International Journal of Hybrid Information Technology
Vol.7, No.4 (2014), pp.123-138
http://dx.doi.org/10.14257/ijhit.2014.7.4.11

GIS: Assessment Model and Evaluation of an Earthquake-stricken Area with a Case Study in Shangri-La

Shuangyun Peng[1], Kun Yang[1] and Yanbo Cao[2]

[1]*School of Tourism and Geographical Science, Yunnan Normal University, Kunming, China, 650092*
[2]*Yunnan Earthquake Administration, Kunming, China, 650224*
daneall11@126.com

Abstract

The ability to rapidly assess the loss of earthquake-stricken area after an earthquake in the absence of on-site information is of significant importance. Due to the unique geology, geomorphology, building structures as well as the social and economic situation in Yunnan, it makes the loss of building and casualties having some differences with other regions when the earthquake occurred. Based on the regional characteristics of Yunnan, this paper assesses the area of destroyed houses, economic loss, the number of earthquake deaths and number of homes lost using multiple models-a building earthquake death model, a destroyed houses model, an economic loss model and a homes lost model. This inturn allows the distribution pattern of the various losses to be displayed on a map by integrating the evaluation model and GIS technology. The value of spatial distribution is more important than simple statistical data as spatial distribution helps us understand the distribution of earthquake damage thus allowing targeted command decisions to be made for technical support of earthquake victims and earthquake-affected areas.

Keywords: *Seismic evaluation model, GIS, Shangri-La, Deqin*

1. Introduction

The seismic situation of China's mainland, islands and the surrounding areas is severe and complicated. Earthquakes threaten the economic and social developments as well as the sustained development of China in the long-term future. In recent years, multiple violent earthquakes have taken place in mainland China. It caused serious casualties and substantial losses of property in addition to having far-reaching social consequences. For example, in 1976, the Tangshan earthquake took a huge toll on the national economy and social stability of the country, bringing long-term pain and casting a psychological shadow upon a large majority of the Chinese population. The Wenchuan earthquake, measuring 8.0 on the Richter scale, caused 69,195 deaths with 17,681 missing and 374,061 injured. It was estimated to affect 46.16 million peoples and brought direct economic losses estimated at up to $100 billion. This painful lesson showed that quick and accurate assessments of such natural disasters and scientific development of contingency rescue plans are very important after an earthquake [1]. Effective and rapid emergency relief operations based on scientifically-sound data depend on grasping the extent of the disaster. However, in the case of earthquakes, most earthquake emergency departments are unable to obtain accurate and complete information on the earthquake-stricken area in the short space of time directly after the event has occurred in which critical emergency and relief effort decisions need to be made. The speed of

ISSN: 1738-9968 IJHIT

gathering detailed information about an earthquake-stricken area plays a vital role for deploying effective disaster relief efforts [2].

Yunnan is located on the Eurasian tectonic plate. At the junction of the Indian plate and the Pacific plate, crustal movements are frequent, is Chinese earthquake-prone areas. The unique topography and socio-economical status of Yunnan give earthquake catastrophes in the Yunnan region certain unique characteristics [3]. The purpose of this paper is to present a building catastrophe assessment model based on the characteristics of Yunan that integrates Geographic Information System (GIS) into the assessment model which can intuitively interpret the disaster situation by using maps. This model could help the Emergency Command Department make better informed scientifically-based decisions for directing disaster relief efforts.

2. Background

Two large earthquakes took place in Shangri-La. They were of M5.1 and M5.9 levels and occurred at 4:44 AM on August 28 and 8:04 AM on August 31 2013, respectively. The epicenters of these earthquakes were located at the junction of Yunnan Diqing Tibetan Autonomous Prefecture, Deqin County, Ganzi Tibetan Autonomous Prefecture in Sichuan. The coordinates of the quakes were latitude 28.22, longitude 99.35 and latitude 28.22, longitude 99.40 respectively. The districts impacted by the earthquakes in Yunnan include Shangri-La County and Deqin County (Figure 1).

