RESEARCH ON THE METHOD OF SEISMIC HAZARD EVALUATION BASED ON THE GIS AND GDP

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ABSTRACT:

This paper, based on the data of contemporary earthquakes in both Zhejiang Province and nearby districts, attempts to analyze firstly the historical damages, then study the distribution of an earthquake possibility and the characteristics of the loss according to the geological conditions, economy and population of this province, so that the method of approximate estimation can be established to improve the governmental abilities in dealing with the quake and provide information as the basis of official relief decisions.Firstly can produce an evaluation model according to the recorded earthquake, stastistic lines with same force in Zhejiang Province, and may thus attain the relation model between the long and short axes of the impact scope with different intensity. Then by comparing this province with nearby districts or those that have similar geological conditions on the occurrence of earthquakes, we can produce the model of the impact scope. This new method adopts the local total output value (GDP) and the population data to replace the traditional house building classification. By combining with the GIS to build a model, this new method may get an efficient and feasible result. Comparing to the traditional evaluation methods, the rapid evaluation of earthquake loss is a valid method which predicts the big dimension of earthquake disaster.

1. INTRODUCTION

With the development of Zhejiang province's social economy accesses to a steady stage, people's living standard enhances with steady step, all kinds of construction work unfold completely, the general public and the community demand higher standard of life and security. Therefore, the impacts of nature disasters are more and more notable. The ruinous and sensible earthquake is one of these disasters. Once the earthquake happens, the concerned departments starve for the information of earthquake area to direct disaster rescues. Thereby, each relative department should work swift, accurately and efficiently during the disaster rescues.

The rapid evaluation of earthquake loss uses experiential models to evaluate the loss of earthquake in a short time. The information about the scale of earthquake may help the government and the relative department to make countermeasures, dispose disaster rescue action and strive for foreign aid. If we can estimate the distribution and degree of the earthquake in a short time, the government may make a scientific decision to rescue disasters, then more people who lived in the earthquake area may rescued, the loss of economy may reduced.

At present, the dominating method of the rapid earthquake hazard evaluation system based on the class list of building. It considers the economic loss of earthquake equals to the multiplication of the dangerous of earthquake, the building vulnerability and the loss rate of building and financial affair. Accordingly, the evaluations of the other kinds of loss are also based on the building's class list. All the evaluations are based on the concern databases of buildings. Nevertheless, the estimations of seismic hazard which based on the buildings' class listing have some deficiencies. Firstly, the collection of data is cockamamie. It needs to collect the exhaustive catalogs of buildings and establishments which are built in the earthquake areas. At present, the relative departments still can not fulfill the database. However, if they finish the whole database now, it is very hard to renew the data in the future. Secondly, it is not scientific to calculate the loss and breakage of establishment in the way of money. It is because the values of buildings and establishments will fluctuate when the value of money is changed. If we use this way to calculate the value of buildings and establishments, the value changes very quickly in the province whose economy develops very quickly, such as Zhejiang province. Thirdly, although the complicated computer programs and the perfect databases are used in the evaluation, the misestimating still exists. Therefore, the rapid evaluation of seismic hazard which is based on the macroeconomic index is attractive. Since it is easy to acquire the database of macroeconomic index, and the database renews in time.

2. THE RAPID ESTIMATION OF SEISMIC LOSS BASED ON THE GDP INDEX

2.1 The Rapid Estimation of Seismic Loss Based on the GDP Index is proposed

The assumption of the rapid earthquake hazard evaluation system which based on the GDP index is: the hazard which is caused by the earthquake has direct correlation with the social finance of this area. The social finance usually can be expressed by the macroeconomic index, for example the GDP or GNP. It directly calculates the economic loss of earthquake, and then we do not need to differentiate the direct economic loss and the indirect economic loss. This kind of evaluation has predominance to the outcome of direct loss, however, it does not consider the detail of loss, and therefore it can not provide the countermeasure of disaster defense. For the macroeconomic index and vital statistics are renewed very quickly, it is a feasible and efficient way to evaluate the seismic hazard.

2.2 The Acquisition of the Data of the Rapid Evaluation of the Economic Loss of Seismic Hazard

The database which is used for the rapid evaluation of seismic hazard is based on the GDP and the vital statistics of villages and towns. The macroeconomic index and the vital statistic database can be acquired easily from the statistic department. In the countries, especially the mountainous area, the density of population is small, we can use 1:50000 base geographic data to dispose it again. In order to use the vital statistic data adequately, we depend on the residential distribution chart and allot the information of census and the GDP data according to the proportion of the occupied acreage of residential buildings. At last, we can use the data and the divinable model of earthquake to make the rapid evaluation of seismic hazard. In the calculation, we use GIS to read the acreage of residential building in different villages and the proportion of residential building in each village. Then we use Attenuation Relations for Ground Motion which is commended by the Forth-Generation Zoning Map of Earthquake Motion in East of China to calculate the infection of earthquake, and judge the distribution of population and the Gross Indices of Macroeconomic Operations which may belong to corresponding area of seismic intensity.

