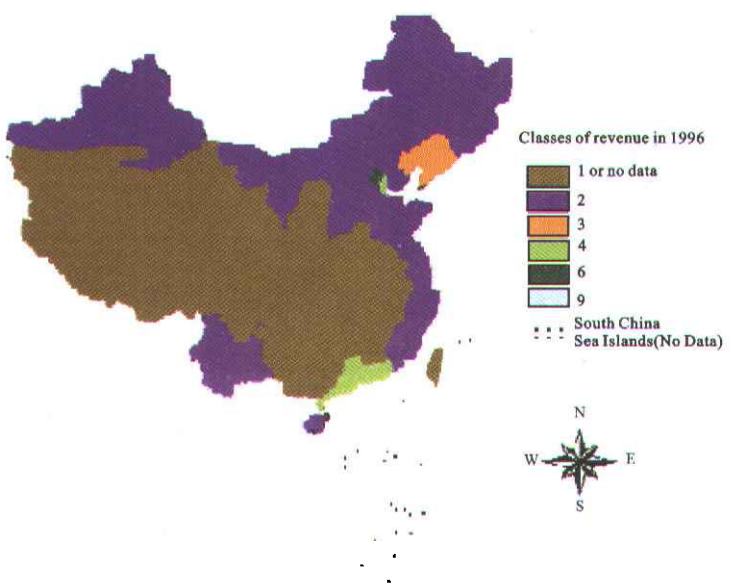

Fig. 2 Classes of government revenue among regions(except the desert areas in Xinjiang)

2.2 Classify Areas by Total Investment

Using the same method as above, the values of total investment in 1998 were classified by "equal interval" into nine classes. Classes 5, 7 and 8 are empty. Table 2 and Fig. 3 show also that the majority of provinces

Table 1 Classes of government revenue among regions

Class	Values of government revenue (yuan/person)	Number	Province
1	0 – 21.26	13	Sichuan, Guizhou, etc.
2	21.26 – 42.52	13	Jiangsu, Zhejiang, etc.
3	42.52 – 63.78	1	Liaoning
4	63.78 – 85.04	2	Tianjin, Guangdong
5	85.04 – 106.30	0	
6	106.30 – 127.56	1	Beijing
7	127.56 – 148.82	0	
8	148.82 – 170.08	0	
9	170.08 – 191.34	1	Shanghai

Table 2 Classes of total investment among regions

Class	Values of total investment (yuan/person)	Number	Province
1	0 – 1511.091	15	Jilin, Shanxi, etc.
2	1511.091 – 3022.162	10	Fujian, Hubei, etc.
3	3022.162 – 4533.243	3	Jiangsu, Zhejiang, etc
4	4533.243 – 6044.324	1	Tianjin
5	6044.324 – 7555.406	0	
6	7555.406 – 9066.487	1	Beijing
7	9066.487 – 10577.568	0	
8	10577.568 – 12088.649	0	
9	12088.649 – 13599.730	1	Shanghai

had lower values of total investment and only majority in class 3 and minority in class 2 are more than the distribution of government revenue values.

2.3 Classify Areas by Combining Same Classes of Both Government Revenue and Total Investment

If one area has the same class level of government revenue in 1997 and total investment in 1998, it indicates that the development trends of the two indicators are similar. Therefore, government expenditure probably was the main stimulus for investment in this area.

In order to obtain areas of the same class level in government revenue and total investment, the same class level areas of the two classifications have to be overlaid. Among nine classes of each classification, classes 1 and 2 are overlaid by the function of "select by theme" with shape file of each theme. No overlay is necessary for classes 3, 4, 6, 9, 5, 7 and 8, because classes 3, 4, 6 and 9 include only one province respectively and classes 5, 7 and 8 are empty. The selected areas are remarked in Fig. 4 and Fig. 5 (Table 3). The results denote the areas where investment was