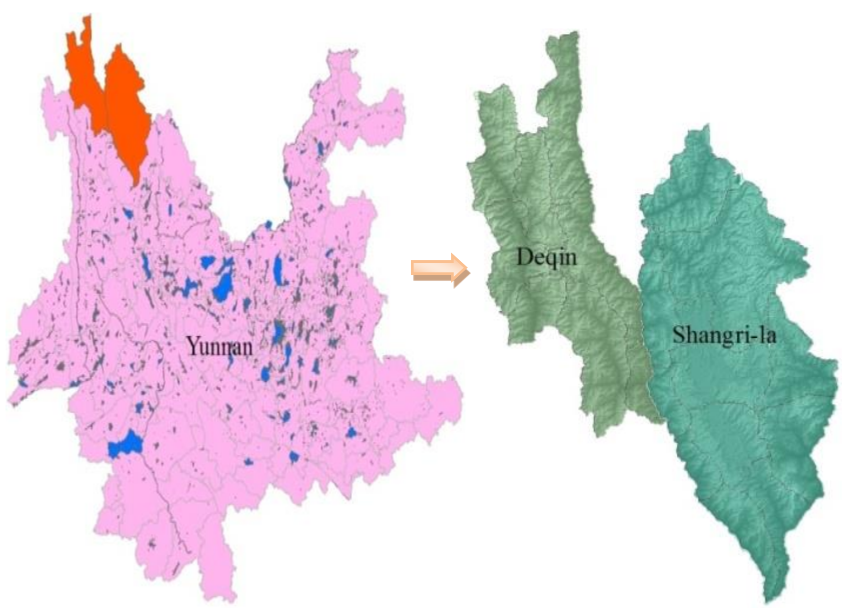

Figure 1. Location of the Earthquake-affected Study Area in Yunnan

(Left)Red indicates Shangri-la and Deqin County in the Figure 1; (Right)Topological scope of the two counties. Shangri-La is located in the northwest of Yunnan, at the southeastern margin of the Tibetan Plateau and eastern mountain range of the Sanjiang Rift Valley area. Topologically, the northwestern side of Shangri-La is higher than its southeast, the highest point being Balaguer that is 5,545 m above sea level while its lowest point is at Luojiji whose altitude is 1,503 m. Shangri-La has an average elevation of 3,459 m and an altitude differential of 4,042 m.

Deqin County is located in the northwest of the Yunnan mountain range area, the southern edge of the Tibetan Plateau, and at the junction of Yunnan, Sichuan and Tibet. The terrain trend of Deqin shows that the north is higher than the south. The highest point, Cavag Bethune, is 6,740 m above sea level while its lowest point is at the southern gate township of the Lancang River whose altitude is 1,840.5 m.

The earthquake zone is found at the junction of Yunling foldbelt which belongs to the Tanggula-Chamdo-Lanping-Simao foldsbelt and Zhongdian foldbelt which is part of Songpan -Ganzi foldsbelt, across the western border of Sichuan-Yunnan block. The structure of the earthquake area is very complex with a core structure of north-south, north-west trending faults. The principal structure of the earthquake is Deqin - Zhongdian fracture, Lung Poon - Joe after breaking the Jinsha River and near the north-south fault.

Economical indicators can show the status of economic development. 2012 is the closest time of these Shangri-La earthquakes. So, this paper chooses the economic dates of 2012. The domestic economical indicators for 2012 of these two earthquake-stricken counties listed in Table 1.

Table 1. Economic Conditions in these Counties in 2012 (million yuan)

Item / County	GDP	Primary industrial output value	Secondary industrial output value	Tertiary output value	Governmen t receipts	Fiscal expend- iture
Shangri-La	597,557	33,696	249,998	313,863	27,488	234,878
Deqin	144,902	11,886	70,492	62,524	10,006	154,898

3. Model and Application

3.1. Isoseismal Attenuation Model

3.1.1. Model

Isoseismal is the basis of the assessment. According to the isoseismal attenuation model, we can analyze the degree of earthquake damage, divide the affected area into hardest hit, medium disaster and light disaster areas, while also evaluating the economic loss, population casualties, and building damage by combining with relevant information such as building on the basis of seismic capacity, geological structure. The calculation process of seismic lines is shown below:

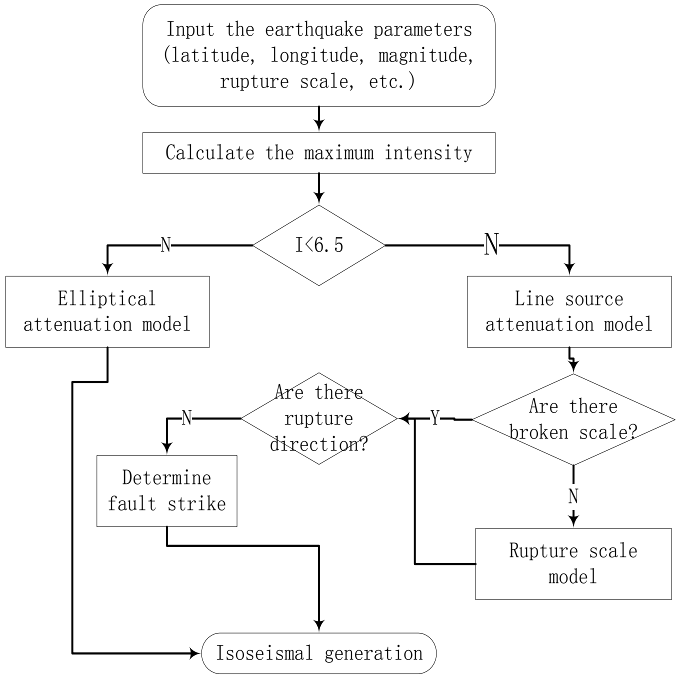

Figure 2. Isoseismal Generation

Firstly, we determined the fracture orientation based on fault strike, aftershock information, historical earthquake data and other information obtained after the earthquake. Secondly, we calculated the surface rupture scale by using the surface rupture scale empirical formula. If there were no preliminary rupture scale input parameters, the default rupture scale empirical formula was used to make an estimate. The formula is shown below (Equation 1).

