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Study of Earthquake Disaster Prediction System of Langfang city Based on GIS

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Abstract. In this paper, according to the status of China's need to improve the ability of earthquake disaster prevention, this paper puts forward the implementation plan of earthquake disaster prediction system of Langfang city based on GIS. Based on the GIS spatial database, coordinate transformation technology, GIS spatial analysis technology and PHP development technology, the seismic damage factor algorithm is used to predict the damage of the city under different intensity earthquake disaster conditions. The earthquake disaster prediction system of Langfang city is based on the B / S system architecture. Degree and spatial distribution and two-dimensional visualization display, comprehensive query analysis and efficient auxiliary decision-making function to determine the weak earthquake in the city and rapid warning. The system has realized the transformation of the city's earthquake disaster reduction work from static planning to dynamic management, and improved the city's earthquake and disaster prevention capability.

1. Introduction

With the rapid development of urban construction, there is an urgent need to assess and improve the city's earthquake and disaster prevention ability, strengthen the seismic key technology research and take effective measures to reduce the earthquake losses. Langfang City developed earthquake disaster reduction information system in 2012. However the earthquake disaster reduction professional model and IT technology and GIS technology is not tight enough in the system, and GIS spatial analysis function is weak, which often lead to earthquake disaster reduction information system lack of real-time characteristics. The earthquake disaster prediction system of Langfang city is the main task of the project ——"Seismic Activity Detection and Seismic Hazard Assessment of Hebei Province", organized by the Seismological Bureau of Hebei Province.

Based on the GIS spatial database, coordinate transformation technology, GIS spatial analysis technology and PHP development technology, the seismic damage factor algorithm is used to predict the damage of the city under different intensity earthquake disaster conditions. The earthquake disaster prediction system of Langfang city is based on the B / S system architecture. Degree and spatial distribution and two-dimensional visualization display, comprehensive query analysis and efficient auxiliary decision-making function to determine the weak earthquake in the city and rapid warning. This paper introduces the development process of this system in detail[1-3].

2. System overall design

The system structure of earthquake disaster prediction system of Langfang city is shown in Figure 1. The workflow is as follows: The spatial database of earthquakes prediction in Langfang City is established according to the distribution of the geologic disaster and the degree of danger, the basic situation of the building and the infrastructure (including name, spatial distribution, structure type, seismic fortification, current working status, etc.) in Langfang City. This system uses the MVC design pattern and GIS spatial analysis Model and the basic principles of earthquake engineering to predict the severity and spatial distribution of urban earthquake disaster and realize the change from static planning to dynamic management of urban earthquake disaster reduction.

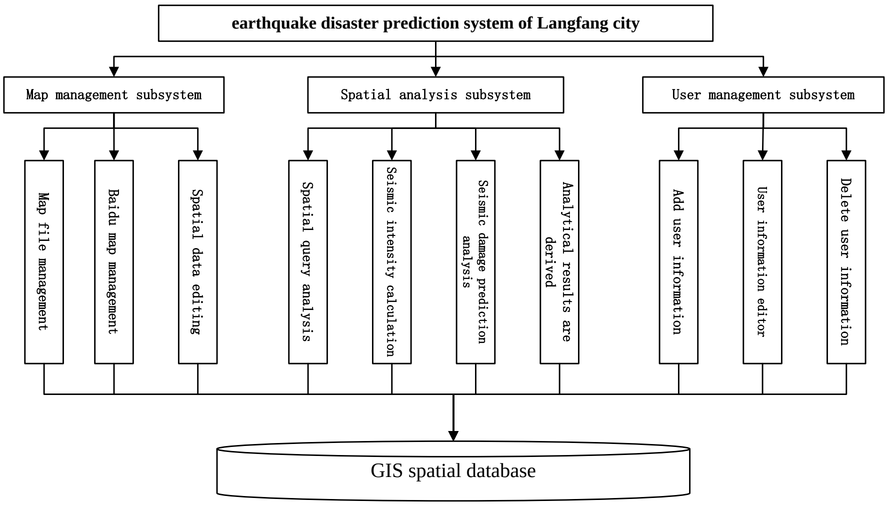

Figure 1. The system structure of earthquake disaster prediction system of Langfang city

3. System implementation

The earthquake disaster prediction system of Langfang city is based on PHP + MySQL database + Baidu map interface + ArcGIS shp layer (projection conversion lifeline data). The system fully utilize the GIS tool to deal with the spatial database,to improve the development efficiency of the application system. The application has a good appearance, more powerful database function, good reliability, and is easy to transplant and maintain.