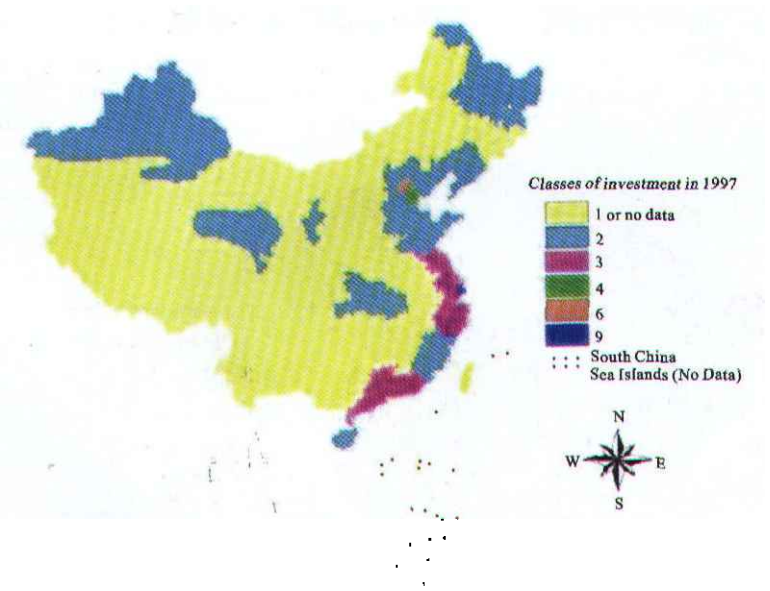

Fig. 3 Classes of total investment among regions (except the desert areas in Xinjiang)

mainly affected by government revenue. We call it revenue-investment area of 1997 – 1998.

Table 3 indicates that from class 1 (eleven provinces) to class 9 (Shanghai), the values of government revenue become higher, as well as the value of total investment. Among these listed regions, only three municipalities belong to both higher investment and higher government revenue. Most regions had both less investment and less government revenue. In a simple way, government expenditure was valid only in a few cities for encouraging investment. But for most provincial areas, government expenditure was too weak to stimulate investment. As a case study, class 9 of revenue-investment area—Shanghai — will be denoted to

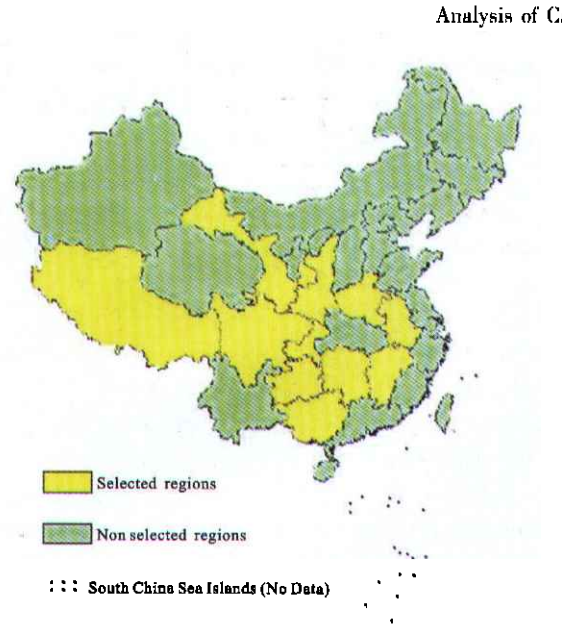

Fig. 4 Selected areas of class 1 in government revenue and total investment

Fig. 5 Selected areas of class 2 in government revenue and total investment

Table 3 Overapped result of same classes within the two classifications

Clase	Number	Region
1	11	Guangxi, Guizhou, Hunan, Jiangxi, Chongqing, Sichuan, Anhui, Henan, Shaanxi, Gansu, parts of Tibet
2	7	Heilongjiang, Shandong, Hebei, Ningxia, parts of Xinjiang, Fujian, Hainan
3	0	
4	1	Tianjin
5	0	
6	1	Beijing
7	0	
8	0	
9	1	Shanghai

define influence area as the central city at different levels of disposable income.

About the regions that could not be overlapped(not listed in Table 3), there were two possibilities: one was that the values of government revenue among some regions were at the higher level than the values of total investment. It means that government stimulus was not strong enough to attract investing. These regions were Guangdong, Liaoning, Hubei and Ningxia. Another was that the values of government revenue among some provinces were at lower level than the values of total investment. It means that some investments were not encouraged by local government expenditure, which perhaps came from central government or private investment. These regions were Jiangsu, Zhejiang, Yunnan, Shanxi, Inner Mongolia and Jilin.

In a general word, the function of local government expenditure encouraged regional investment mainly in some urban areas which have been important industrial bases historically. Therefore, in these cities large amount of investments have been concentrated on which resulted in distinct discrimination of investment among these cities and their neighbor provincial areas.

