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Scientific decision aid system of the restoration and reconstruction based on GIS technology

Wang Yanru[1,2], Fu Bin[3], Li Bo[1],Zhang Maoyu[1]

[1]Wenzhou University, Zhejiang Province,Wenzhou, 325035, (CHINA)

[2]Tongji University, Shanghai,Shanghai, 200092, (CHINA)

[3]Wenzhou Design Group Co., Ltd.,Zhejiang Province, Wenzhou, 325001, (CHINA)

ABSTRACT

Considering the needs of earthquake rapid recovery and reconstruction after the quake, it is proposed in this paper that scientific decision aid system of the restoration and reconstruction based on GIS technology. The system could be used to evaluate the post-earthquake restoration and reconstruction project funds forengineering structure of all kinds of housing (includingresidential housing, education system, health system, culture system, welfare system etc) and infrastructure (includingtransportation system, electric power system, communication system, electric power system, communication system, public civil facilities and hydraulic engineering etc). On the basis of detailed degree for the data achieved,it can be realized that the dynamic visual management of earthquake recovery and reconstruction fund evaluation system. The system has certain help to the reconstruction for engineering structure in earthquake disaster area.

KEYWORDS

GIS; Decisions-making; Disasters.

INTRODUCTION

Destructive earthquakes not only caused heavy casualties, but also lead to varying degrees of damage to engineering structure and equipment facilities. It is war that to restore the normal order of production and living as soon as possible by the earthquake emergency rescue or reconstruction after an earthquake. The important precondition for winning the war is that the governments at all levels should make scientific and correct decision and do the work of restoration and reconstruction in time. In front of the complicated disaster caused by destructive earthquakes, the governments at all levels make decisions acorrding to the information from all sides and comprehensive analysis or processing of that information. It is difficult to provide one or a few good solutions for decision makers to choose from by one or a few experts with unilateral knowledge. However, it will abandon the secondary factors by giving a computer preset model and the calculation analysis function; and the computer could give objective answer soon even in real time according to the needs of humans. For post-earthquake recovery and reconstruction of government scientific policy-making, it is urgently needed a similar software that scientific decision aid system for the restoration and reconstruction based on GIS technology. About to the research on earthquake disasters management and post-earthquake recovery and reconstruction aid decision systems,it is the fledgling stage[1][2][3]or blank in China; and there are also some countries to study this subject in the world[4][5][6][7]. Therefore, it is very necessary to a work on the scientific decision aid system for reconstruction after earthquake disaster.

SYSTEM REQUIREMENTS ANALYSIS

Scientific decision aid system for the restoration and reconstruction based on GIS technology is on the basis of the seismic damage assessment and the corresponding database for the engineering structure damaged in a investigated area. It can realizethe visualization dynamic management for the funds evaluation in the different areas including the post-earthquake restoration and reconstruction cost from all kinds of housing construction, infrastructure, industrial and mining enterprises of engineering structure damages. The system can provide the allocation of funds for restoration and reconstruction of engineering and it is suitable for local actual condition of the earthquake disaster area. What's more, it can provide a basic service platform for decision-making of governments and reconstruction planning for the earthquake disaster area. The main function of the system are as follows:

1) it can implemente visual simulation assessment for the funds of the post-earthquake restoration and reconstruction according to administrative area classification and according to industry classification;
2) the suggestion that fund allocation of recovery and reconstruction could be provided;
3) the flexible way of the output.

