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Saulėtekio al. 11, 10223 Vilnius, Lithuania
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APPLICATION MONTE CARLO METHOD ON SIMULATION OF DISASTER PREVENTION AND PROTECTION IN COMMUNITY

Kuo-Chung Wen
Associate Professor
Graduate Institute of Architecture and Urban Planning, Chinese Culture University
55, Hwa Kang Road, Yangmingshan, Taipei 111, Taiwan, R.O.C.
wenkc@ms1.hinet.net

Sheng-Kai Huang
Postgraduate Student
Graduate Institute of Architecture and Urban Planning, Chinese Culture University
55, Hwa Kang Road, Yangmingshan, Taipei 111, Taiwan, R.O.C.
Faun7415@yahoo.com.tw

ABSTRACT

This research using the Monte Carlo Method needle to the disaster to cause disaster damages in the discussion community to guard against the disaster relief plan and the disaster reciprocity, provides recognizes the community dangerous region the spatial distribution. The research to the community guards against the disaster relief spatial systems and the spatial analysis unifies the Monte Carlo Method risk assessment to take this research the main overhead construction. In the research to the Shiji Chang-an community to take the example, first carries on the Shiji Chang-an community overall spatial basic data to construct the construction. The conformity guards against the disaster relief theory and the spatial analysis method, simulation carries on appraisal the overall risk take the street block as the unit using Monte Carlo Method, finally describes recognizes the Chang-an community the dangerous region spatial distribution.

KEYWORDS

Monte Carlo Method, Disaster Prevention and Protection, Community, Risk Evaluate

1. INTRODUCTION

In recently, all will population density in the region continuously rises. The city is continuously excessive development. Cause to reduce to the safety of the city living environment. And defend the programming of the relief system all is a consideration with the city dimensions. For this reason, the quality of the environment space of the community is easily subjected to the threat of equal degree. Therefore this research wants to aim at community space to seek refuge risk factor to carry on study and valuation. With the angle of the risk application needle in Monte Carlo imitate analysis method the creation is to the disaster become to defend the correlation between relief programming and disaster in the disaster Sun study community. The space that provides city dangerous district further distributes appearance.

1. The disaster prevention and protection database establish with Chang-an community in Shi-ji.

2. Monte Carlo evaluates the construction of methods at the risk of the community disaster.

3. Chang-an community dangerous district space distributes of recognize with valuation.

2. RESEARCH

2.1. Disaster, Prevention and Protection Framework

With county (city), municipality for commanding center. Take each country (town, city, section) as integrity to defend a relief basic unit. And with neighborhood on for seek refuge unit of three layer class space system of the city disaster prevention and protection. Public facilities greenly system with defend the structure of the integration of the base of the relief refuge. My country defined the disaster prevention function of place because of the space scale. Large open the space most conduct and actions compound type in the temporary disaster prevention commanding center, supplies, foreign help...etc. to defend relief base [1]. Thin say to the structure of the disaster prevention and protection system as follows:

1. The plan in disaster prevention and protection system level

The first stage seeks refuge the base as in front road. Mainly provide family to come together, urgently exchange refuge message and urgently from the place saved. The second stage seeks refuge life place at the time: Mainly include neighboring school, park...etc. to open space. Transfer time to seek refuge life place over a long period of time in the third stage: Include neighboring school, county and village parks.

Depend on the city layer class. Providing conduct and actions to defend a relief and seeking refuge public facilities and park of activity greenly can be classified into:

2. Disaster prevention and protection system

The establishment of safe city should start to do from the living space (community). Depend on its turn the area is different. Be classified into close neighbors, life and area living space. Its definition and its content are illustrated as follows respectively:

1). close neighbor living space: In this district. Area in the primary school is the center of residents' daily life. The living inside of circle takes residents as corpus. By the way of mutual aid carry on community construction. While the disaster is happening, the system can independently launch a disaster prevention activity. After disaster takes place the ability immediately takes disaster prevention base in the region as center. The independence that constructs community lives.

2). living literary circles: The city hall is helped to area to establish the base of the disaster prevention support everywhere. Also take base as center. Contact residents and administration. The living need of the support "close neighborhood living space".

3). area living space: Take administrative area as corpus .The city hall launches a wide and Fan rescue activity for the center.

The turn of the disaster prevention refuge its main personnel is around about 30,000-45,000 people. And seek refuge the district that the scope control can arrive in 300 meters or five go to pretty much the clock. And because its base attribute is different. And there is the programming of different consideration. Mainly it can be divided into four types on the programming.

A. disaster prevention and protection point

The disaster prevention base should take into with whole current conditions to combine .Depend on its valid road area, go to all levels road it within the reach of sex's etc. as the content of main valuation. Its disaster prevention and protection base also can take in to be divided in to seek refuge life base, medical treatment base, the base of the supplies support, fire fight base and police base etc. because of its different type.