3 CAPITAL FLOW

Owing to the discrimination of investment among some cities and neighbor provincial areas, these neighbor provinces in turn became capital sources to provide great amount of money to their corresponding central cities. Hence, capital flowed from neighbor provinces, even from far away located provinces, to the central cities. There are three steps to analyze the process of capital flow in this paper: 1) defining the central cities, 2) defining neighbor provinces, 3) analysis of conditions of capital flow.

3.1 Defining Central City

Capital formation is a capital pool and the most important source for investing. In order to define the central city of investment, the ratio of investment to capital formation is denoted to be the criterion to describe the relationship between real investment and investment potentiality. The greater this ratio is, the more relative power of investment is in the corresponding region (city). If the value of this ratio is greater than 100, it means that investment of this region has been over capital formation ability. Absolutely, some investments of this region (city) have to be obtained from other areas. Table 4 is the ratios of investment to capital for-

Table 4 Ratio of investment to capital formation in 1998

Region	Investment/capital formation(%)	Region	Investment/capital formation(%)	Region	Investment/capital formation(%)
Tibet	122.42	Gansu	86.40	Guizhou	72.31
Shanghai	96.18	Sichuan	84.98	Shanxi	69.70
Xinjiang	90.55	Qinghai	83.50	Jiangsu	68.70
Guangdong	90.31	Hebei	81.07	Hubei	68.40
Ningxia	89.96	Tianjin	79.76	Anhui	67.00
Guangxi	89.64	Heilongjiang	78.20	Fujian	64.80
Yunnan	89.21	Hunan	78.18	Inner Mongolia	62.83
Liaoning	87.17	Zhejiang	77.70	Henan	61.43
Hainan	87.02	Beijing	76.74	Jiangxi	60.82
Shaanxi	86.61	Jilin	75.91	Shandong	60.79
				Average	78.64

Notes: The order of this table is according to the value rank of this ratio; Tibet is a special case, which mainly accepted investment from the central government.

mation among provincial units.

Among the top ten regions in Table 4, Tibet, Xinjiang, Ningxia, Guangxi, Yunnan, Liaoning and Shaanxi were mainly invested by central government with public welfare and poverty alleviating projects for balancing regional development (this will not be discussed here). Table 4 also showed that Guangdong belonged to the type that the value of local government revenue was at the higher level than the value of total investment. It means that a majority of investment came mainly from local investors. Only Shanghai belonged to both kinds of investment-revenue and highest investment area where capital came from various sources.

3.2 Defining Neighbor Regions

Inflow and outflow of capital is always going on. If the value of capital inflow can be relatively higher than the value of outflow, the inflow will become the main stream. The area with the main stream of capital inflow will be called investment region, vice versa. Depending on the average ratio value (78.64%) of investment of capital formation, if the ratio values were greater than 78.64%, the regions would be called investment regions. Conversely, they would become capital regions (Fig. 6).