$$I = C1 + C2Lg(L) \quad (1)$$

L is the expected scale of the earthquake rupture. C1, C2 are the correlation coefficients based on regional regression of actual earthquakes. Thirdly, we choose the attenuation model by seismicity (I). When I<6.5, the elliptical attenuation model is chosen. Combining the characteristics of Yunnan, this paper used the isoseismic elliptical intensity model which was previously reported by Li [4]. Li and colleagues (2012) took the intensity attenuation relationship of the Yunnan region as the intensity attenuation model to draw an ellipse isoseismal.

$$\begin{cases} I_a = 5.4154 + 1.2792I - 3.8738\lg(R_a + 21) \\ I_b = 3.3421 + 1.1719I - 2.8268\lg(R_b + 7) \end{cases} \quad (2)$$

I_a, I_b are the macro axis and minor axis of the intensity. I is the surface wave magnitude. R_a, R_b, respectively are the length of the long and short axis of the i intensity. When I> 6.5 in Equation 1, we utilize the line source attenuation model. The line source model draws an elliptical envelope by ellipse isoseismal which is of equal intensity on the surface rupture brings. According to the characteristics of Yunnan, Li and colleagues (2011) used the least squares linear regression model to analyze the historical seismic data Yunnan based on previous studies. They obtained the earthquake source rupture lengths and magnitude of the relationship by intensity as an independent variable [5]. The relationship is shown below (Equation 3).

$$\lg L = \begin{cases} 0.39I - 1.24 & 6.0 \le I \le 7.7 \\ I - 5.90 & I \ge 7.8 \end{cases} \tag{3}$$

The final step corrected affecting parameters which included epicenter, rupture direction, rupture scale. These parameters were obtained from on-site investigation. Correcting these parameters enabled more accurate field calculation results to be obtained.

3.1.2. Data

The elementary parameters of earthquakes in Shangri-La areas follow:

Table 2. The Basic Parameters of Earthquakes in Shangri-La

ID	Time	Epicenter		Magnitude	Focal depth(km)
		Latitude	Longitude		
1	At 4:44 on August 28, 2013	28.22°	99.35°	5.1	9
2	At 8:04 on August 31, 2013	28.22°	99.40°	5.9	10

According to the measurements made by the Yunnan Seismographic Network, this earthquake consisted of 1,668 minor earthquakes, of which 1,125 ranged between 0.0 to 0.9 on the Richter scale, 376 between 1.0 to 1.9, 145 between 2.0 to 2.9, 13 between3.0 to 3.9, 7 between 4.0 to 4.9, and 2 between 5.0 to 5.9. The locations of these minor quakes are showed in Figure 3.

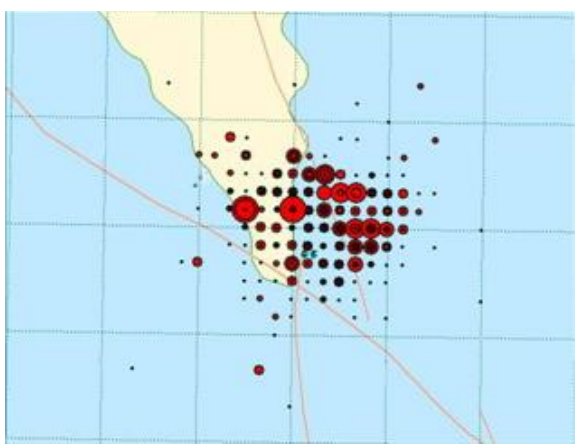

Figure 3. Earthquake Sequence Distribution

3.1.3 Application: To get Shangri-La earthquake isoseismal on the map, we integrated the decay model and GIS by using ArcMap (a GIS software) and got the following result.