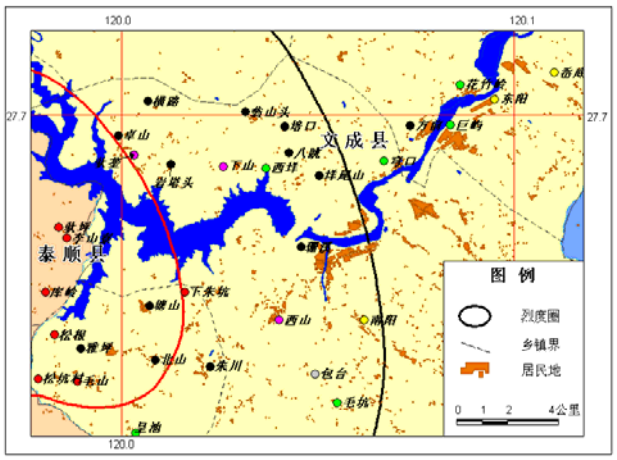

Chart 1. 1:50000 Residential Distribution 、 Seismic Intensity distribution Chart

2.3 The Model of Seismic Hazard Evaluation

2.3.1 The Calculation of Economic Loss

In order to objectively measure the differences of seismic macro vulnerability of class index in these areas which have different levels of economic and social development, we use population density, GDP per capita, GDP per unit area and the GDP per capital and per unit which are calculated through the constant price of 2000, and so on five indicators for references to analysis the loss rate and the death rate of seismic intensity zoning. Through these calculations, we can measure the possible catalogue value of different indicators. In order to get an objective and rational class index and a scientific outcome, we decided to use the GDP per capital which are calculated by the constant price of 2000 as the class index of seismic macro vulnerability. (We will call it GDP per capita 2000) According to the GDP per capita 2000, we set 2700$ and 10000$ as the references of different societies. And then we can build the relationship of seismic macro vulnerability in different societies. Then we do the analysis according to the intensity area allocation methodand the GDP per capita 2700 Yuan and 10000 Yuan which are calculated by the constant price of 2000. (Look at chart 2) Then the relationship of macroeconomic loss can be expressed as:

$$MDF = A \bullet I^B \qquad (1)$$

MDF represents the loss rate of GDP, I represents the seismic vulnerability, A and B are coefficients. The value will be filled in Table 1.

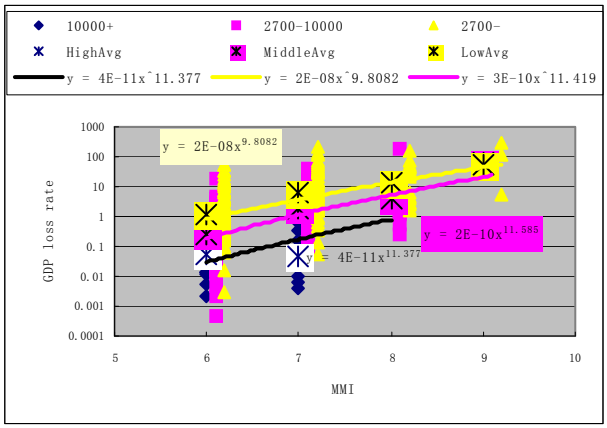

Chart 2: The relationship between the GDP loss rate and the vulnerability

2.3.2 The Calculation of Casualties

In this part we will allocate the data of casualties according to the intensity area, and then analysis the data according to the GDP per capita 2700 Yuan which is calculate by the constant price of 2000. (Look at chart 3)

