THE DEVELOPMENT OF URBAN EARTHQUAKE DISASTER INFORMATION MANAGEMENT SYSTEM IN CHINA

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Key Words

Urban Earthquake Disaster, Information management system

Abstract

This paper gives an overview of the urban earthquake disaster information management system (UEDIMS) developed in China, including the framework, database, modules and some sample cases. UEDIMS is a result of the urban earthquake disaster predication project which was support by China Earthquake Administration and local government. It is a professional software system which is used to manage the earthquake disaster related information, predicate the economic loss and casualty of a certain scale earthquake disaster, and supply information and analysis models for emergency response decision making.

Introduction

Since the end of 1980s, under the financial support of China Earthquake Administration and local government, many cities in china implemented the earthquake disaster predication project, which included the estimation of destroy of buildings, pipes, roads, bridges etc. and the probably economic loss and casualty under a certain earthquake magnitude. In each predication project, all the information from the sub-projects was finally combined into an information management system, The urban earthquake disaster information management system (UEDIMS), which includes the basic geography information, predication results, relative documents etc. UEDIMS is a software system based on GIS which is used for manage the earthquake disaster related information. It also includes many professional models which can predicate the economic loss and casualties of a certain scale earthquake disaster. Other than the predication, this kind of software can supply information and analysis models for decision making, such as the hazard profiling, an automatic produced report of the disaster influence, and best path analysis for medical center, best path analysis for fire fighters, etc.

System Framework

UEDIMS can be divided into five layers: Platform, database, models, application and service. The platform layer includes the operating system - Windows server 2003, the database software – SQL

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Server and the GIS software – ArcGIS. The database layer is constructed above SQL server and spatial database engine, which includes the basic geographic data, the thematic earthquake disaster predication related data, the population and economic data and other related data. The models layer includes the core professional models which are used in the software developing, such as the earthquake attenuation model, the building and lifeline system destroy predication model, the casualty and loss estimation model, the best path analysis model, etc. The application layer is the professional software layer which is built on the above layers. The software is a GIS based software, which manage the information spatially. Almost all the data is related to a map layer. The information service layer is based on the application layer and used to supply professional information to government and ordinary people, which is also developed on GIS. Users can browse and identify the information through the internet browser and a map interface (Fig.1).