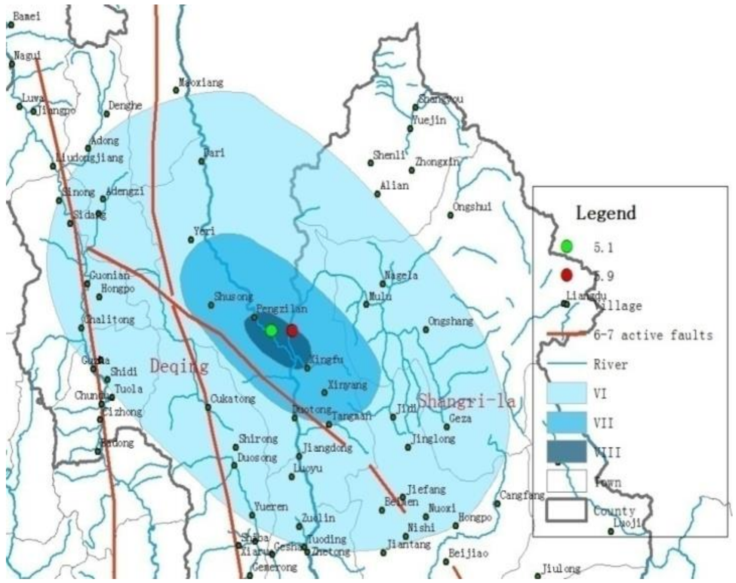

Figure 4. Location of the Shangri-La earthquake Isoseismal

The range of the VIII disaster area is from the Sanjia village of Nixi town of Shangri-la County in the southeast of Yunnan to Benzilan town of Deqin County in the northwest of Yunnan, from Migong village of Benzilan town of Deqin County in the southwest of Yunnan to Kangsa village of Nixi town of Shangri-la County in the northeast of Yunnan - an area of about 68 square kilometers. The range of the VII disaster area is from Xixiang town of Shangri-la County in the southeast of Yunnan to Guanyong village of Benzilan town of Deqin county in the northeast of Yunnan, from Niding village of Benzilan town to Bala village of Nixi town in the northeast of Yunnan－an area of about 745 square kilometers. The range of the Ⅵ disaster area is from Shangri-la County in the southeast of Yunnan to Feilai temple of Deqin County in the northwest of Yunnan, from Guilong village of Deqin County to Zaxiangshang village of Shangri-la County in the northeast of Yunnan -an area of about 5258 square kilometers.

3.2. Earthquake Death Loss Assessment Model

3.2.1. Model

Previously published literature show that a large amount of research has been conducted on various aspects of the earthquake death assessment model. At present, there are nearly 27 different methods to assess the number of deaths caused by an earthquake. There are five methods that do not consider the vulnerability of houses and mainly use earthquake magnitude and intensity, population density, and earthquake time as the core parameters. 22 other methods account for vulnerability of houses but these can be divided into two kinds – deterministic or probabilistic- based on estimates of the variables used in the formulae. These variables are determined values in the deterministic method which is obtained by an empirical formula according to the seismic administration's published post-earthquake survey or departments' statistics dates. Probabilistic estimation methods are carried out by estimating the probability of earthquake death parameters. For the case of Yunnan, Zhou calculated relationships between earthquake magnitude and earthquake deaths by building a model [6].

He found that the number of earthquake deaths increase with increasing earthquake magnitude.

Han built earthquake intensity-Earthquake death ratio distribution matrix. Intensity-houses collapsed rate distribution matrix and their empirical relationship in Tonghai County. Economic factors directly affected the vulnerability of housing structure which has a direct impact on the vulnerability of personnel shock to death [7]. However, the level of socio-economic progress of Yunnan is uneven. Therefore, this paper utilizes the earthquake death loss assessment model which was suggested by Li (2012). Li proposed a multi-factorial earthquake death and economic regression model based on the socio-economic situation of Yunnan. The model is shown in Equation 4 [8].

$$
\begin{aligned}
y = \exp\{&-6.732*10^{2} + 4.32*10^{2}x - 2.8154*10^{2}x^{2} - 2.046*10^{2}z \\
&+1.1452*10v + 1.245cs - 0.1717*10^{-2}cs^{2} - 0.244GDP \\
&+0.4337*10^{-4}GDP^{2} + 1.7905*10t + 0.4*10^{-2}s + 0.5*10^{-2}x*GDP
\end{aligned}
\tag{4}
$$

y is the number of earthquake deaths. t is the moment of earthquake. If earthquake time between 21:00 to 9:00, t=1. If 3earthquake time between 9:00 to 21:00, t=0. x is magnitude. Z is seismic intensity. s is the population density. v is intensity area. s is the per capita net income of farmers. c_s is per capita revenue. GDP is GDP per capita.

3.2.2. Data

This earthquake involves 43 administrative villages of 12 towns of Shangri-La and Deqin County. The stricken population has 114,051 people, 22,483 families which include 81,837 people of 15,460 families of Shangri-La, 32,214 people of 7,023 families of Deqin County. By the end of 2012, Shangri-La County GDP was 5,975,570,000 yuan, fiscal revenue 274,880,000 yuan, rural per capita net income was 4,078 yuan. Deqin County GDP was 1,449,020,000 yuan, fiscal revenues 100,060,000 yuan, rural per capita net income was 1,947 yuan.

3.2.3. Application

Calculating the numbers of earthquake death based on earthquake death-economic multi-factor regression model and the above data. We get the results is 2 that are the casualties. The civil administration department statistics there are three people were killed which included two in the car were killed by a falling rock, land slides death of another man. Three deaths have some chance, thus resulting accuracy is insufficient to determine the model. The accuracy of the model calculation will be repeatedly fitted.

3.3. Housing Damage Loss Assessment Model

3.3.1. Model

According to seismic attenuation relationship of historical earthquakes in Yunnan Province, combined with data from the statistical yearbook, the existing database earthquake emergency basis points and some sample survey data, the population and households' data of assessment area, calculating housing construction area per capita, various types of housing structure proportion, establishing housing area estimation models. We can build the Earthquake houses destroyed rapid assessment model based on each intensity District Housing vulnerability matrix which is obtained by counting and analyzing historical earthquake data using data collated from the earthquake damage assessment reports since 1992 onwards. On the basis of housing damage assessment reset price and population density, we can estimate the number of houses damaged, the economic losses and the number of people that have lost their homes [9].The total area of the housing is calculated using Equation 5.

$$S = P * (1 + \rho) * \lambda * (1 + \sigma) \tag{5}$$

S is the total area of housing. P is the number of population. ρ is the population growth rate. λ is per capita housing area. σ is the growth rate of per capita housing area.

