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The application of MapInfo9.5 in rural space planning based on neural network theory

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ABSTRACT

The vast rural areas in China are now facing increasing problems and conflicts with the fast development of the economy and society, especially the rapid advancement of the urbanization process. Finding the way to shift the urban-rural dual structure to urban-rural integration is in desperate need. Urban and rural planning can not only serve as a tool of practicing development policies but can also provide basis for policy-making. The paper takes Jiangning District, which is located at the urban and rural junction region of Nanjing as an example to make spatial analysis through the application of mapinfo 9.5 based on neural network theory and the spatial analyzing approaches of the urban-rural integrated planning. Meanwhile, the paper makes a couple of beneficial discoveries in areas including equilibrium of urban and rural land use, layout of the rural industries, distribution of basic infrastructures, protection of the ecological environment and the innovation of the policy-making mechanisms.

Key words: Urban-rural integration; MapInfo 9.5; Rural area; Neural network.

INTRODUCTION

According to the statistics delivered by the China's National Bureau of Statistics, in 2011, population urbanization rate in China has exceeded 50%, marking its turning from rural society to urban society. In the unprecedented process of social transition, it's a high time to solve the urban-rural dual structure and intricate problems of agriculture, rural development and farmers which exist for a long time in China. Effective plans are needed to cope with the commonplace problems in rural areas such as extensive utilization of space resources, lack of public service and infrastructure as well as deterioration of the natural and ecological environment. In this context, the central government has put forward the strategies of building new socialist countryside since the Eleventh Five-Year Plan put into practice, mentioning that the crux of urban planning work is to lead the healthy development of the countryside by making development plans for rural residential locates with the perspective of balanced development between regions as well as coordinative development of urban-rural area. In June, 2007, the National Urban-rural Coordinated Pilot Areas for Reform were established in Chongqing and Chengdu, making its first trial of regime reform at the altitude of urban-rural coordination.It has been made clear that great importance should be attached to the three rural issues and that the integration of urban and rural development is the essential way to solve these problems in the report delivered at the 18th National Congress in 2012, symbolizing that the integrated urban and rural development has become one of the national strategies and the important guidance to solve the multiple problems facing China these days.

The paper takes Jiangning sub-district, which is located at the urban and rural junction region of Nanjing as an example to explore the spatial analysis tools applied to the layout of rural settlements in Jiangning district based on the principle of integrating the development of urban and rural areas. It not only contributes to the fully implementation of the rural regional and space planning mentioned in the Urban and Rural Planning Law but can also be of some help to provide the countryside with some solutions concerning industrial transformation, spatial agglomeration, cultivated land protection and ecology conservation.

APPLICATION OF GIS IN URBAN PLANNING

GIS, short for Geographic Information System, is a kind of spatial information system. It is a system designed to digitally store, analyze, manage, present stimulate all types of spatial and graphical data concerning geography and spatial variation[1]. GIS is the merging of Digital earth science, topography, remote sensing, environmental science, computer science, informatics and applied mathematics and consists of data, people, hardware, software and process [2]. GIS belongs to the category of information system, but the ability to function and deal with geographic referencedata has made it different[3]. Geographic reference data is used to describe the spatial data featuring geometry characteristics and offers related attributes information to compose a combination reflection of locations and attributes of those spatial elements [4]. In recent decades, GIS has widely applied to fields including environmental protection, ecology planning, urban planning, resource investigation, land management, agriculture, forest and husbandry, water and electricity, public infrastructure management, statistics, business and finance because it is accurate, time-effective, efficient and convenient[5-8].