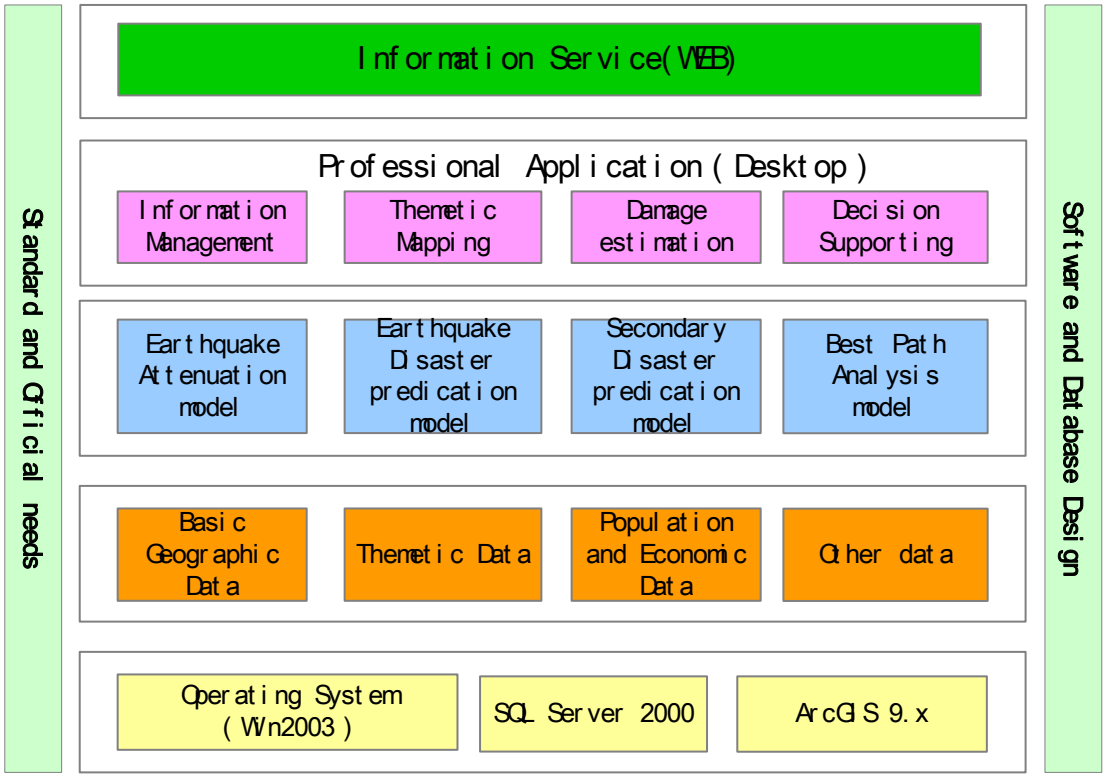

Fig.1 The framework of urban earthquake disaster information management system

Database

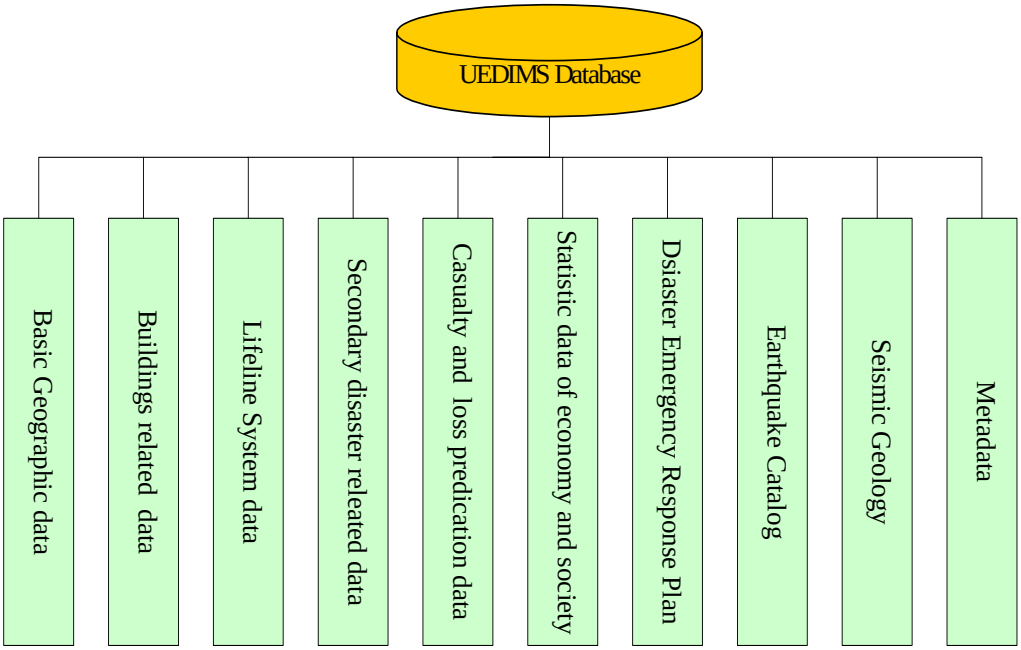

Fig.2 The database of UEDIMS

Usually, the database can be divided into two parts, the first part is the spatial related data and the second part is other statistic data which used for computation and predication. The spatial data can be displayed by map or table. Other data can only be displayed by table. Normally, the non-spatial data is used as a background and for computation.

The spatial data includes the basic geographic data and the thematic earthquake disaster related data. In many cases, the big scale basic geographic data, for example 1:500 to 1:2000, is used as the background map and for data investigation, such as buildings and lifeline system. The urban earthquake predication project produce lots of thematic data, such as the earthquake zonation, seismicity analysis, the vulnerability analysis of buildings, the vulnerability analysis of lifeline system, the influence of secondary disaster, casualty and loss estimation and emergency response plan (Fig.2).

Those data is managed in database software or as data file refer to the category. The spatial data can be stored in ESRI Shape file format, in ESRI geodatabase format or in SQL server through the ArcSDE spatial data engine.

Core models

Many professional models are used in UEDIMS, including the earthquake attenuation model, the damage predication models for buildings and lifeline system, the casualty and loss predication model, the secondary disaster predication mode, etc. Two sample models are given here, the earthquake attenuation model and the casualty estimation model.

An eclipse attenuation model is adopted by most seismologists in China. This model suppose that the earthquake attenuate along the earthquake fault direction as an eclipse, following is an attenuation function which is used in the southern area of China.

$$I_a = 4.2373 + 1.5360M - 1.7183\ln(R_a + 14) + \varepsilon_{Ia}$$

$$I_b = 2.8626 + 1.5360M - 1.5716\ln(R_b + 7) + \varepsilon_{Ib} \quad .$$

Where Ia and Ib is the earthquake intensity, Ra and Rb is the attenuation radius along and vertical to the fault direction, and M is the magnitude of the earthquake.