From Fig. 6, all of the neighbor provinces of

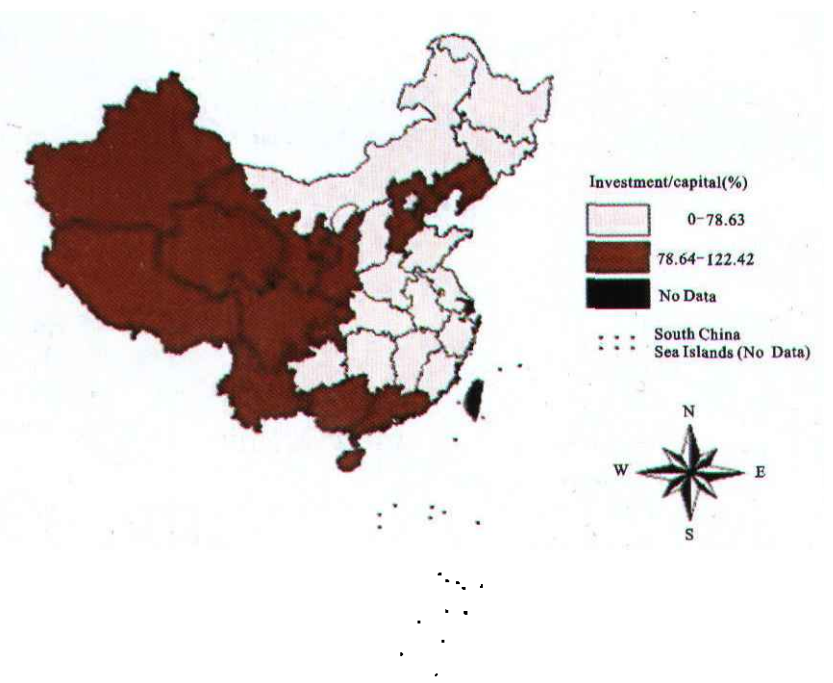

Fig. 6 Classification of investment and capital regions

Shanghai were capital regions that had the most economic power in China. The lighter color provinces around Shanghai which were Shandong, Jiangsu, Zhejiang, Fujian, Anhui, Jiangxi, Hunan, Guizhou, Hubei, Henan and Shanxi will be selected as the potential capital providers for Shanghai. The economies of these provinces have rapidly grown in China. This indicates that Shanghai is not only the capital region, but also has the most powerful capital providers compared with other investment regions.

3.3 Conditions of Capital Flow around Shanghai

During capital flow process, the principle is: the greater difference of GDP between central city and neighbor areas, the greater difference of investment return can be observed, the easier of the capital flows to the central city. Slope analysis of GIS will be adopted to describe the conditions of capital flow around Shanghai.

Iso-lines of GDP values which will be used to display the difference between central part and neighbor areas have been retrieved by interpolating grid files of city points with attribute values of investment. There are two ways in ArcView to interpolate input points, which are Inverse Distance Weighted (IDW) and Spline interpolators. Because the Spline interpolator is a general-objective interpolating method, it fits a minimum-curvature surface through the input points. It is not appropriate if there are a large number of changes in the surface within a short horizontal distance owing to the fact that it can overshoot given values. IDW interpolator assumes that each input point has a local influence that diminishes with distance. It weights the points which are closer to the processing cell and greater than those farther away. A specified number of points, or optionally all points within a specified radius, can be used to determine the output value for each location. For per capita values of investment, there are large changes in the surface within a short horizontal distance among cities. Therefore, IDW is adopted in this paper. A choice of No Barriers will use all points specified in the No. (number) of Neighbors or within the identified radius. One thousand map unit of the contour interval is denoted to create the contour lines. The interpolating is going on in ArcView within the minimum rectangular area which is defined by top points of the selected area and the values of per capita GDP of cities inside the rectangle regions as input points. The isolines of GDP within these selected regions are shown in Fig. 7.

More density of the slope means more difference of

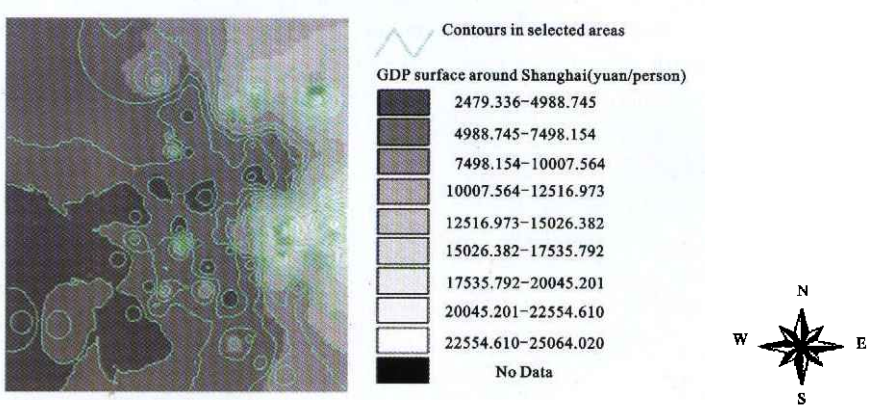

Fig. 7 Iso-lines and surfaces of GDP around Shanghai City

per capita GDP values between Shanghai and neighbors, as well as easier capital flow from neighbor provinces to Shanghai. Therefore, some areas that have higher slope values of GDP become more potential capital providers for investing in Shanghai (Fig. 8).

From Fig. 8, neighbor regions had small differences among each other and all of them were capital sources. The closer neighbors of Shanghai is from, the more potential capital providers they are. These indicated that economic "neighborhood" coincided with physical "neighborhood".