Table 1. Current situation ofcommunities in Jiangning Subdistrict

Community	Natural village(units)	Registered residents(persons)	Total land area (hectare)	Construction land area (hectare)
Jiangning	29	7802	434.35	84.97
Yuye	1	490	0	0
Chenyang	16	2062	537.33	106.37
Sijia	21	3451	535.45	113.99
Jianzhong	25	3516	582.95	114.74
Lulang	21	6190	511.07	80.67
Zhumen	25	2913	973.49	152.6
Hexi	17	3247	542.62	73.03
Yecun	1	3802	52.5	52.5
Tongjing	21	3983	557.97	83.67
Nanshanhu	37	4343	1291.8	227.04
Mulong	36	6306	1196.4	210.04
Xinmin	29	3075	646.14	97.11
Hehua	33	4237	1185.6	180.9
Xinghui	19	5550	1024.5	192.83
Xinchao	10	1640	218.35	20.03
Shanghu	27	3850	690.77	119.09
Qingxiu	26	3636	868.73	159.7
Xining	26	2648	939.79	121.72
Damiao	22	2440	925.17	126.89
Paifang	20	2015	835.12	92.05
Huatang	26	3300	1136.2	189.87
Miaozhuang	23	2220	687.87	102.11
Tianran	8	1922	436.45	79.59
Hongmu	9	2108	1216.2	120.45
Total	528	86746	18027	2902

The most commonly used GIS analytical tools are Arc GIS and MapInfo and they share the same basic principle. Arc GIS is the general term for a series of geographical information system software produced by ESRI and consists of desktop version, server edition andmobile device. MapInfo is a desktop geographical information system delivered by MapInfo mainly for data visualization and information map-visualization. It can achieve the automatic function of spatial data by integrating a variety of databases and coalescing computer mapping techniques based on the conception of map and its application. It possesses the function of querying, editing and analyzing the data as average geographical information systems while it can also support web release and the 2nd time development so as to make it readable for the public by using geo-database technology. MapInfo, which stands for “Mapping +Information”, is an information integration system made up of map data and object properties [9]. With the integration use of GIS and MapInfo, the paper is intended to explore the spatial analytical technologyof the rural planning by applying the technic for distributing rural residential locates in Jiangning district.

MAJOR PROBLEMS FACING RURAL AREAS IN CHINA: JIANGNING DISTRICT AS AN EXAMPLE

Located at the urban and rural junction region in the southern part of Nanjing, Jiangning sub-district is not only the most frequent and intimate place for the interaction between urban and rural areas but also the most important place for urbanization drive in Nanjing. There are 1 provincial development zone—JiangningBinjiang Economic and Technological Development Zone and 25 communities. The overall area is 257.8 km^2,of which 221.7 $km^2$is land and the rest is waters (including part of YangtzeRiver). In 2007, the total area for urban and rural construction is 44.69 km^2, among which the Binjiang development zone takes up 9.36 km^2. Up to the end of 2007, the district has a population of 86746(Tab 1). In terms of administrative system, Jiangning has already become a sub-district. However, there exists a distinctive dual-structure concerning economy, society, landscape and administrative regime. The spatial development problems for rural areas are urgent to be solved.

The low-efficiency of land-use: We obtain the map of population density, natural village density, construction land per capita, GDP per unit of land and output efficiency of construction land for different communities by using the data of registered population, land-use and economic output and the MapInfo 9.5 software.

Population in Jiangning sub-district is in low density and separate distribution. Among the 25 communities, there are 528 villages and those with a population of less than 100 makes up for 21.49%(Fig 1). The total registered population is 86746. All the communities have a population density of less than 20/ha and a majority of those have a population of less than 10/ha except for Yuye and Yecun community.The rural construction area per capita reaches 362.71m^2, almost 2.41 times of the upper limit set by the government, which is 150 m^2, 12 communities have a construction area of over 400 m^2 per person, including Tianran community, Hongmu community, Nanshanhu community, Xining community, Damiao community, Zhumen community, Hehua community, Paifang community, Huatang community, miaozhuangcommunity, xingxiu community and Chentang community. (Fig 1)