The casualty estimation model is based on building damage grade and the distribution of people in different type of buildings. The builds are usually divided into three categories as to the using: first is apartment, second is office room and the third is public place, such as cinema, railway station, etc. An ordinarily adopted casualty estimation function is as following:

$$M_D(I) = C\eta(A_1 r_{d1} + A_2 r_{d2} + A_3 r_{d3})$$

$$M_H(I) = C\eta(A_1 r_{h1} + A_2 r_{h2} + A_3 r_{h3})$$

Where $M_D(I)$ is the dead numbers under the I intensity influence, $M_H(I)$ is the heavy injured number under the I intensity influence, C is the percent of people who are inside during the earthquake, A1 is the total area of the buildings which are devastated, A2 is the total area of the buildings which are heavily damaged, A3 the total area of the buildings which are Middle damaged, A4 the total area of the buildings which are light damaged, η is the population density, rd1 and rh1 is the dead ratio and injured ratio of the devastated buildings, rd2 and rh2 is the dead ratio and injured ratio of the heavily damaged buildings, rd3 and rh3 is the dead ratio and injured ratio of the middle damaged buildings, rd4 is the injured ratio of the light damaged building.

The software

The professional version UEDIMS software includes four sub-systems: the basic information management, earthquake disaster prevention, earthquake disaster predication and emergency response support. The basic information management sub-system manages all the data that used by the software system and also supply update function for buildings and other core data. The earthquake prevention sub-system manage the earthquake disaster related information and supply some analysis function for identify the vulnerable place of the city. The earthquake predication sub-system supply lots of function for predicating damage of buildings, roads and pipelines, the causality, the economic loss and the secondary disaster influence under a certain earthquake disaster. The emergency response support sub-system supply functions for medical treatment, evacuation and infrastructure repairing analysis. It also can create a report automatically which includes the disaster influence estimation and the emergency response plan and is very useful for decision making (Fig.3).