4 CONCLUSION

GIS technology has been mostly concerned with handling physical data and modeling physical environment. However, the requirements of GIS for handling socio-economic information in many cases are different from those concerning with the phenomena in physical environment. Analysis of capital flow among regions re-

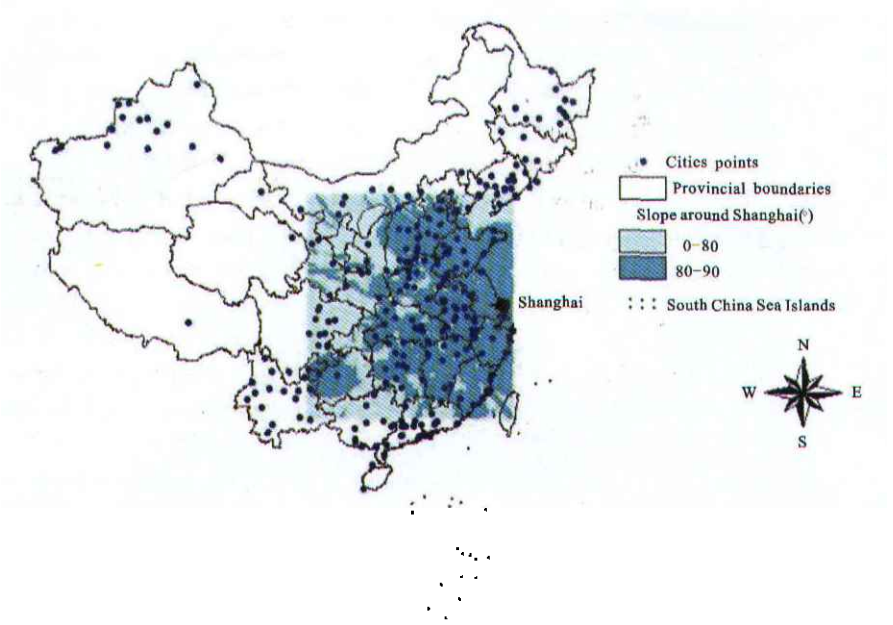

Fig. 8 Classification of GDP slope around Shanghai

quires the transitions both from economic values to physical landscape and from physical surface to economic explanation. There are three aspects, which have been dealt with for these transitions in this paper.

(1) Sections 2.1, and 2.2 transformed values of government revenue and regional investment (in provinces and cities) into landscape maps as Fig. 2 and Fig. 3, which gave an overview about spatial distributions of these parameters. Different colors in these maps denoted different levels of these parameters.

(2) Section 2.3 provided a simple way to do cluster analysis with overlaying various thematic layers. Fig. 4 and Fig. 5 displayed the results that were obtained by thematic selection function of ArcView.

(3) Section 3.3 tried creating surfaces from point samples of per capita GDP values by IDW interpolator. Although general contours about investment are similar among different interpolators, different group samples within different extents can create varied contours. IDW interpolator was adopted to give a clearer visual statement about GDP values among cities within a specific area than Spline one. With these interpolating maps, the situations of capital flow around Shanghai were displayed. With classification of slope values around Shanghai, capital flow conditions and potential capital providing regions were visualized.

Spatial exchange of economy among regions includes two processes — spatial diffusion and spatial concentration that goes on simultaneously. Spatial diffusion goes on when spatial differences are less; meanwhile, spatial concentration goes on when spatial differences are greater. Capital flow follows the latter process. Under these two ways of investment as above, Shanghai has become the city with highest investment in China.

Note: All of the data were from the Statistic Book of China (1996, 1997, 1998, 1999, 2000)

REFERENCES

ARMSTRONG Harvey, TAYLOR Jim. 1985. *Regional Economics & Policy*[M]. London: Philip Allan Publishers Limited, 121.

MARTIN David, 1991. *Geographic Information System and Their Socioeconomic Application*[M]. London: Routledge Press, 28.

The Statistics Bureau of China, 1996 - 2000. *The Statistics Book of China*[M]. Beijing: The Statistics Press of China. (in Chinese)

YAO Yong-ling, 2001. *Distribution of Economic Potential Growth in China — GIS Analysis for Regional Economic Development* [R]. Report of the Institute of Geodesy and Photogrammetry, ETHZ