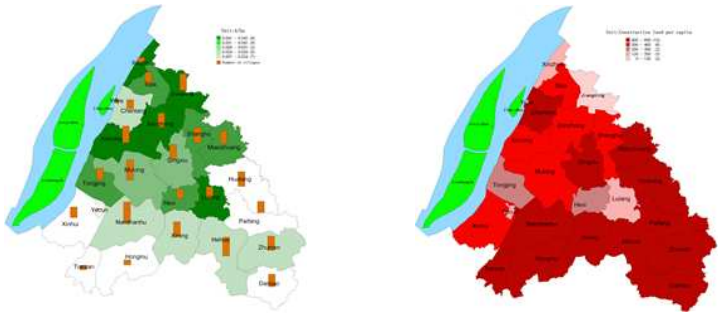

Fig1. Analysis of natural village density and construction land per capita (MapInfo 9.5)

Judging from the land use, it is extensive and low-efficient. A large amount of the land are used for building industries and small property housingby an illegal way named “rent to cover requisition”, thus leading to the sprawl of rural construction area. Economic income per area of most communities is less than 250,000 Yuan/ha with low efficiency in land production except for Yuye and Yecun community for their tiny land scale (Fig 2). On the other side, apart from Jiangning, Lulang and Tongjin community, all the rest have a output of nonagricultural construction area per capita of less than 2 million/ha, far behind the average level of Binjiang development zone, Jiangning district and Nanjing as a whole (Fig 2).

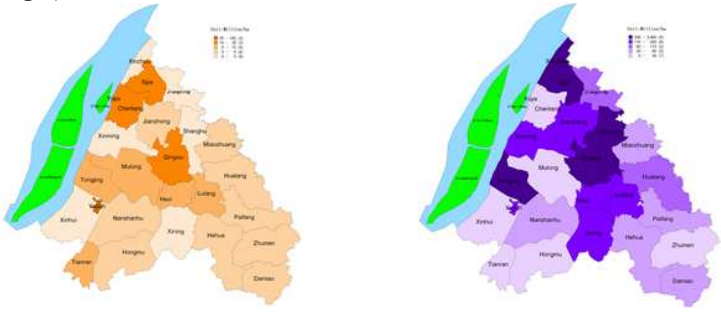

Figure 2. Analysis of economic income per area and land output efficiency (MapInfo 9.5)

Lack of rural supporting facilities: In China, most of the public service facilities are provided for cities only and due to the shortage of public fiscal revenues, the construction of public facilities in the countryside have long been

lagging behind. In Jiangning sub-district, though the incomes of the farmers are increasing due to the transition from agricultural work to nonagricultural industries and some sort of investment income, the overall situation is not that good. Rural areas are in great need of investment for public services and infrastructures because the rural public finance system hasn't been established yet., thus resulted in the low-level of rural public services and supporting infrastructures, which cannot cater to the increasing demand of transportation, water supply, sewage disposal, entertainment, medical and sanitation as well as commodity market facilities.

The severe limitation of ecological environment: The rapid development of economy and society has provided Jiangning sub-district with thriving momentum for development. Since the establishment of Binjiang Development Zone in 2003, it has contributed a lot to the economic development of Binjiang New Town and is in great need for land. Take Binjiang development zone as an example. Area for construction extended 74ha,103ha and 134ha in 2005, 2006 and 2007, with the growth rate of 28%,22% and 43%. Apart from what mentioned above, the rent to cover requisition policy for industrial development and residence has made it even worse. However, Binjiang New Town is faced with a severe limitation of ecological protection while urging for development. On one hand, it is a significant part of the ecological net rack because it possesses a great amount of hills, rivers and lakes. The west part of Yangtze River and the east part of Yuntai Mountain is the significant ecological corridor in Nanjing and faced with even more severe ecological limitation. On the other hand, Binjiang New Town is divided by major transportation corridors including Ninma highway, Nin'an railway, Ninwu railway and 205 national road. The cost will be huge if we choose to develop stretching over major transportation corridors.