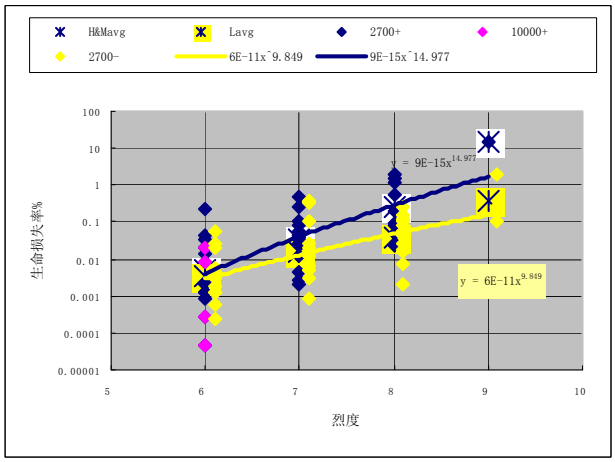

Chart 3: The relationship between the death rate and the vulnerability

Because there are only four samples in intensity VI when the value of GDP per capita 2000 is above 10000, we can not do the fit. Therefore, we classified them to the value of 2700-10000 Yuan. Then we get the relationship between the death rate and the intensity. It can be expressed as below:

$$R = A \bullet I^B \qquad (2)$$

GDP per Capita （Constant Price of 2000）/Yuan	Intensity *I*				Remark
	Ⅵ	Ⅶ	Ⅷ	Ⅸ	
Above 10000	0.0285	0.1647	0.7525	2.8739	$A=4\times10^{-11}$， B=11.377
2700-10000	0.2070	1.2345	5.7987	22.6950	$A=2\times10^{-10}$， B=11.585
Below 2700	0.8576	3.8897	14.4118	45.7542	$A=2\times10^{-8}$， B=9.8082

Table 1: The seismic economic loss rate which is based on the macroeconomic index (GDP)

Method of Evaluation	Casualty of People （Per Person）		Economic Loss （Per Ten Thousand Yuan）	Corresponding
	Be Injured	Death		
Construction of Building	0	0	4521	46%
The Distribution of GDP	0	0	6652.5	67%
The Result of Investigation	0	0	9936.1	100%

Table 2: The comparison of two methods of seismic hazard evaluation

R represents the forcastable death rate; I represents the intensity; A and B are the coefficients. The matrix of seismic death rate and vulnerability can be expressed in Table 2.

3. THE INSTANCE OF SEISMIC HAZARD ANALYSIS

In order to test the applied effect of the method of seismic hazard evaluation that is based on the GIS and GDP, we will choose an earthquake which happened between Taisun county and Wencheng county in Zhejiang province on February 9th, 2008 to analysis. The parameters of earthquake will use the actual epicenter position and magnitude of earthquake. Then we will use the model mentioned above and consult the seismic hazard loss rate and the cost of building to do the calculation. This calculation can be separated into two parts:the first part uses the traditional method which based on the breakage of building to evaluate the hazard of earthquake; the second part uses the method which based on the distribution of GDP to do the rapid evaluation of seismic hazard.

Analysis the Table 3, we will find that: when we use the data of buildings' construction which acquired from the 5th census in 2000 and the traditional method of seismic evaluation, the outcome of calculation has large difference with the result of actual investigation. However, when we use the method of GDP distribution and residential area model which based on the 1:50000 base geographic data, we get the 85%value of actual economic loss. The new method is correspondingly better. The new method which uses the GDP distribution to evaluate the economic loss of seismic hazard is a feasible way. Therefore, we can get the conclusion that: the traditional way which uses the constructions of building to evaluate the economic loss of seismic hazard is not as good as the new method which uses the distribution of GDP.

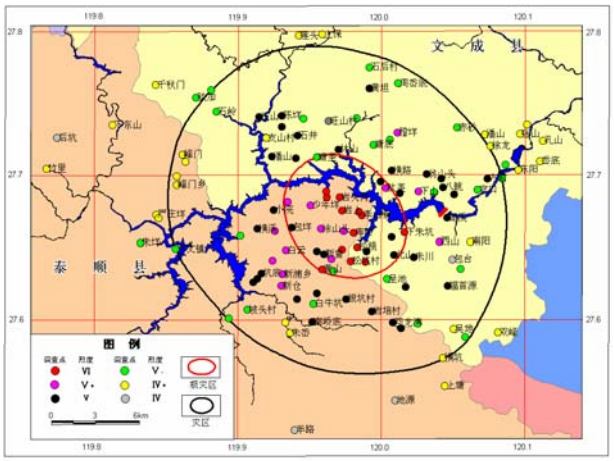

Chart 4: The distribution of intensity of M_L4.6 earthquake of Taishun

4. CONCLUTION

Therefore, we can get the conclusion that: the traditional way which uses the constructions of buildings to evaluate the economic loss of seismic hazard is not as good as the new method which uses the distribution of GDP. This is because the data of the traditional evaluation method is quite hard to acquire and uneasy to renew. However, the data of macroeconomic index is quite easy to acquire and they are renewed in time. The result of the new method of seismic evaluation which based on the GIS and GDP is scientific and efficient.

In the future more researches can be made on the new methods of seismic hazard evaluation.

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