The total area of the damaged housing is calculated using Equation 6.

$$\mathrm{E} = \sum_{1}^{i} S_i * A_i * D_i \tag{6}$$

S_i is the house total area of the i assessment district. A_i is the proportion matrix of the various types of housing structure of the i assessment district. D_i is the ratio matrix of destroyed houses of the i assessment district.

Economic losses which were caused by the destruction of housing can be acquired by using Equation 7.

$$L_h = S_h \times R_h \times D_h \times P_h \tag{7}$$

S_h is the total gross floor area of one class of house. R_h is the destruction rate of damage grade of one class of house. D_h is the damage loss ratio of damage grade of one class of house. P_h is housing reset price of one class of house.

The number of lost homes is the number of people who lost their homes due to the earthquake and outdoor refuge. Equation is follows.

$$T = \frac{c + d + e/2}{a} \times b - f \tag{8}$$

a is a household living area. b is the number of people per household. c is the destruction housing area. d is severely damaged area of non-simple houses. e is the destroyed area sum of non-simple houses with medium damage area and simple houses. f is the number of deaths.

The above model involves the following strategic points. The first is housing structure classification. The following classification criteria: High level architecture (level 10 and above), frame construction, brick-concrete structure, post and panel structure, civil structure, other structure which includes Chuan Dou timber structure, stone structure, bamboo and wood structure. The second is floor area per capita and the ratio of each structure. The third is housing floor area estimation model which was built based on the economic level and the administrative level. The fourth is the relationship between the number of housing structure type, proportion and the population density. The fifth is the houses destroyed matrixes which will build the houses rapid assessment model in different intensity of earthquake. The sixth and final strategic point is building the earthquake house economic loss rapid assessment model based on building damage matrixes.

3.3.2 Data: The data of population and house construction are obtained from 9 sampling points of Deqin County and seven sampling points of Shangri-La County. Sampling point data are in the following table:

Table 3. Sampling Point Data

County	Town	Village	Family	Population
Shangri-La	Nixi	1	532	2,155
	Jiantang	3	1,496	8,339
	Zage	3	586	2,733
	Dongwang	2	549	2,661
	Wujin	2	408	1,609
	Nixi	3	1,240	5,027
	Jiantang	7	10,649	59,313
Deqin	Benzilan	2	716	3,726
	Shenpin	2	932	3,896
	Xianuo	4	1,093	4,312
	Yanmen	3	696	3,140
	Yunling	2	355	1,936
	Tuoding	2	435	1,938
	Benzilan	3	1,073	5,588
	Shenpin	2	1,501	6,259
	Yangla	2	222	1,419

Since most of the areas affected by the earthquake are rural, they are the principal areas considered in this work. In rural areas, farmers' net income represents economic level which can be divided into two levels on account of 5,000 yuan. Figure 5 reflects the relationship between income and housing area in rural areas.

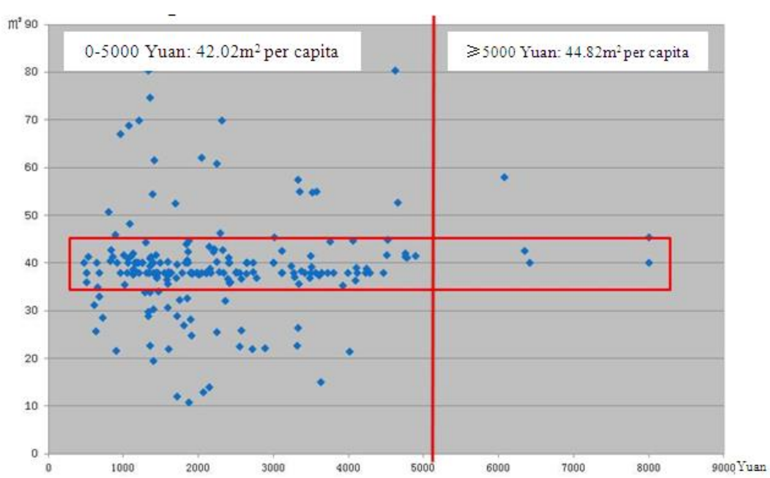

Figure 5. The Relationship between Income and Housing Area

Statistics show that in rural areas 80 percent of the per capita gross floor area is about 40 square meters. When the farmers' per capita net income is less than 5,000 yuan, per capita gross floor area is 42.02 square meters while for farmers with per capita net income more than 5,000 yuan, the per capita floor area is 44.82 square meters. Figure 6 shows the proportion of civil structures change with economic trends in rural areas.

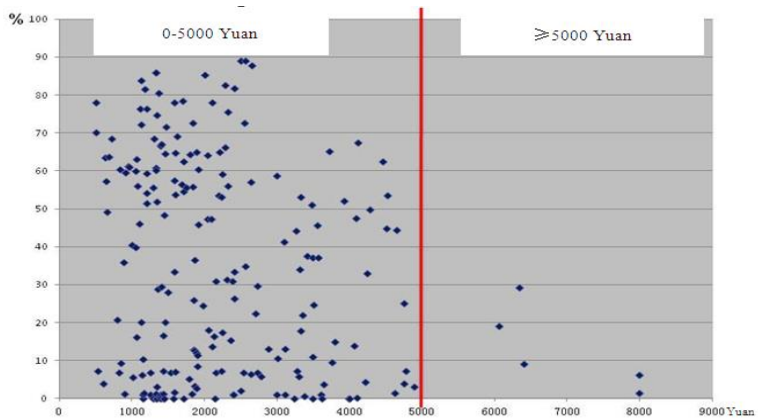

Figure 6. The Proportion of Civil Structures Change with Economic Trends

Figure 7 reflects the proportion of brick structures change with economic trends in rural areas.

