

# The New Application of GIS in Urban Planning: Based on Urban Space and Fire Disaster\*

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**Abstract**—GIS's strength lies in the powerful function on the combination, dispose, analysis and output functions of spatial and attribute data, which fully satisfy the need for large-scale data analysis and processing in urban and rural planning. In the aspect of urban and rural space, GIS can do quantitative research to the growth of urban space, as well as assist city planning and management. In the aspect of city guard against fires, assessment of city regional disaster risk is helpful to plan the deployment of urban disaster prevention provides important theoretical significance and application value to the reduction of accident loss and the improvement on the urban safety management. In the perspective of a rural and urban planner, this paper discusses the application of GIS on urban space and fire disaster.

**Keywords**—urban spatial growth, fire risk assessment, the fire application system

## I. INTRODUCTION

GIS, which refers to as Geographic Information System, began a rapid development in technology of geography research in the 1960 s. GIS consists of two parts. On the one hand it is an emerging interdisciplinary describe, store, analyse and output of the theory and method of the spatial information. On the other hand, on the basis of geographical spatial database, GIS is a system of computer technology, timely provide a wide range of spatial and dynamic geographical information for geographic research and geographic decision-making service with a geography model analysis method. The continuous development of GIS technology is paid attention to city managers day by day. It has also become a new technical means in the field of urban planning.

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## II. QUANTITATIVE RESEARCH OF URBAN SPATIAL GROWTH

### A. Research Background

At present, the study of the urban spatial growth has been quite mature in urban economics, urban sociology, urban geography, and urban aesthetics. Lacking of objective quantitative analysis method, qualitative analysis method makes the urban and rural planning work with larger subjectivity.

The application of GIS transforms urban planning work from qualitative analysis to quantitative analysis. GIS provides an effective method for land selection of spatial properties characteristics, with greatly improvement in accuracy and efficiency of evaluation work.

### B. Research Approach

Select the appropriate evaluation index for the regional environmental sensitivity evaluation with the support of GIS spatial analysis technology. On this basis, determine the regional construction land boundary is prohibited. Then evaluate construction land suitability, and determine the regional construction land expansion boundary under the extensibility of the total construction land control.

This approach consists of 5 steps, evaluation of regional comprehensive environmental sensitivity, identification of constructive expansion prohibited zone, evaluation of construction land suitability, determination the scale of construction land between scale boundary and expansion boundary, and determination the boundary of construction land expansion.

#### 1. Evaluation of regional comprehensive environmental sensitivity

Theoretically, there are two computing method, weighted calculation method and index calculation method. But in practical application, it is difficult to determine the contribution rate of each evaluation factor to comprehensive environmental sensitivity in planning area. Therefore, usually we adopt index calculation method for calculation in application.

#### 2. Identification of constructive expansion prohibited zone

On the basis of regional comprehensive environmental sensitivity evaluation, determine the prohibited construction boundary. If any factor in the assessment of environmental sensitivity calibrate for highly sensitive area need to be

protected, we should take collection of all highly sensitive factors, and identify it into prohibited construction boundary.

### 3. Evaluation of construction land suitability

Theoretically, there are two computing method, weighted calculation method and index calculation method. But in practical application, usually we adopt index calculation method for calculation in application.

### 4. Determination the scale of construction land between scale boundary and expansion boundary

To reasonably border construction land expansion, first of all should be reasonable scale boundary within the boundary of the scale of construction land. At present there are mainly two kinds of method, one is difference method. According to increased construction land planning history data, by using the methods of trend analysis, linear regression method calculated the added value of the possibility of the construction land area during the planning period. Then would the added value and the actual planning of new construction land scale within the boundary of the difference between the total value as the scale boundary within the boundary of the available amount of construction land. The other method is scenario analysis. On the basis of the current planning of construction land scale amount of construction land within the boundaries, according to the right to use construction land may increase trend, for sure a certain proportion as the number of new construction land reserve scale boundary within the borders of the land use quantity.

### 5. Determination the boundary of construction land expansion

On the basis of the four steps above, according to the theory of land supply and demand balance, the macroscopic land consolidation microscopic phase equilibrium point of view of land supply and demand. To construct the land expansion within the boundaries the basis of the amount of construction land, combined with GIS spatial analysis technology, from meet the largest local construction land suitability and regional environmental sensitivity in the Angle of the lowest complete extension border space allocation of construction land, thus the expansion of the urban and rural construction land border drawn.

## III. CITY FIRE RISK ASSESSMENT AND FIRE CONTROL APPLICATION SYSTEM

### A. City Fire Risk Assessment based on GIS

As the city scale is more and more big, the city's population has increased dramatically, high-rise building, with the increase of urban fire risk, fire frequent accidents, casualties and property losses caused by the growing.