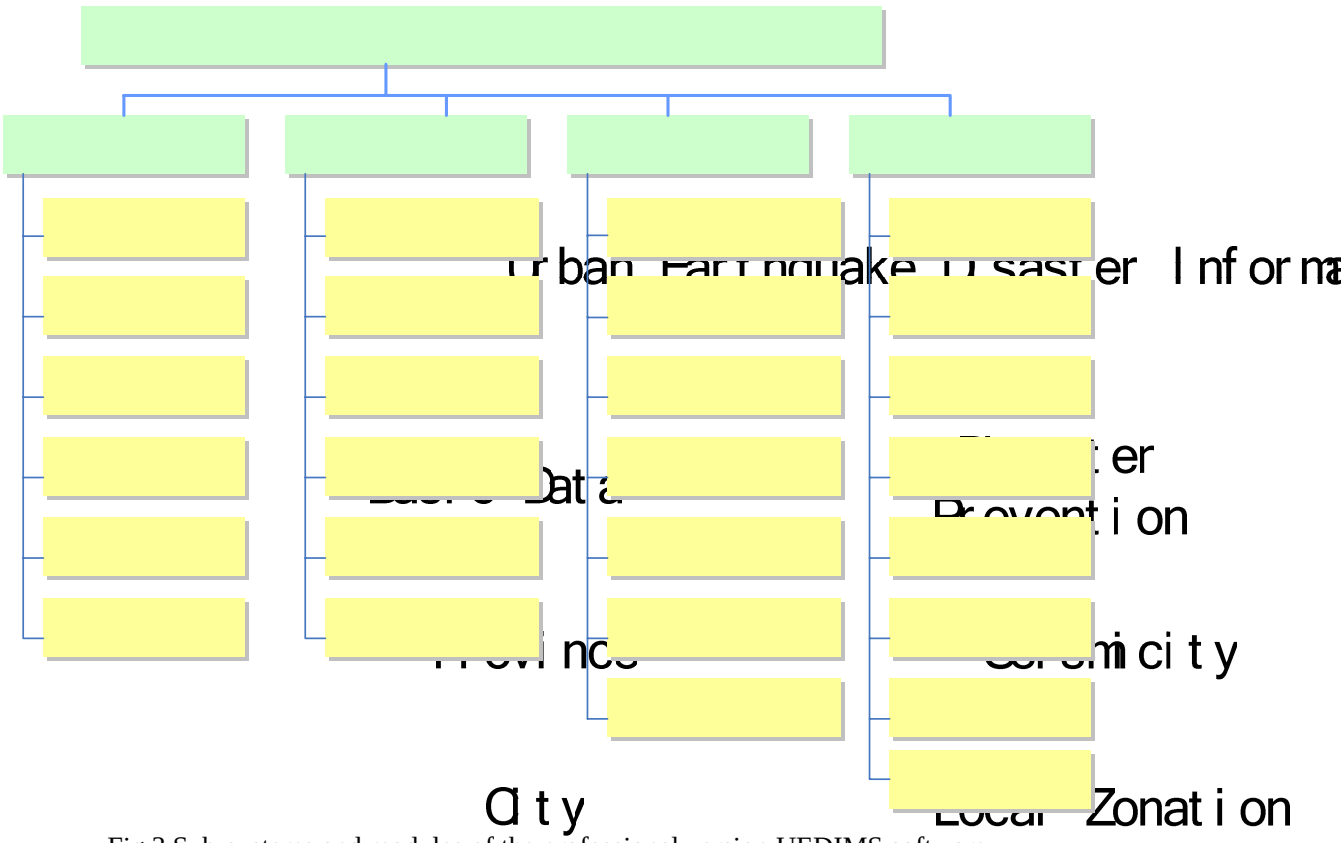

Fig.3 Sub-systems and modules of the professional version UEDIMS software

Some other application was created above the professional version UEDIMS, including the 3D Scene display, the WEB information service. The WEB service version UEDIMS is also develop on GIS platform, which supplies information identify through the map interface. It also supplies some documentary browsing and searching function.

Sample cases

Since the late of 90s, many cities around China develop UEDIMS for earthquake disaster information management and emergency response, Such as Fuzhou, the capital city of Fujian province, Guangzhou, the capital city of Guangdong province. Those software systems almost have the same database and software structure because they were constructed under a national standard. Following are some screen captures of those software's interfaces and results created by them.