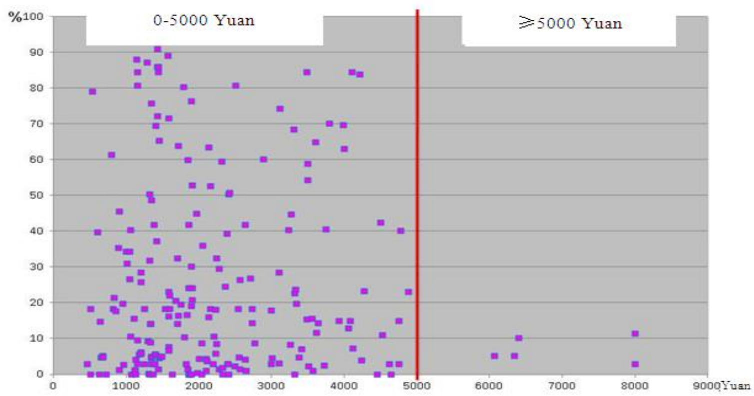

Figure 7. The Proportion of Brick Structures Changes with Economic Trends in Rural Areas

Figure 8 reflects the proportion of brick-concrete structures change with economic trends in rural areas.

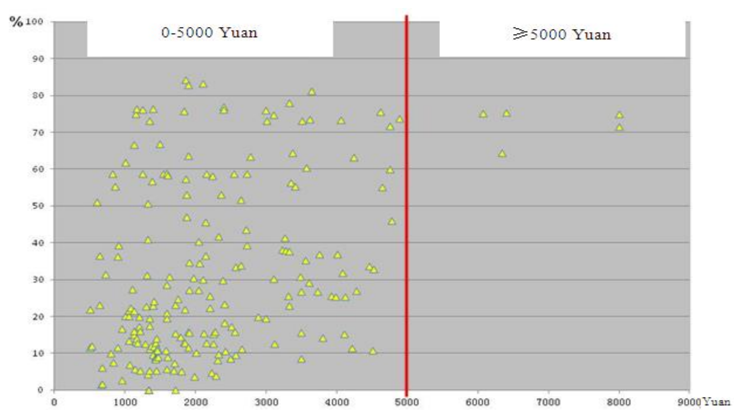

Figure 8. The Proportion of Brick-concrete Structures Change with Economic Trends

Figure 9 reflects the proportion of frame structures change with economic trends in rural areas.

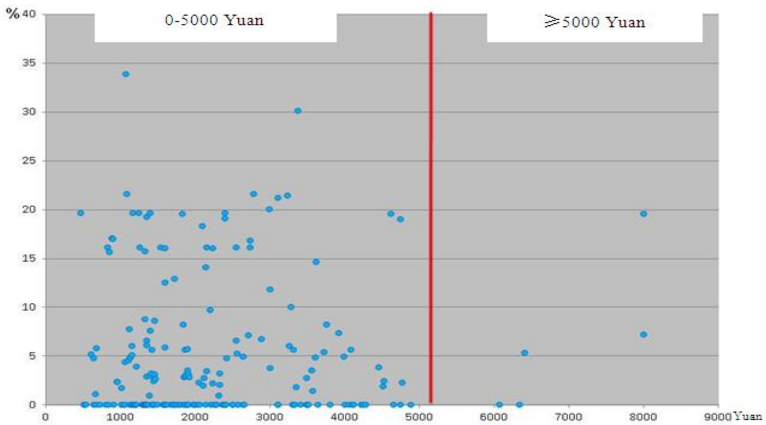

Figure 9. The Proportion of Framestructures Change with Economic Trends

The following table presents statistics showing the proportion of each housing structure in rural areas.

Table 4. The Proportion of Each Structure Housing

Civil structures		Brick structures		Brick-concrete structures		Frame structures	
0-5000 yuan	>5000 yuan	0-5000 yuan	>5000 yuan	0-5000 yuan	>5000 yuan	0-5000 yuan	>5000 yuan
35.12%	11.38%	24.79%	9.7%	31.34%	72.52%	4.98%	5.35%

By counting and analyzing the housing destroyed status of each intensity zone, we can build various buildings vulnerable intensity matrix and house damage matrix. The following table lists the destruction ratio matrix of intensity area.