Application of urban-rural integrated planningtechnology

Improvement of land-use efficiency in the countryside:

(1) Equilibrium of urban-rural spaces contributes to the intensive use of rural land

The spatial development is facing severe conflict of demand and supply. According to the Pre-research of General Land-use Planning in Jiangning District, the total demand of land for construction is 43.77 km^2during 2005-2030. However, the newly-added land use index is far less than 21.8km^2, which means that there is a huge gap between demand and supply. At the same time, inadequate funding capital makes it difficult for rural areas to keep pace with the city operation model to turn the abundant spatial resources into cash due to the lack of infrastructure and public service facility investment. As a result, the plan takes intensive land use as principle to develop the 3 km^2 of rural area by 2030 in accordance with the rural area reconstruction scheme and the aim of keeping a population of 33000. At present, the construction land per capita is 362.71m^2 while the total scale is 28.5 km^2. There by, it can be estimated that the total scale for construction in rural areas will reach a total amount of 25.5 km^2 in 2030.

(2) Reconstruct rural settlement system and implement intensive developing principle

In order to change the situation of excessively scattered residential locates in the countryside, we must control the scale for development and strengthen the importance of feedback and support from Binjiang development zone.According to the plan, the developing area will be the reconstruction work of several closely related communities both in space and function and have a certain population and industrial basis. Itbreaks throw the boundaries of administrative villages and form 3 small towns that have perfect infrastructures and are major for residential, commercial or industrial affairs. It will also form 3 villages for ethnic minorities and 20 characteristic residential locates that feature in residence , commerce and tourism, thus forming a complete urban-rural cluster system with the Binjiang New Town (Jiangning sub-district town included), which is located at the west of Ninma highway.

(3) Integrate the industrial layout and promote land economic output

We make general planning for its industrial development space with the perspective of urban-rural as a whole and on the basis of deep investigation into Jiangning sub-district's current situation and development vision of industry. Primary industry: strengthen the planting industries with characteristics, form large-scale and cooperative operation between cooperates and farmers and develop ecological and sightseeing agriculture to form the spatial layout vision of "One area, Two belts". Secondary industry: Industrial land are mainly located in the development zone. Rural industrial land can only been seen in 4 communities that have relatively good industrial foundation. Moreover, industries are limited to deep processing of agricultural products and logistics only（Fig 2）.

Construction of rural ecological security pattern:

Quantitativeresearches are needed for the ecological suitability of land in order to improve the rural ecological environment. This research uses the factor weighted summation method to analyze the ecological sensitivity of Jiangning sub-district. The steps are as follows: Current situation stimulation with GIS-ascertain the impact factors of ecology -evaluation classification of single ecological factor and its analysis - determine weight of single factor and weighted stack - confirmation of classification standard for ecological sensitivities - confirmation of synthetic

eco suitability and its classification - determination of land suitability - estimation of limited land scale for use - plan for urban-rural spatial regulation(Fig 3).Considering the scale of research area and its features, the paper picks up the 10 ecological factors which can be grouped into 4 categories as follows: vegetation cover, water resources (Yangtze River, rivers and reservoir), landform (altitude and slope),human activity factors (construction area for city and town, construction area for rural development, railway, high-level highroad). We divide the selected factors into 5 levels according to the extent they had been influenced by the development and grade them of 9,7,5,3,1 in accordance with the former classification.