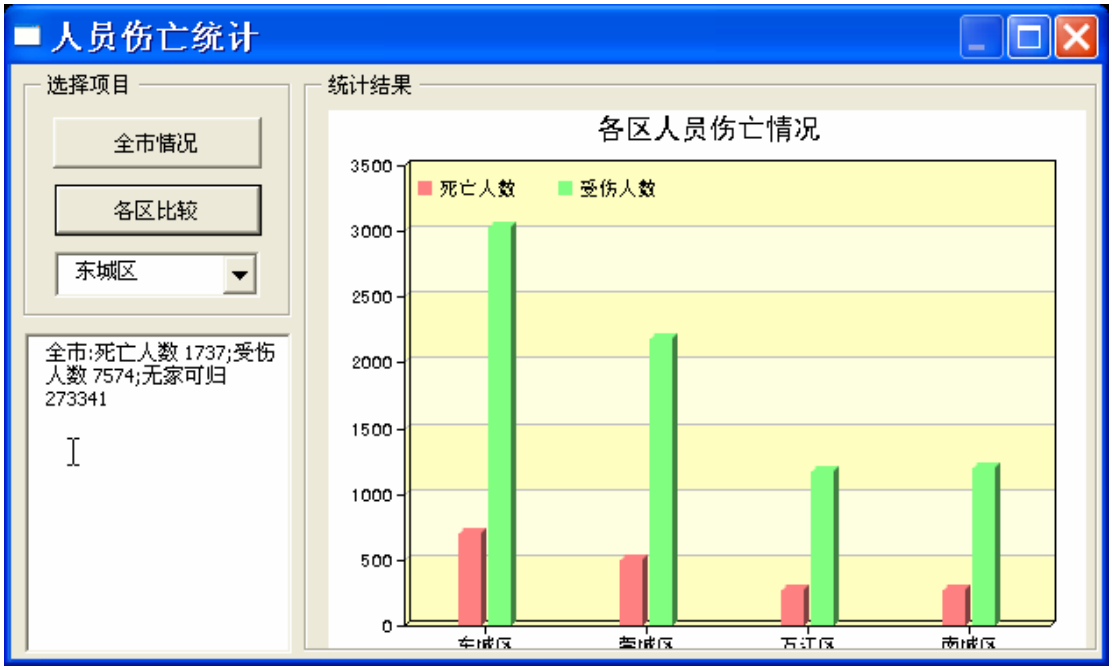

Fig.4 a comparing chart of the dead numbers among different districts

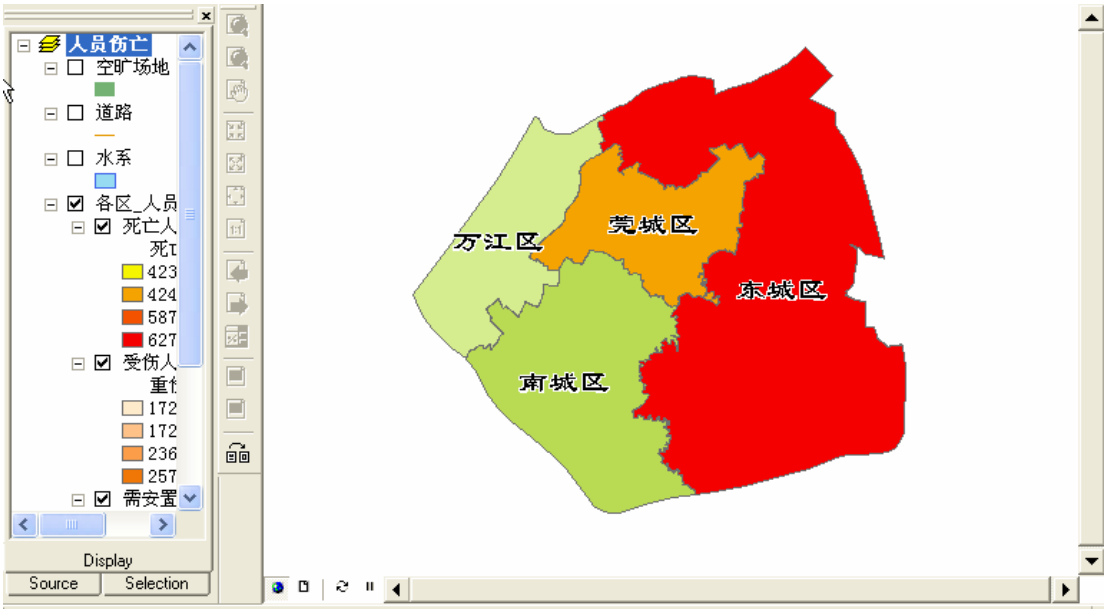

Fig.5 a thematic map of dead numbers of different districts

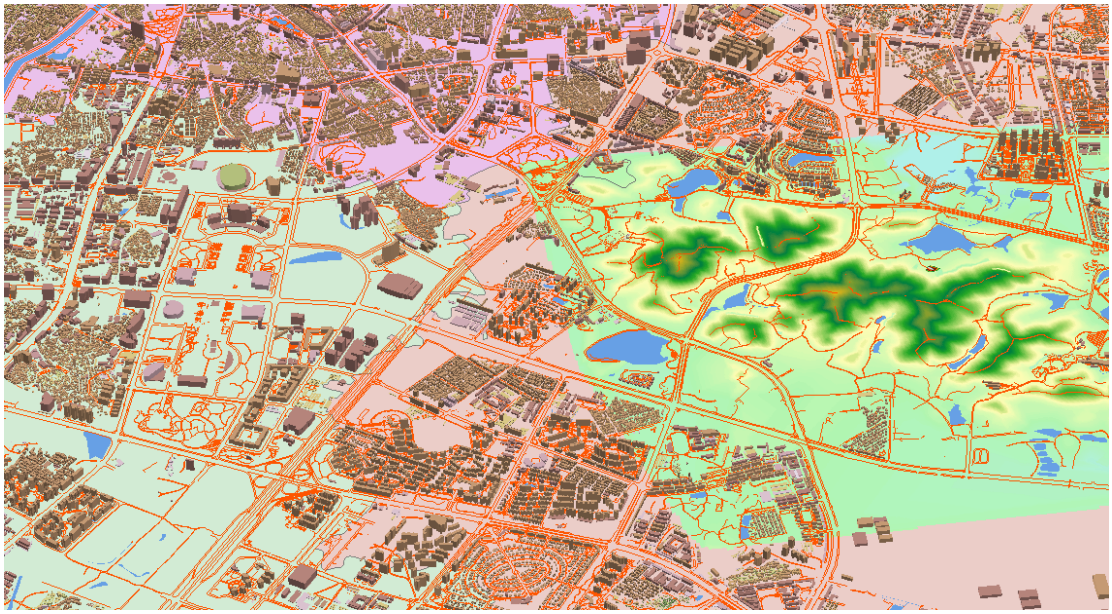

Fig.6 a 3D Scenario of the Urban Area Created by UEDIMS

Fig.7 a web map Service supplied by UEDIMS

Author's Biographies

Dr Li Yigang, currently associate professor of national earthquake response support service, China earthquake administration. Research interests include earthquake disaster prediction, emergency management, GIS&RS application and 3D Geologic Structure modeling.