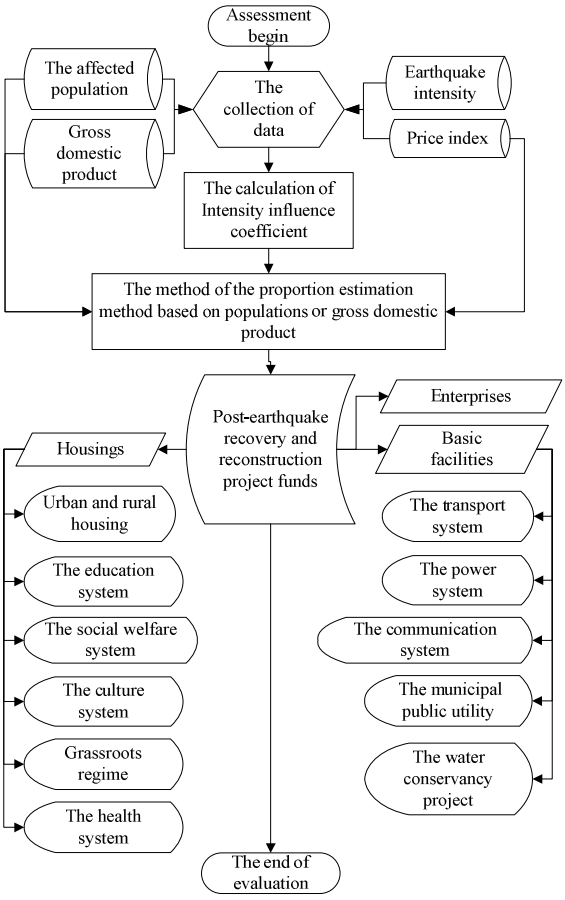

Figure 1 : Rapid assessment schematics

SYSTEM DESIGN

The principle of system evaluation

Scientific decision aid system of the restoration and reconstruction based on GIS technology is divided into rapid assessment and early evaluation of two phases. When the earthquake occurred early, at the beginning of assessment and the less data collected,the rapid assessment module is used[8]; the module takes use of the proportion estimation methodbased onpopulations which is the per capita indicators evaluation method. According to the local populations, post-earthquake restoration and reconstruction project funds of all kinds of housing (including housing, urban and rural, education system, health system, cultural system, social welfare system and grass-roots regime) and infrastructure (including transport system, power system, communication system, municipal public facilities, water conservancy project) could be calculated by the per capita indicators evaluation method. The evaluation method to calculate post-earthquake restoration and reconstruction project funds of enterprise is the proportion estimation method based on the proportion of GDP. The principle of rapid assessment is shown in Figure 1.

When the earthquake disasterloss assessment is finished and the information is more, the early evaluation module is used[8]. The module takes use of the method based on earthquake disaster loss assessmentreport to calculate the post-earthquake restoration and reconstruction project funds for all kinds of housing; andthe method based on the proportion of direct economic loss assessment is used for the post-earthquake restoration and reconstruction project funding of infrastructures and enterprises. The principle of early evaluation is shown in Figure 2.