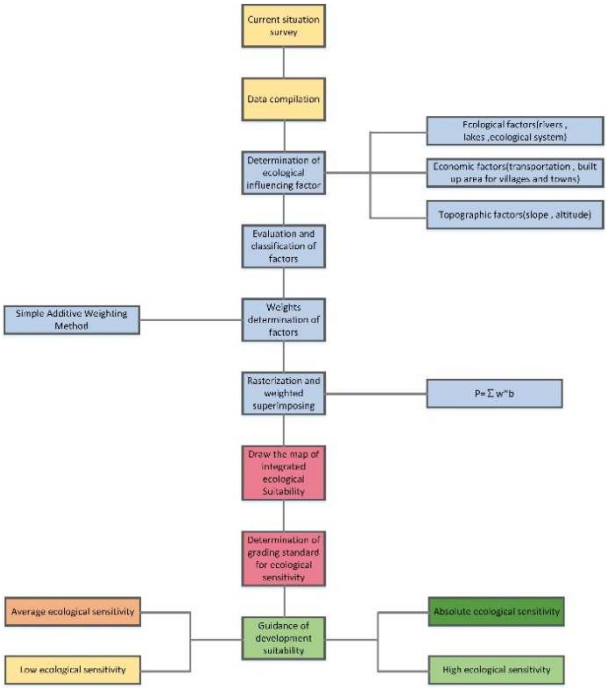

Fig 3. Technology Roadmap of Ecological Sensitivity Analysis

We get the single factor analysis picture by rasterizing the vector picture according to the evaluation standard above and reclassifying its result. We then calculate the classification range and weighted factors and overlie the results with the following formula. At last, we get the final outcome of ecological sensitivity and divide them into 4 categories according to their grades: absolute sensitive, high sensitive, average sensitive, low sensitive.

$$\mathrm{Pi} = \sum_{i=1}^{n} W_i \times B_i \qquad (1)$$

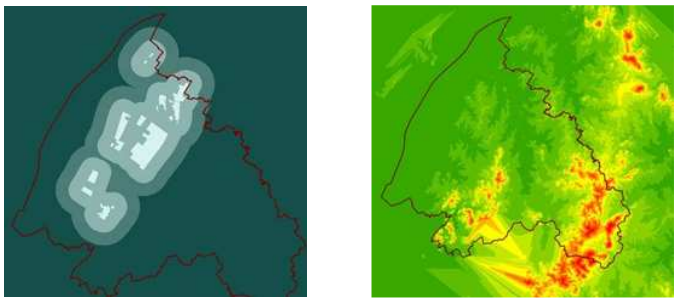

Fig 4. Analysis of Elevation and the impact of construction land (ArcGIS 9.3).

According to the sensitivity classification, we get the values for different areas as follows:
Absolute ecological sensitive area: The compensation fee for development is very high. The environment can hardly stand the human destruction and interference and once destructed, it can hardly recover. Area of land belonging to this category is 83km^2, 32% of the whole area.

High ecological sensitive area: The compensation fee for development is relatively high. The environment can only

stand the human destruction and interference at a very small level and once destructed, it needs a long time to recover. Area of land belonging to this category is 27km^2, 11% of the whole area.

Average ecological sensitive area: The compensation fee for development is relatively low. The environment can stand the human destruction and interference at a much stronger level and once destructed, it needs a short period of time to recover. Area of land belonging to this category is 90km^2, 35% of the whole area.

Low ecological sensitivearea: The compensation fee for development is very low. The environment can stand the human destruction and interference at a very stronger level and once destructed, it can recover quickly. Area of land belonging to this category is 58km^2, 22% of the whole area.

Supporting policy and regime innovation for rural areas:

(1) Innovation of land system

Economic stimulation system for intensive land use must be improved. In order to accomplish this, we must first connect the index of intensive utility with related tax. Second, we should exert the deposit- returning policy, which means we levy deposits on the land users first and then return the deposits to themwhen those investors made an investment that meet with the official standard.

(2) Innovation of urban-rural administrative regime

Scientific and differential assessment regime should be found to contribute to the transition from GDP-centered regime to the assessment regime with multilevel indexes. The basic task for rural communities is promoting agricultural production. Therefore, the task of attaining the set value for secondary industrial production and attracting investment should never be transferred to these areas.

(3) Innovation of administrative regime for urban-rural planning

Administrative organization must be founded with the principle of urban and rural area as a whole. We should also establish integrated regulation methods and systems to push forward the full coverage of plan administration.

CONCLUSION

Besides, lack of rural planning implementation leads to the lag of planning technologies. This paper explores the application of mapinfo 9.5 based on neural network theory which has the universal use in urban planning in rural area planning. We generate the thematic maps of rural economic and social development pictures by using MapInfo and make the ecological sensitive analysis of Jiangning sub-district by ArcGIS, offering rational support to better the land-use and providing the basis for the layout of industries, public service facilities, infrastructures and residential settlements.

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