THE DEVELOPMENT OF RESERVOIR-INDUCED SEISMICITY
AND RISK ASSESSMENT SYSTEM

Xiang Ding

Institute of Earthquake Science, China Earthquake Administration, Beijing, 100036, CHINA

dingxiang525@163.com

Xiaoqing Wang

Institute of Earthquake Science, CEA, Beijing, 100036, CHINA, wangxiaoq517@163.com

Youhua Zheng

Institute of Earthquake Science, CEA, Beijing, 100036, CHINA, zhyh2002@126.com

Feiyu Zhang

Institute of Earthquake Science, CEA, Beijing, 100036, CHINA, 61138461@qq.com

Long Wang

Institute of Earthquake Science, CEA, Beijing, 100036, CHINA,wanglong_cn@hotmail.com

1. INTRODUCTION

There are currently more than 80 000 reservoirs in China, among them there are more than 300 ones with reservoir capacity is and greater than 1 billion m^3, tens of ones with the dam height being or greater 100m. More and more reservoirs are planned to be built in China as the social and economic development and technical progress. Relatively, the number of reservoir induced earthquakes occurred in China has obviously increased. The total of more than 30 reservoir induced earthquake events with maximum magnitude occurred in China has been identified (Fig. 1). Meanwhile, faced more and more complicated seismic environment, the seismic safety of reservoir has been paid wide attentions. The model and basic analysis process for risk assessment of reservoir induced seismicity (RIS) is introduced in the paper. Based on the methodology, the design idea and main functions of the Reservoir Induced Seismicity and Risk Assessment System (RISaRiskAS 2007 for Window) which has been developed by the authors are also introduced in the paper.

2. THE SEISMIC RISK ASSESSMENT FOR RESERVOIR INDUCED SEISMICITY

The research of risk assessment for reservoir induced seismicity will contain seismic hazard analysis, the seismic risk estimate. The prediction model is needed to be built through the researches of distribution area, the activity modes, the maximum magnitude, the seismicity level of reservoir induced seismicity and the

factors affecting the above features. Based on the seismic strength and level, the seismic hazard can be implemented. Then the risk of reservoir induced seismicity can be estimated according to the seismic hazard, the social wealth and their vulnerability. The results will be usable for the decision-making of safety operation of reservoir. The basic process of the research is shown in Fig. 2.
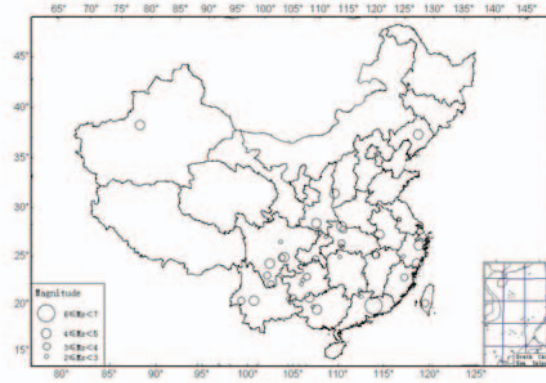

Fig. 1 The distribution of reservoir induced earthquakes occurred in China.
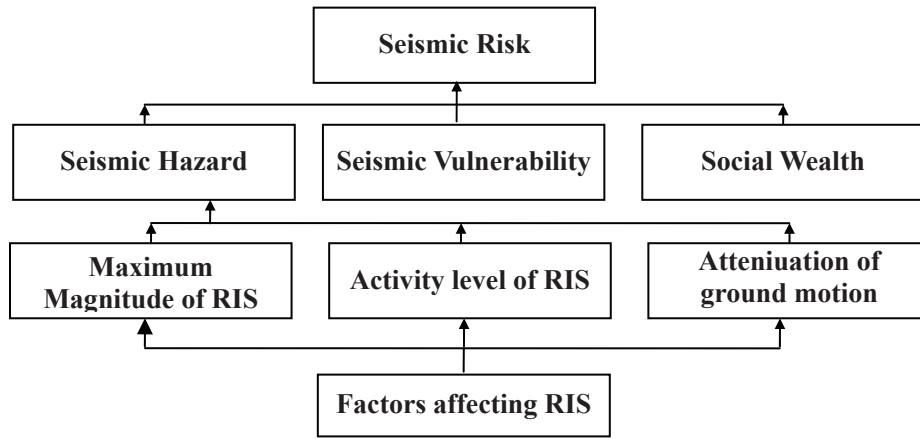

Fig. 2 The basic process of risk assessment for reservoir induced seismicity.