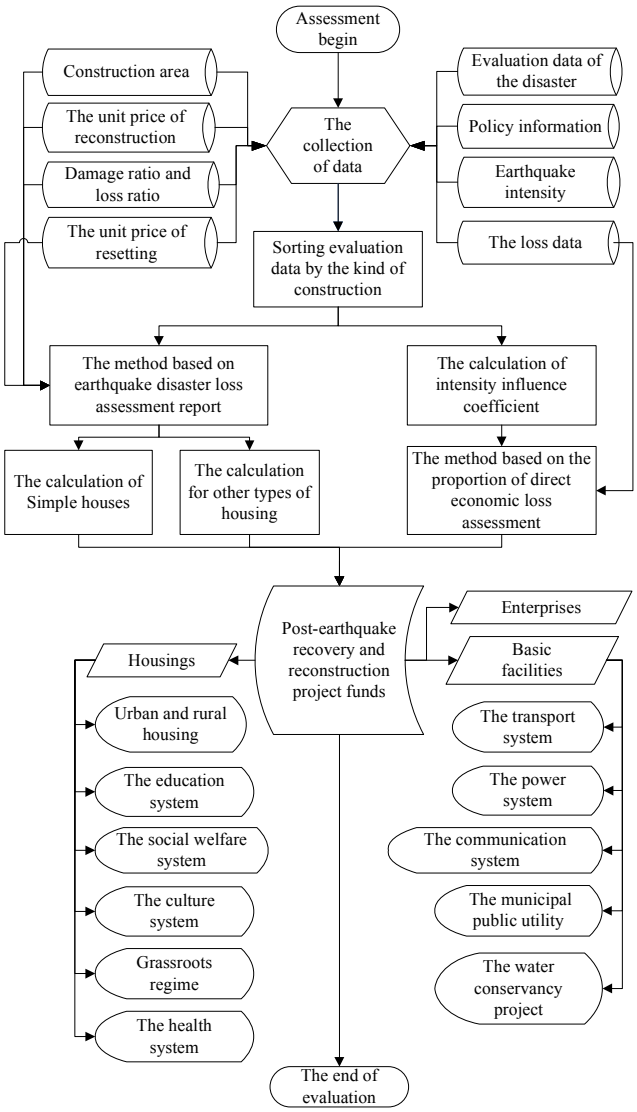

Figure 2 : The early evaluation principle diagram

Theimplementation process of the system

The implementation process of the system,scientific decision aid system for the restoration and reconstruction based on GIS technology, is divided into three steps. The first step is the collection of data. The data includes the information of background layer and model parameter. The database for background layer information contains the population, GDP, the

information of constructions, infrastructures or enterprises. And the data of the unit price of reconstruction, the unit price of resetting,damage ratio and loss ratio are input the scientific decision aid system. The second step is the calculation of evaluation model. The assessment result can be divided into rapid assessment results and the early evaluation results acording to the precision of the assessment result. The last step is the results outputs. The scientific decision aid system could provide post-earthquake recovery and reconstruction project funds in accordance with the tpye of constructions. The output mode can be used in a text or graphics output. The implementation process of scientific decision aid system is shown in Figure 3.

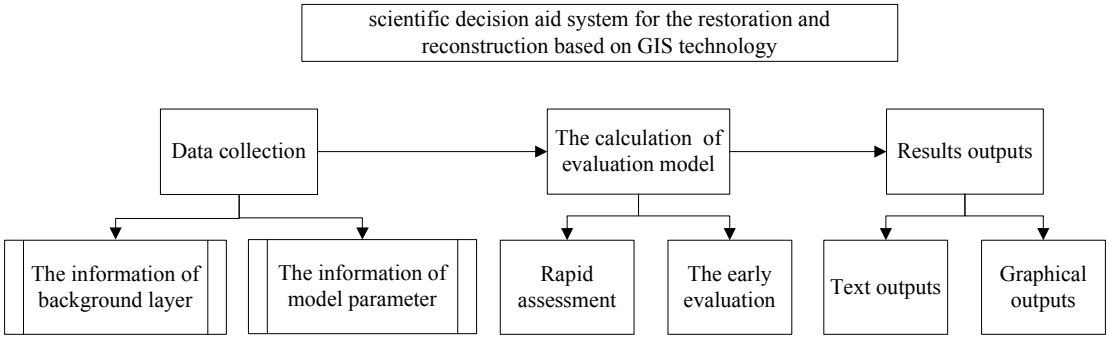

Figure 3 : The business flow diagram of the system

The system function is introduced in detail

The functions of scientific decision aid system for the restoration and reconstruction based on GIS technology contain the basic information, model parameters, the analysis of recovery and reconstruction funds requirements, and the output of the results. The main interface is as shown in Figure 4; and the main functions of the system mend are shown in TABLE 1.

