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## Study and implementation of fire sites planning based on GIS and AHP

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### Abstract

Urban fire is a hidden danger for city safety. Therefore, the overall layout of fire fighting facilities is an important part of fire control planning in cities. This study combines the method of GIS and AHP together. The paper, which fully considers the complicated data and their mutual influence, makes full use of spatial analysis, data processing and query. Planning and analysis will be more flexible and universal by utilizing this method, and the complexity of spatial location selection can be decreased considerably, which consequently may overcome the casualness and uncertainty of subjective site selection. And finally, the approach satisfies the planning requests of some related fire fighting department to a certain degree.

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Key words: GIS(Geographic information system); AHP(Analytic Hierarchy Process); fire station planning© 2011 Published by Elsevier Ltd.

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## 1. Introduction

Urban fire is a hidden danger for city safety. Therefore, the overall layout of fire fighting facilities is an important part of fire control planning in cities.

Reasonable construction of fire facilities and layout of fire stations can improve governments' ability to reduce or prevent fire disasters in cities considerably. What's more, safeguarding urban infrastructure and protecting the lives of local residents are all possible results. Accordingly, a safe environment can be created there.

Recently, with the rapid development of national economy and urban construction, city scale is much larger than before, but fire fighting facilities are relatively lagging. The incoordination between comprehensive ability to resist fire in city and its development reveals gradually. At present, the most prominent issue related to domestic fire stations planning is the insufficiency of fire sites. The principle of fire sites planning is to reach the edges of your areas of responsibility within 5 minutes after alarming. Moreover, proper area of responsible regions may be 4 to 7 square kilometers.

However, most of our cities can not reach that standard. As cities continue to expand, number of fire stations has not increased accordingly. In addition, when it comes to the finished fire sites, problems may be the uneven spatial distribution, inappropriate planning and so on. For example, traffic congestion around fire sites and narrow roads can definitely contribute to the delay of prime time for rescue, because fire engines can not get to the fire scenes in time. Consequently, our safety can not be guaranteed effectively. In contrast, the layout of fire sites in western countries is relatively complete. They are denser, more reasonable. Thus, it will cost less time for the firemen to reach the scenes. Then, fire can be controlled and damage can decrease to a lowest level. Furthermore, the construction mechanism of fire sites in our country is not so smooth and cycle of building is too long. Therefore, we should give priority to those that are in urgent and the most useful when pondering which should be built first.

## 2. Research Status

Currently, there are two major methods to plan the layout of fire stations, that are Abstract Mathematical Models and GIS combined with AHP. What should be done first when you use Abstract Mathematical Models is to choose the elements that need to be researched into according to the requirement of fire sites selection (identify the problems). Then a series of mathematical equations or geometric symbolic can be used to express every element related to site selection (build models). And finally, the problem can be solved under the previous steps (solve the models). The features of this method can be concluded in the following passage.

We are able to solve the location issue that has just one factor. But, some factors, for instance, density data, is hard to express by mathematics equation. In addition, establishment of models is so complex that it needs sufficient mathematics skills to solve the problem and it is difficult to transform mathematical models to computer models. What's more, some abstract models are easy to divorce from reality, and it is not easy to consider all the complex essential factors and their mutual influence. The versatility of this traditional method is not so good. Therefore, it is hard to provide intuitionistic interactive analysis-tools to policy-making people. Specifically, as to fire station planning and constructing in a city, the traditional analytical method for location selecting cannot be used if considering immense amount of data of transportation, population, economy and so on.

But GIS combined with AHP can make full use of GIS functions such as space analysis, data processing and inquiry. It has following characteristics. In the process of location selection, the complex data and their mutual influence can be considered well. And it is not necessary to use massive complex mathematical equations to describe space position of each factor. Moreover, the analysis is more flexible and it is easy for data renewal. Location selective models are easier to understand. In addition to that, there is a variety of GIS software to utilize, so it is not necessary to realize foundational analysis function from the very bottom. Secondary development functions of GIS can also be used to develop excellent man-machine interactive interface. As a result, GIS combined with AHP is a tendency to planning recently, and many efforts have been made to conduct planning problems using GIS. However, mature planning and experiments are relatively few towards the selection of fire station location.

On the basis of the foundation concluded by predecessors, this research has analyzed basic principles of fire station planning and proposed a technical solution of fire station planning based on GIS and AHP. Take data of BeiJing within 3rd Ring Road for example, location selection AHP models are designed by using GIS network analytic method, buffer analytic method and superimposition analytic method. Then we realize the selection of

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