3. THE RISK ASSESSMENT MODEL OF RESERVOIR-INDUCED SEISMICITY

According to the risk assessment process of RIS and the spatial and temporal change of the related assessment parameters, a model developed by Wang et al (2004, 2007, etc.) is introduced in the risk assessment of RIS as following:

$$EL(t_1 \le t \le t_2, R) = \sum_I \int_{t=t1}^{t2} P(t,R,I) f(t,R \mid I) W(t,R) dt$$

Where $EL(t_1 \le t \le t_2, R)$ refers to the estimated losses in region R within time interval $t(t_1 \le t \le t_2)$; $P(t,R,I)$ refers to the occurrence probability of ground motion I of reservoir induced earthquake in region R at time t; $W(t,R)$ refers to the social wealth (such as population, buildings, properties or even GDP) in region R at time t; $f(t,R \mid I)$ refers to the loss ratio of social wealth to ground motion I in region R at time t;

The risk assessment model introduced above has been considered the spatial and temporal varieties of RIS.

The estimated risk can be the life loss, the economic loss or other ones in cope with the different needs.

4. THE DEVELOPMENT OF RESERVOIR-INDUCED SEISMICITY PREDICTION AND RISK ASSESSMENT SYSTEM

4.1 The design object of the system

The Reservoir-Induced Seismicity Prediction and Risk Assessment System (RISaRiskAS 2007 for Windows) is a practical software system designed to manage the data of reservoirs and RIS in China and implement the risk assessment. The system is based on the RDBMS and GIS environment with strong analytical and processing capabilities as a practical tool to research of RIS, decision-making of dam safety and earthquake emergency management.

4.2 The main functions of RISaRiskAS

The main functions of RISaRiskAS are as followings (Fig. 3):

(1) File Management functions include "Open" an existed system database file, "save as" a new database file or compact a database file, etc.

(2) Database management functions include view, add, edit, delete records of various data as tables as following: (a) the basic reservoir data, the RIS case data, the RIS serial catalog, the risk region of RIS, the regional seismic environment as well as the literature associated with reservoir and RIS; (b) the population and economic data; different type of building; (c) data used for seismic hazard analysis and scenario earthquakes determination, such as the seismicity parameters of seismic zones, the potential seismic region, the seismic ground motion attenuation relation; (d) the life, building or economic (GDP) vulnerability functions; etc.

(3) Maximum magnitude prediction functions include several methods for the prediction of the maximum magnitude of RIS. The methods were developed by the authors and others (Wang et al, 2009; Zhang et al, 2009).

(4) Seismic hazard analysis function realizes the probabilistic seismic hazard estimate in the reservoir region caused by both the reservoir induced earthquakes and natural earthquakes (Wang X Q et al, 2007, 2009; Wang L,2009).

(5) Risk estimate before earthquake function will implement the risk estimate according to the model introduced above in the paper.

(6) Rapid risk estimate after earthquake function will estimate the life loss or direct economic loss rapidly after a catastrophic reservoir induced earthquake occurs.

(7) Geographical information management has the basic function as GIS software.

(8) Query and view functions provide to query information from the database and then view them. The

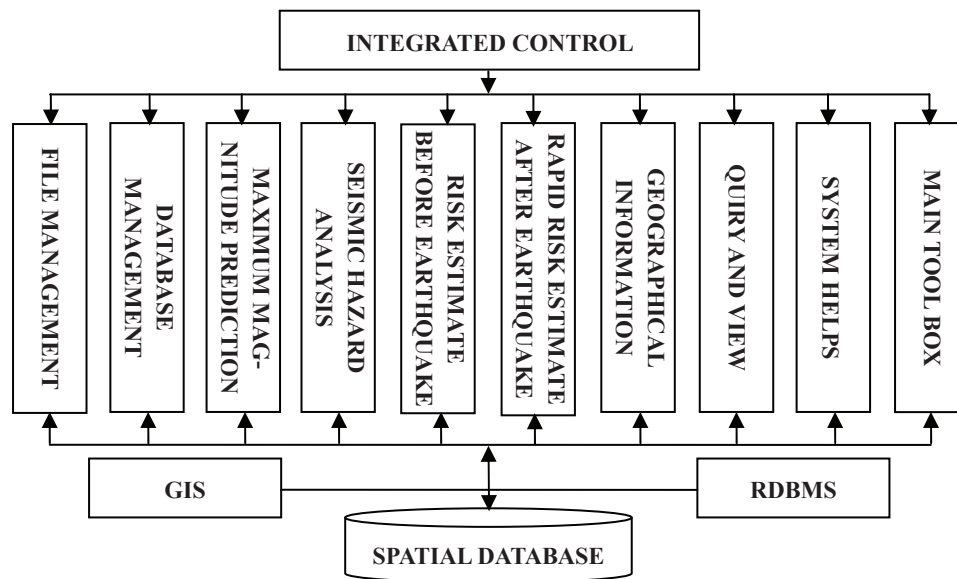viewed data can be outputted as a file or sent for printing.

Fig. 3 The system integrate frame Chart.

5. CONCLUSION AND ACKNOWLEDGEMENT

The paper introduces the methodology for risk assessment of reservoir-induced seismicity and the development of RISaRiskAS. It has shown potential ability in practical research of RIS through cases study while the results have not been presented here for a limited extent of paper.

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