Table 5. The Destruction Ratio Matrix of Intensity Area

Intensity	Structure type	Destroyed	Heavy damage	Moderate damage	Slight damage	Well
Ⅵ	Frame structures	0	0.12	0.95	17.32	81.61
Ⅵ	Brick-concrete structures	0.05	0.35	2.95	20.19	76.46
Ⅵ	Brick structures	0.91	0	25.58	0	73.51
Ⅵ	Civil structures	1.24	0	29.80	0	68.96
Ⅶ	Frame structures	0	1.39	8.77	32.91	56.93
Ⅶ	Brick-concrete structures	0.38	4.46	15.32	31.36	48.48
Ⅶ	Brick structures	5.03	0	54.83	0	40.14

Ⅶ	Civil structures	7.80	0	53.61	0	38.59
Ⅷ	Frame structures	2.19	7.96	13.49	47.36	29.00
Ⅷ	Brick-concrete structures	2.30	14.61	35.23	31.85	16.01
Ⅷ	Brick structures	27.01	0	63.92	0	9.07
Ⅷ	Civil structures	27.68	0	65.51	0	6.91
Ⅸ	Frame structures	0	12.00	33	34	21
Ⅸ	Brick-concrete structures	11	38.15	14.5	18.05	18.3
Ⅸ	Brick structures	53	0	47	0	0
Ⅸ	Civil structures	59.10	0	40.9	0	0

The following table lists the destruction ratio of housing.

Table 6. The Destruction Ratio of Housing

Structure type	Destroyed	Heavy damage	Moderate damage	Slight damage	Well
Frame structures	85	55	25	7.5	2.5
Brick-concrete structures	85	55	25	7.5	2.5
Brick structures	90	0	40	0	2.5
Civil structures	90	0	40	0	2.5

Reset price refers to the cost of repairing damaged houses, restoration to pre-earthquake standards required of the same size based on current prices. Referring to reset price of Yunnan, combined with the actual situation of the Shangri-La earthquake, we calculated the housing unit-price of Shangri-La and Deqin (Table7).

Table 7. Reset Price

Structure type	Frame structures	Brick-concrete structures	Brick structures	Civil structures
Unit-price	1600	1000	700	500

3.3.3. Application

The total houses damaged area obtained using the house destroyed area model and the above earthquake zone data was 946,882.17 m2. Additionally we integrated the model and GIS software to obtain more comprehensive results. In this paper, the ArcGIS software which developed by ESRI company was chose. Using GIS, the spatial distribution was obtained [10]. On this basis, it was possible to obtain the whole spatial distribution map of earthquake areas by utilizing the spatial interpolation tools which were provided by ArcGIS. The following map reflects spatial distribution of houses damaged [11].

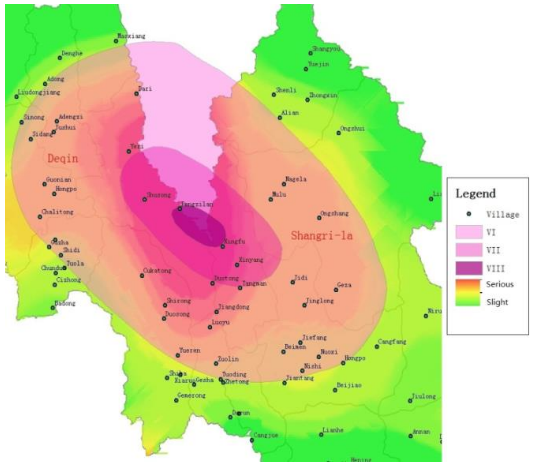

Figure 10. Spatial Distribution of Houses Damaged

The purple areas indicate the regions where houses were severely damaged while houses in the green areas were less affected. Houses were more heavily damaged area in the VIII and VII band. The damage status of Deqin was more severe compared to Shangri-La, with the damage levels being closely related to housing construction, the economic level of the region.

We counted the house economic losses caused by the earthquake at 736,728,200 yuan based on the houses destroyed economic losses model associated with the above data. At the same time, we obtained the spatial distribution of house damaged economic loss according to regional housing structure, housing replacement costs, economic level, and geology. The following figure shows the spatial distribution of houses destroyed economic losses.

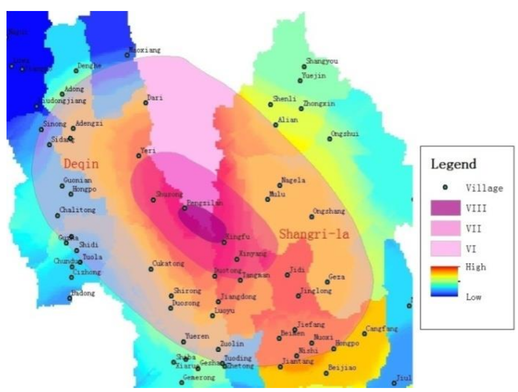

Figure 11. The Spatial Distribution of Houses Destroyed Economic Losses

Houses destroyed are closely related to the local economic level. Due to very poor economic level of Deqin County which is one of the most impoverished counties, the extent of damaged houses in Deqin was more serious than Shangri-La. But, it's relatively low cost of repair and replacement lead to the houses destroyed economic losses being less than Shangri-La. The map reflects this feature (Figure 12).

The number of lost houses was 15,786, which was obtained using the lost house model and the above data. According to the housing structure, population density, we can get the regional distribution of lost homes.