#### 1. New type of fire evaluation model based on GIS

The method of model based on geographic grid space, introduce the geographical factors of fire risk assessment model, to improve the traditional risk model. In this model is

based on the nature of the different area fire impact factor and space distribution characteristics, calculation of different fire risk factors on the influence of different mesh, weight and the contribution of fire risk value. Then to superposition of index system according to their weights, status for city fire risk grade figure, provide reference for urban disaster prevention and mitigation planning.

## 2. Fire evaluation method

### a) Data preparation

Spatial data mainly through the visual of aerial photo interpretation, take partial overlap method, to determine who on the part of the terrain, then use tonal shape texture shadows size position graphics related combination of comprehensive analysis, combined with years of similar land use vector data field investigation sample data, topographic map and soil map, etc., and with reference to the national land classification, through the digital screen, forming network, construction, hazards, key protection units, fire stations, mountain, city distribution, such as water area, water supply point.

### b) Urban fire risk evaluation method based on grid GIS

Grid GIS was used to study the premise of urban fire risk is to determine the size of the grid, grid under the condition of the GIS software to extract the different scale of various land use type area. And extract of 100 m \* 100 m and 200 m \* 200 m and 300 m \* 300 m and 400 m \* 300 m and 500 m \* 500 m 5 types of scale of land area percentage. On this basis, the more under the condition of every dimension, grid area of land use type change of the coefficient of variation, the smaller the coefficient of variation, the scale of the grid is the best grid urban fire risk evaluation.

### c) Urban fire risk evaluation index system

From the urban area environment, fire hazard and protection ability three aspect, choose three grade 1 and 10 2 levels of indicators, using principal component analysis method and AHP method to get the weight. Level 1, by using principal component analysis to determine the weights of index layer, avoids the principal component calculating secondary amplification effect on this sample. Level 2 index using AHP method to determine the weighing values of layer, so as to realize the organic combination of the subjective and objective empowerment, makes the evaluation results more accurate. The most beneficial to spontaneous combustion values 1, the most unfavorable values 0. The characteristic value of qualitative indexes is according to the standard comparison.

### B. City Fire Control Application System based on GIS

#### 1. The significance of GIS

The most important character of the system is the act of all kinds of spatial and non-spatial attribute data management, operation and spatial data analysis. It has two obvious advantages.

*a) The first advantage*

Alarm scheduling subsystem can shorten the time of receiving alarm, the police and the police, and the ability to provide rapid and accurate support, improve the urban fire rescue comprehensive ability as a whole.

*b) The second advantage*

Joined with the traditional system in the data storage, data query and data security advantages, and join the spatial data analysis and graphical visualization display the characteristics of the data is more intuitive, greatly improve the system usability.

2. Function study of City Fire Control Application System

*a) Fire Alarm System*

It mainly by the traditional artificial management under the "119" telephone alarm is improved, namely by the fire alarm system based on GIS to call to check, and to determine the "counter check telephone number" "calling", finally according to the "calling" corresponds to the unit information on the map to locate the precise location of fire, the application of this system to shorten the time by a police were called to the police, and increased the accuracy of positioning.

*b) Fire Control Scheduling Command System*

On the basis of fire alarm system based on GIS is increased the fire forces scheduling function, using network topology analysis model to calculate the arrived at the location of fire area, the director of the fire detachment of the best route to arrival, and displayed on the map, to provide fire dispatch personnel for reference, this kind of system has greatly reduced the traditional fire dispatch commander in a police the subjectivity on the route selection, make fire team of a police line more accurate and scientific.

*c) Integrating GPS/GSM wireless alarm network system*

Between alarm and alarm terminal receiver adopts the wireless communication method, because of the sensor and the use of wireless devices, greatly reduce the intermediate links, accelerates the pace of police, and eventually realize the fire command center to a fire alarm and send real-time monitoring, automatic alarm.

IV. CONCLUSION

Urban and rural planning in China will develop greatly fast. The development of the city will bring new opportunities for urban GIS. This article only views from urban space and disaster prevention, two aspects in the application of GIS in urban and rural planning. However, the actual application scope and depth are much more than these. Sincerely hope that there will be more and more new technologies, including GIS, applied to the urban and rural planning, for the rational development of urban and rural planning, to make our city, country to realize the real urban and rural areas as a whole and intellectual growth.

REFERENCES

- [1] LiuZhao. GIS city bus database construction and the analysis method of research[D]. TJU, 2008.
- [2] FengChunying, XuZhisheng, XuLiang. City fire simulation analysis and fire emergency command system design and implementation[J]. Journal of disaster prevention and mitigation of engineering, 2005, 25(2): 189-194.
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