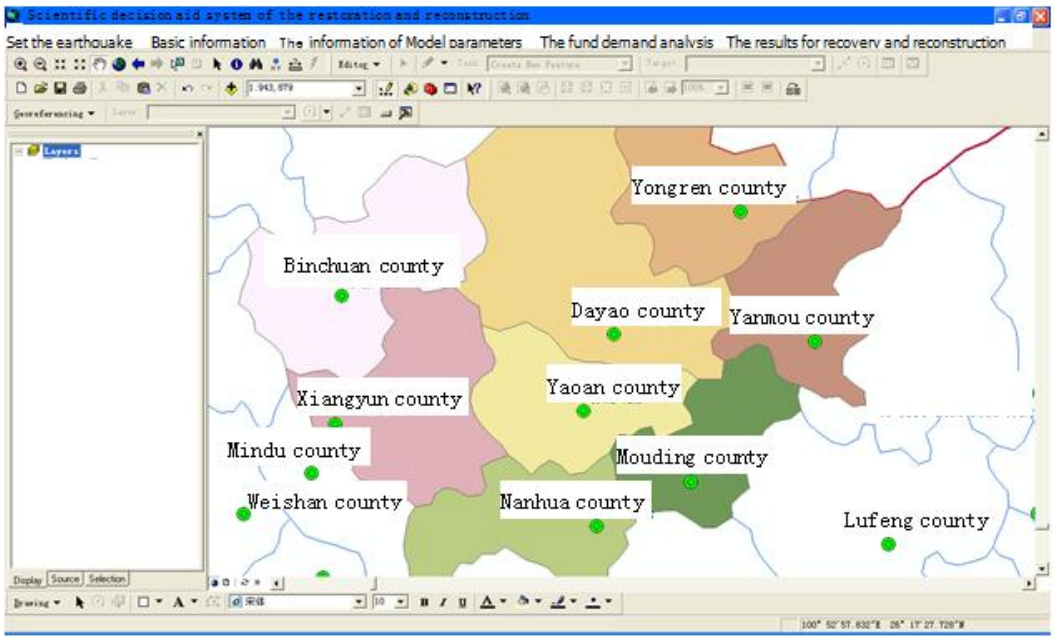

Figure 4 : Main interface of the system

TABLE 1 : The main function menu of the system

Set the earthquake	Basic information	The information of Model parameters	The fund demand analysis	The results for recovery and reconstruction
The parameters input	Administrative area Intensity influence area Evaluation area Building information	The loss ratio of simple houses The loss ratio of non-simple houses The unit price of reconstruction The unit price of resetting Direct economic loss of all kinds of infrastructures Direct economic loss of enterprise	The intensity influence coefficient Rapid assessment Early evaluation results	Graphics display of Evaluation results The analysis results of rapid assessment and early evaluation

(1) Set the earthquake

When the earthquake occurred early,no damage intensity information, the earthquake intensity influence field can be determined by setting the earthquake. The post-earthquake restoration and reconstruction project funds are estimated by the method of the rapid assessment. In this system, the dialog box for setting earthquakes can appear by just click the set button. The dialog box is shown in Figure 5. The intensity influence field is calculated by the parameters input. It is as shown in Figure 6.