3.1 Design of spatial database for the earthquake disaster prediction system of Langfang city

Langfang earthquake damage forecasting space database, including the distribution of geological hazards and the degree of danger, the basic situation of buildings and infrastructure and lifeline and other information, the relevant content of the author in the previous article has been described in detail, will not repeat them here.

3.2 map projection conversion

At present, the projection of data we collected is WGS84 coordinate system. However the system will eventually be displayed on Baidu map. Baidu map using Baidu coordinates (BD09). So we must use a coordinate system that has been used after at least two times of encryption. Coordinate conversion is very necessary. At present, Baidu provides a coordinate for the conversion of the API.Application of the API, this paper to achieve the WGS84 Baidu coordinates of the conversion.

3.3 seismic intensity attenuation

China's vast territory, geological structure is complex, which, from the seismic intensity of the shape of the complex shape of the earthquake can also be reflected. In general, the seismic intensity of the isosceles line is oval, which is due to the impact of geological structure. along the direction of the earthquake direction of the intensity of attenuation is slow, and the vertical direction of the fault attenuation faster, decay of the direction The difference to the far field gradually disappear, isometric line and tend to round. Thus, the difference in the ratio of the major axis to the minor axis length of the isosceles of the seismic intensity in different regions can reflect the regional differences in seismic intensity attenuation, which is one of the bases of the seismic intensity attenuation relationship. In this

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paper, we use the above two kinds of intensity calculation method to calculate, to provide technical support and assistance to earthquake experts.

3.3.1 round model. The seismic intensity attenuation includes two empirical formulas.
The first one: the intensity of meizoseismal area is equal to the magnitude plus 2 or 3, and the plain area (Langfang, for example) plus 2. For example, the system set the highest intensity 6 earthquake corresponding to 8 degrees, 7 corresponding to the earthquake intensity is 9 degrees, the highest intensity 8 earthquake corresponding to 10 degrees. The other one is an empirical formula. In general, the higher the intensity, the faster the decay. The distance that need when 10 degrees decay to 9 degrees is about 5km while 10km for 9 degrees to 8 degrees, 20km for 8 degrees to 7 degrees, 40km for 7 degrees to 6 degrees.

3.3.2 linear focus model. The relationship between the attenuation of the linear focus earthquake intensity in the North China area is as follows:

$$I_l = 2.033 + 2.010M - (0.923 + 0.151M)\ln(R' + 27.035)$$

$$I_s = 0.064 + 1.949M - (0.433 + 0.169M)\ln(R' + 13.073)$$

I is the intensity value corresponding to the focal depth, magnitude and epicentral distance and R' is the distance from the source to the target area ($R' = \sqrt{h^2 + D^2}$) , h is the focal depth, and D is the epicentral distance[4-5].
In addition to the three major factors of long axis distance, short axis distance and fault strike, it is necessary to determine the fault strike. We introduce the potential zoning map of the whole country into the ArcGIS software platform, and use the segment of the potential source area to simulate the earthquake fault, and finally get the fault to this element, and perfect the attenuation relationship under the line source. In the Langfang area simulation occurred a 7 earthquake, the effect shown in Figure 2.