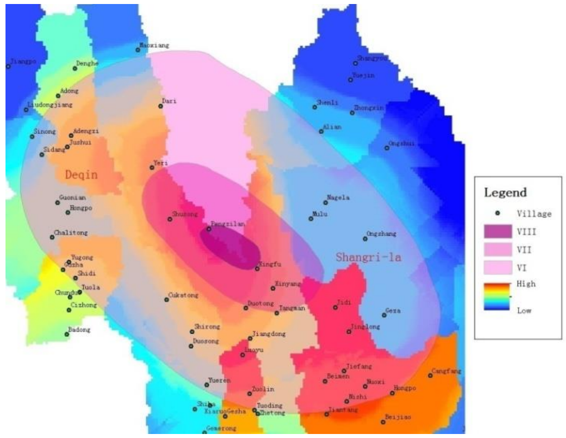

Figure 12. The Spatial Distribution of Lost Homes

The number of lost homes was related to the damage condition of the houses and the population density. Although relatively fewer Shangri-La County houses were damaged, the population density in this region is much larger; the number of people who lost their homes in this area is relatively greater.

4. Conclusion

The advantage of GIS is its ability to intuitively understand the spatial distribution of natural and socio-economic of areas. Earthquake damage assessment model can quickly evaluate housing losses and casualties based on historical data and the earthquake monitoring data. Integrating GIS and earthquake damage assessment model can help master the spatial distribution of earthquake losses. This could provide emergency command centres a convenient way of accessing earthquake data rapidly. However, it is very important to improve the prediction accuracy through further research before implementing such a system.

Acknowledgements

Thanks to the financial support of National 863 Plan NO.2012AA121402, National Natural Science Foundation of China NO.41201463, Special Research Fund for the Doctoral Program NO.20115303110002, the Yunnan Science Fund No.2009FXW001, Yunnan Provincial Department of Education Fund NO.2011Y314, the National Education Information Ministry of Education Key Laboratory NO. EIN2011B008.

References

[1] Y. Yuan, “Loss Assessment of Wenchuan Earthquake”, Journal of Earthquake Engineering and Engineering Vibration, vol.28, **(2008)**, pp. 10-19.

[2] H. Chen, J. Dai, Botao Sun and Y. Wang, “Investigation Report on Influence Factors of Causalities in April 14, 2010 Yushu Earthquake”, Journal of Earthquake Engineering and Engineering Vibration, vol.31, **(2011)**, pp. 18-25.

[3] M. Mekni and R. Beaubrun, “Model-Based Geo-Simulation Approach for Performance Evaluation of 1xEV-DO”, International Journal of Hybrid Information Technology, vol. 1, no. 2, **(2008)**, pp. 51-66.

[4] X. Li, Q. Guo, Y. Lu, Y. Zhang and W. Pan, “Preliminary Assessment Methods Used in Yingjiang 5.8 and 7.2 Earthquakes the GISenvironment”, Journal of Seismological Research, vol. 35, **(2012)**, pp. 104-109

[5] Z. Li, J. Qin, Y. Su, "The Relationship of Earthquake Magnitude and Frequency Under the Condition of Discrete Magnitude", Chinese Journal of Geophysics, vol. 54, **(2011)**, pp. 1038-1042.
[6] S. Zhang, K. Yang and S. Peng, "A study on Digital Isoseisms Fast Drawing Method Based on GIS-Take an Example of Yunnan Province", Geoinformatics 2013 21st International Conference, Kaifeng, **(2013)** June 20-23.
[7] D. Li and M. Li, "Mathematical Modeling", Science Press, Beijing, **(2009)**.
[8] Y. Li, "Research the Number of Yunnan Earthquake Death", Yunnan Science and Technology Press, Kunming, **(2012)**.
[9] H. Lu, F. Zhao and Y. Hu, "Research on Building Earthquake Insurance Lost Estimation Using GIS", Technology for Earthquake Disaster Prevention, vol. 1, **(2006)**, pp.273-277
[10] H.D. Xing , X. Wang, Y. Du, Y. Wei, Y. Yang and R. He, "Urban Building Vulnerability Analysis and Application Research Based on GIS Technique", Journal of Disaster Prevention and Mitigation Engineering, vol. 32, **(2012)**, pp.728-753.
[11] Z. Zhao, D. Cui, S. Yu and J. ZHong, "Seismic Casualty Assessment for Wenchuan Earthquake", World Earthquake Engineering, vol. 28, **(2012)**, pp.20-25.

Authors

Shuangyun Peng, he received the MS from the School of Tourism and Geographical Science, Yunnan normal University, Kunming, in 2002 and 2005. He is currently a lecturer of the School of Tourism and Geographical Science, Yunnan normal University. His research interests include GIS, GIS for earthquakes, Integration of GIS and application model.

Kun Yang, he received the MS from the University of New South Wales, Sydney, in 1998 and 2000. He is currently a professor of the School of information science, Yunnan normal University. His research interests include software engineer in GIS, environmental GIS, health GIS and spatial simulation model.

Yanbo Cao, he received the MS from the School of Tourism and Geographical Science, Yunnan normal University, Kunming, in 2003 and 2006. He is currently an engineer of Yunnan Earthquake Administration. His research interests include the loss assessment of earthquake, GIS for earthquakes, emergency command in earthquakes.