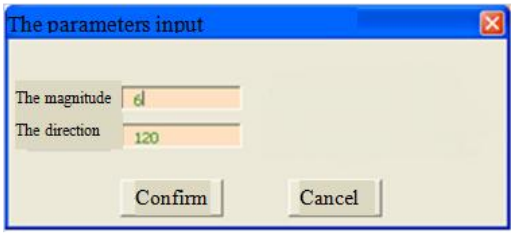

Figure 5 : The dialog box for setting the earthquake

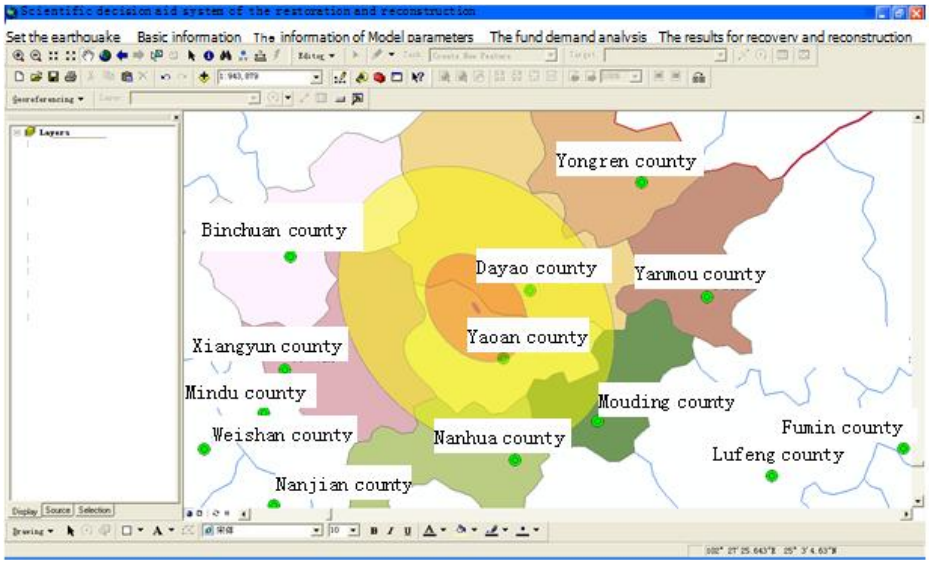

Figure 6 : Influence field ofintensity

(2) Basic information

Basic information refers to the background layer information, including administrative area, intensity influence area, evaluation area, building information and so on. This information can provide support for the calculation and analysis of models. It is as shown in Figure 7 and 8.