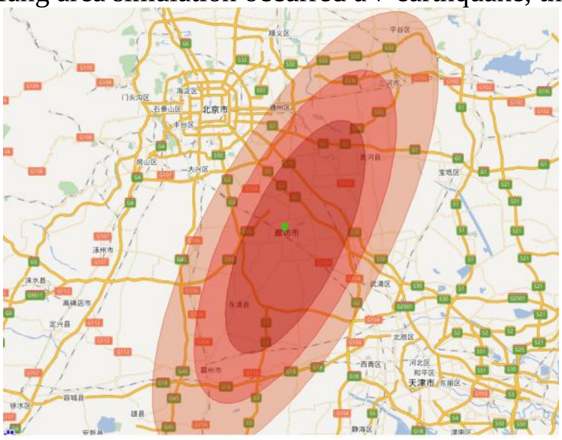

Figure 2. The linear focus Seismic Intensity Map

3.4 Building damage prediction
Langfang city has up to tens of thousands of buildings, one by one investigation is almost impossible. Therefore, according to the village distribution, street administrative area, scope of work and accuracy requirements, the Langfang City Planning Area is divided into 109 prediction unit grid.
The seismic damage prediction of the group building adopts the combination of the typical analysis and the group forecasting. Due to the large number of buildings in Langfang City, the group prediction method is adopted. And the damage factor analysis method is used to determine the damage state of the buildings under different earthquake intensities.
The basic idea of the damage factor method is to find out a number of factors that have great influence on the earthquake damage of the building on the basis of summing up the historical damage data and

to quantize it. We put these numerical factors as the earthquake damage factor, said d. After the damage factor is obtained, the factors are summarized as the earthquake damage factor table, and the damage index D of the building is obtained according to the formula (1). Through the statistical analysis of the previous earthquake damage, we can determine the range of the damage index D corresponding to the five damage levels which are basically intact, minor damage, moderate damage, serious damage and collapse. The calculated D value is compared with the range table to determine the damage of the building.

$$D = w\prod_{i=1}^{9}\prod_{k=1}^{2,3,4,5,6} d_{ik}^{m_{ik}} \tag{1}$$

W is the conversion factor of the peak acceleration of ground motion A, $A<0.05g$，$w=0$；$0.05\leqslant A<0.1g$，$w=0.4$；$0.1\leqslant A<0.2g$，$w=0.8$；$0.2\leqslant A<0.3g$，$w=1.6$；$0.3\leqslant A<0.4g$，$w=2.4$；$A\geqslant 0.4g$，$w=3.2$； When the i item in the k class mik takes 1.when there is no k class mik takes 1.

There are two main advantages to the prediction of the earthquake damage of the group building by the seismic damage factor method. First, the damage factor method does not need very detailed investigation to the sampling data of buildings, to avoid the difficulties of collecting and processing a large number of building drawings and related information, which can improve the sampling rate and is also very easy to carry out practical work. Second, the precision of seismic damage prediction can be satisfied by the earthquake damage factor method. The system simulates the earthquake damage of buildings in Langfang area under the 7 earthquake, and the results are as follows:

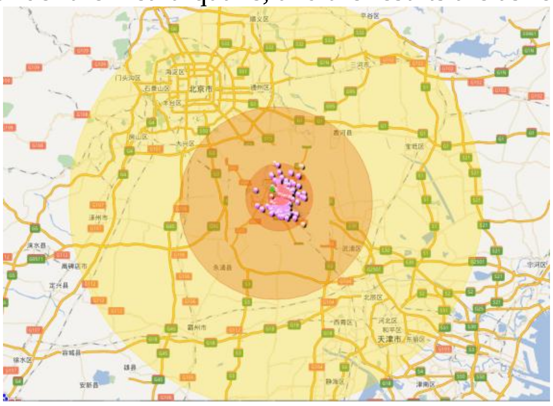

Figure 3. The earthquake prediction of buildings in Langfang City

3.5 earthquake damage prediction analysis

In order to improve the anti-earthquake and anti-disaster capability of Langfang, this system is based on the basic principle of earthquake prediction and spatial engineering of earthquake. The system is analyzed by accident tree model, AHP model and successive approximation model and GIS spatial analysis technique in the aspects of personnel casualty loss assessment, lifeline damage prediction, traffic system earthquake damage prediction and secondary disaster prediction. Through the analysis, we can find out the existing earthquake disaster prevention capacity in Langfang, find out the weak links and key links, and provide technical support for the decision-making departments to take the earthquake disaster prevention and control measures in advance.

3.6 User Management

This module mainly includes user management, that is, users add, edit and delete and other functions.

4. Conclusion

According to the current situation of improving earthquake disaster prevention capacity of the city to our country, we put forward the implement scheme of system of earthquake damage prediction of Langfang city based on GIS technology. We can predict the different intensity of earthquake disaster under the condition of the injury and city spatial distribution and show them on map to determine the city seismic weak link and quickly alert. The system has realized the transformation of the city's earthquake disaster reduction work from static planning to dynamic management, and improved the city's earthquake and disaster prevention capability.

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