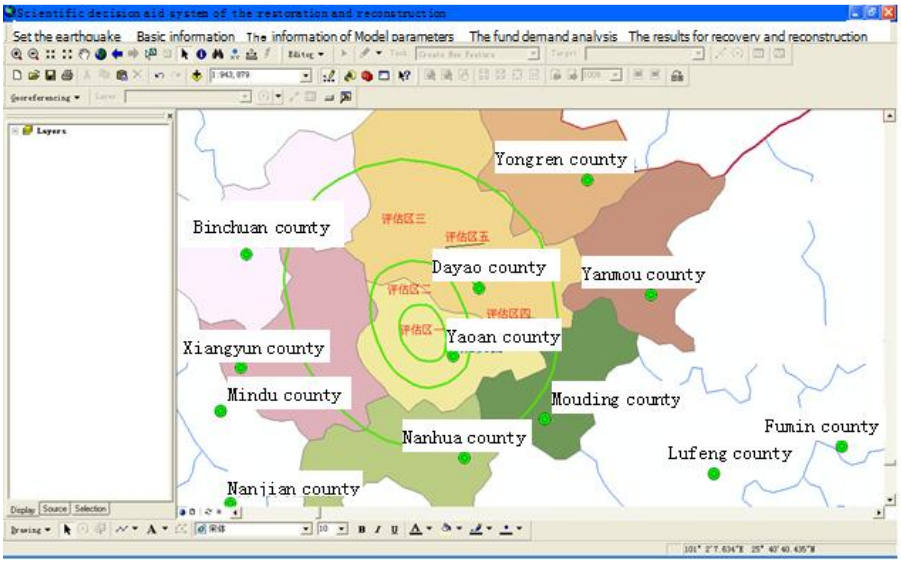

Figure 7 : Information of evaluation areas

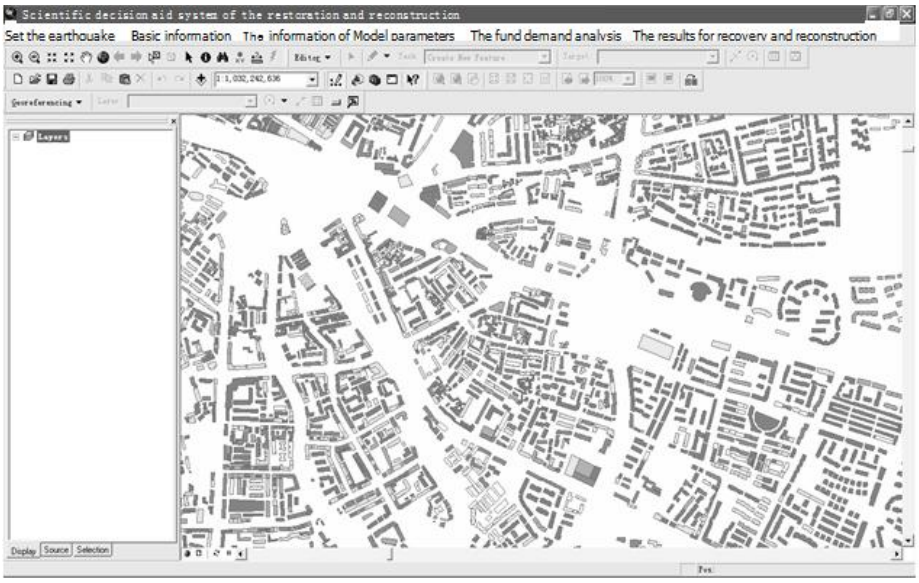

Figure 8 : Housing Building Information

(3)The information of model parameters

Model parameter information refers to the input data according to the actual circumstance of earthquake. It containsthe loss ratio of simple houses,the unit price of reconstruction, the unit price of resetting, direct economic loss of all kinds of infrastructuresor enterprise and so on. The input of data can use the way by interface input and invoke the text, as shown in Figure 9,10,11,12.

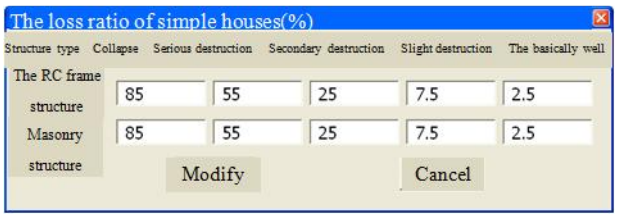

Figure 9 : The loss rate for the non-simple houses

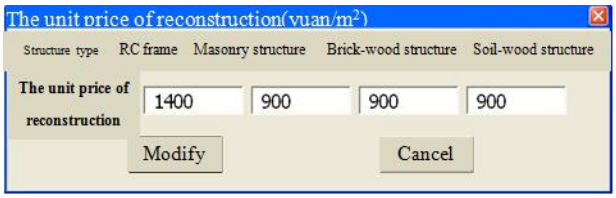

Figure 10 : Reconstruction unit price of housing

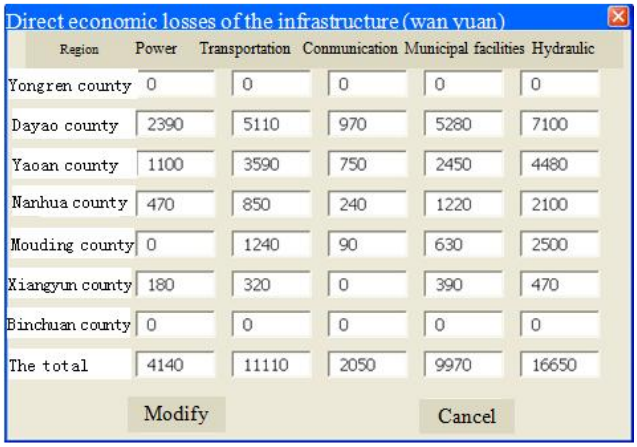

Figure 11 : Direct economic losses of the infrastructure

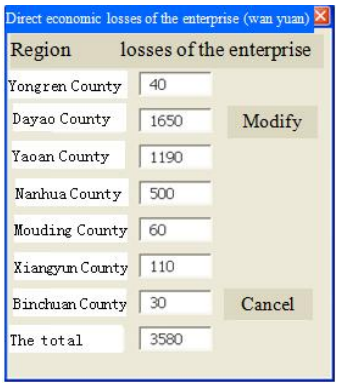

Figure 12 : Direct economic losses of enterprises

(4)The fund demand analysis and the results forrecovery and reconstruction

By clicking the corresponding button in the main menu for the requirement analysis of recovery and reconstruction fund, the intensity influence coefficient,rapid assessment and early evaluation results can be calculated. The analysis results of rapid assessment and early evaluationcan be shown two ways such asthe display interface and text. It is shown in Figure 13, Figure 14, Figure 15,and Figure 16.

The results output of rapid assessment (wan yuan)

	Yongren	Dayao	Yaoan	Nanhua	Mouding	Xiangyun	Binchuan	Region affected
Housing	4075	232947	340660	91352	64771	108693	65790	908288
Urban and Rural housing	2889	165114	241462	64751	45910	77043	46633	643802
Education	347	19834	29005	7778	5515	9255	5602	77335
Health system	312	17851	26105	7000	4963	8329	5041	69602
Cultural system	302	17256	25234	6767	4798	8051	4873	67282
Social welfare system	87	4958	7251	1945	1379	2314	1400	19334
Grass-roots level power system	139	7934	11602	3111	2206	3702	2241	30934
Infrastructure	21	26986	50034	4314	4935	22600	4385	113274
Transportation	2	2987	5538	478	546	2501	485	12538
Electrical power	5	6571	12183	1051	1202	5503	1068	27583
Municipal service facilities	1	1299	2408	208	237	1088	211	5451
Communication	5	7169	13291	1146	1311	6003	1165	30090
Hydraulic engineering	7	8961	16614	1433	1639	7504	1456	37613
Enterprise	7	1727	5739	52	73	965	66	8629

Figure 13 : Theresults output of rapid assessment

The result output of early evaluation (wan yuan)

	Yongren	Dayao	Yaoan	Nanhua	Mouding	Xiangyun	Binchuan	Region affecte
Housing	4007	229066	334984	89830	63692	106882	64694	893155
Urban and Rural housing (simple)	2363	135601	199506	53071	38087	64176	38374	531177
Urban and Rural housing (non-simple)	585	32883	46884	13002	8760	14439	9210	125764
Education (simple)	284	16272	23941	6368	4570	7701	4605	63741
Education (non-simple)	70	3946	5626	1560	1051	1733	1105	15092
Health system (simple)	218	12530	18434	4904	3519	5930	3546	49081
Health system (non-simple)	54	3038	4332	1201	809	1334	851	11621
Cultural system (simple)	188	10775	15854	4217	3027	5100	3049	42209
Cultural system (non-simple)	46	2613	3726	1033	696	1147	732	9994
Social welfare system (simple)	75	4310	6341	1687	1211	2040	1220	16884
Social welfare system (non-simple)	19	1045	1490	413	278	459	293	3997
Grass-roots level power system (simple)	85	4870	7166	1906	1368	2305	1378	19079
Grass-roots level power system (non-simple)	21	1181	1684	467	315	519	331	4517
Infrastructure	0	65396	34169	17054	15424	4528	0	136571
Transportation	0	7496	3038	1642	0	599	0	12777
Electrical power	0	16028	9916	2970	4288	1065	0	34268
Municipal service facilities	0	3042	2072	839	311	0	0	6264
Communication	0	16561	6767	4263	2179	1299	0	31069
Hydraulic engineering	0	22269	12375	7339	8646	1565	0	52193
Enterprise	1	5489	3401	1890	224	393	14	11412

Figure 14 : The result output of early evaluation

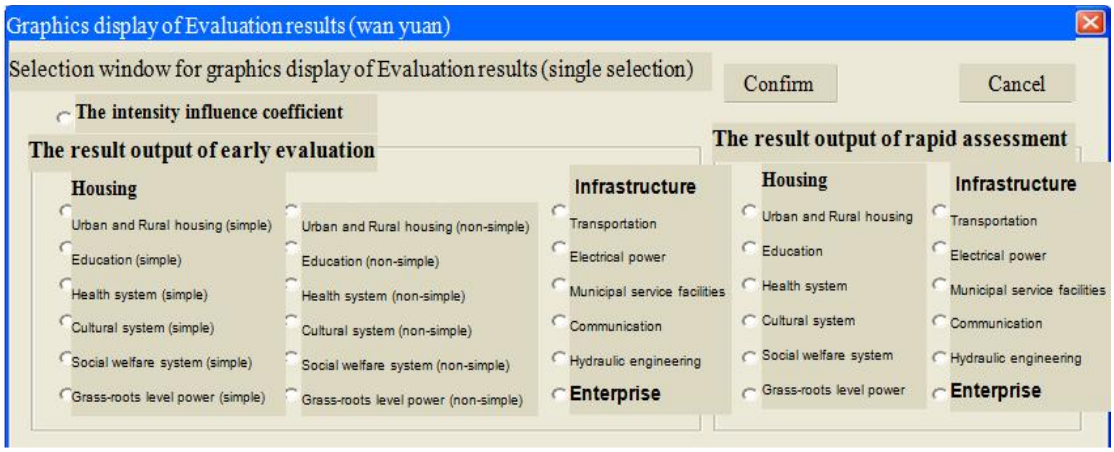

Figure 15 : Selection window for graphics display of Evaluation results

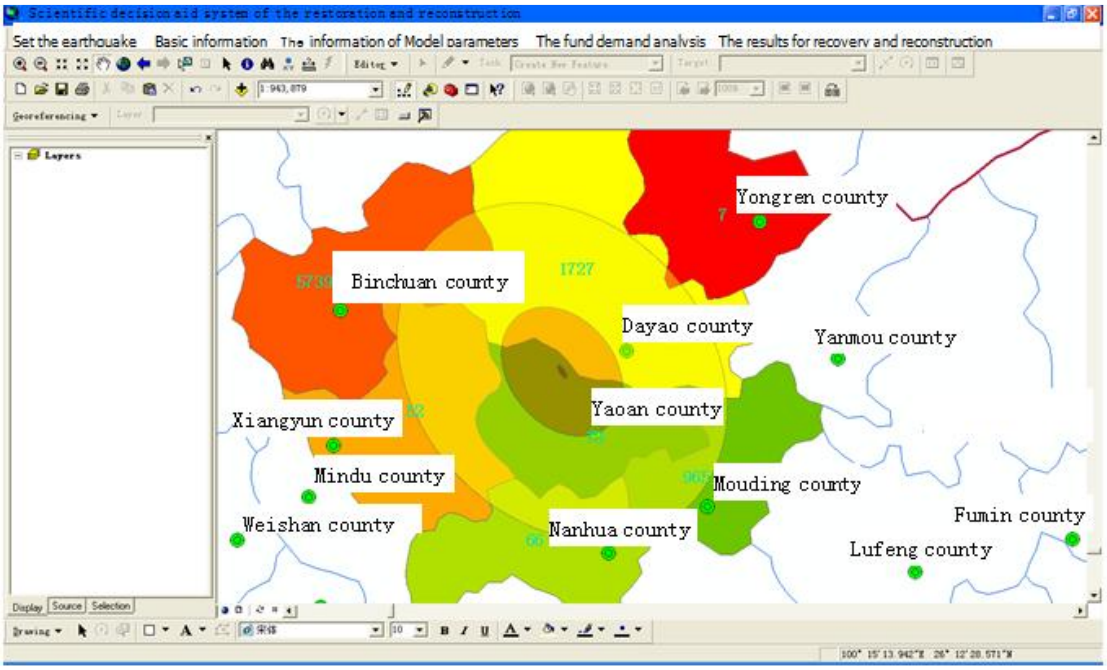

Figure 16 : The evaluation results of enterprises

CONCLUSIONS

It is analyzed that the needs of scientific decision aid system of the restoration and reconstruction based on GIS technology in this paper. And it is introduced that the operation principle and the system function. The system could be used to evaluate the post-earthquake restoration and reconstruction project funds for engineering structure of all kinds of housing and infrastructure. The system can be realized that the dynamic visual management of earthquake recovery and reconstruction fund evaluation system. What's more, it can provide a basic service platform for decision-making of governments and reconstruction planning for the earthquake disaster area.

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