B. disaster prevention and protection circulation

Defend a relief to circulation system to be divided into urgent channel, rescue to transport channel, fire fight channel and refuge channel four types. The fire fight channel specifies breadth 20 meters above of main connect the evil road is the urgent road of first floor class. Match with urgent channel to provide the refuge the personnel to lead to seek refuge district and vehicle to deliver supplies to the function of each base by 15 meters above road. The 8 meters above is a fire fight channel. It links to each street block. The

effect is the devotion of providing the fire fighting. Besides 8 meters following is to seek refuge channel. With is the transportation network that links to before three layers class to link to the base of the refuge space [2], [3].

2.2. Estimate Disaster of Risk

The disaster risk valuation most carries on the earthquake dangerous degree, the fire dangerous degree, the Hong disaster dangerous degree valuation that sought refuge a dangerous degree with relief. Evaluating by earthquake risk among them is more. As for the earthquake risk valuations most combine mathematics calculation formula to carry on an estimate. Also its risk valuation item and disaster take place behind not corresponding period become of the disaster risk carry on a classification. In order to carry on a risk estimates [4].

1. Disaster risk estimate process

In the disaster risk estimate process it can concretely explain and carry on the valuation of the disaster risk and present. The process following is:

(1) Factor study and classification

Mainly aim at with the result that the disaster factor carries on a whole study. With explain it each with the result that the type and characteristic of disaster factor.

(2) Influence factor annotation

The exploitation can simply identify or can calculate to wait for mode to carry on each one with the result that the annotation of the disaster factor.

(3) Data calculation and sketch present

Carry on the estimate of the environment disaster risk degree by mathematics calculation. Also carry on presenting by the data and the sketch. With be provided for decision to carry on.

2. Disaster risk estimate theory

(1) The space item categorizes

Be mainly divided into disaster prevention risk in the valuation the method natural condition with the result that the disaster factor, community disaster prevention is whole to go together with appearance and external disaster prevention resource three greatly part of.

(2) Natural condition with the result that disaster factor

Natural condition with the result that the disaster factor is mainly inquires into the influence that the disaster causes. Also aim at the environment sensitive factor in the region as main valuation item. See as the inundation of the earthquake disaster fault district, the soil liquefaction potential district or water disaster etc.

(3) Deploy the community disaster prevention and protection

Deploy the community disaster prevention and protection is mainly separate to do prevention sense. The disaster notifies system, building corpus, the community outdoor space, outward links...etc. This part valuation item is mainly carried on an estimate by the building and the community. In addition to the hardware explains building corpus, the community outdoor space and outward links to belong to space entity part. Other items then are partial to artificial factor etc. the software is part of.

(4) Outside disaster prevention souse

Include seeking refuge base and defend relief channel and support to make an agreement among them etc. This part is main depend on be within the reach of sex to carry on valuation. With is the valuation item of contact.

2.3. Disaster Factor Categorizes

Its valuation item mainly uses the earthquake and the fire as a main disaster type. Its analysis in addition to natural condition with the result that the disaster factor outside also aims at a whole resource to carry on valuation. It is mainly divided into substantial environment with the result that disaster risk and not-substantial environment with the result that the disaster risk is two parts [5].

(1) The community space substantial environment with the result that the disaster risk evaluates

Main in the community space with the result that the disaster evaluates factor to be subjected to dangerous degree, building by building outside of dangerous degree etc.. The constructing oneself to be subjected

to a dangerous degree counts, builds age, structure type...etc. It's just like the floor. Outside the building builds by constructing a density, illegal buildings degree, wood a house comparison, prevents fire a lane to take up...etc.. Evaluate another item to still have already defended relief base and construct valid width etc. of the in front road, road.

(2) The community space not- substantial environment with the result that the disaster risk evaluates

Un-substantial environment with the result that the disaster risk valuation factor mainly behaves a people's characteristic, economic industry, disaster prevention education, community disaster prevention consciousness...etc.. This part is in the process of estimating in not easy quantity turn. Also don't a little bit not easily evaluate.

2.4. Spatial Analysis Method

This research is in addition to carry on each space number basic covariance and calculation. Also carry on a calculation to parts of space analysis item.

The network analysis mainly carries on the calculation of the space path anti- resistively. Carry on minimum anti- Zu path, service area calculation...etc. by the calculation number. Mainly carry on space here etc. the calculation of turn.

$$\text{area } z(X) = \sum_{(i,j)\in A} C_{ij} X_{ij} \tag{1}$$

2.5. Monte Carlo Simulation

When the problem was included indetermination factors. Solving of tradition method may obsolescent. It can't lead the indetermination factor into a certain mode. Then beg to take solution. It's in order to overcoming this problem. Is assumption of fix the value change into a probability to assign an output values. Be again probably of need combination. And the Monte Carlo simulation method would be by computer with the random sampling carry on the above-mentioned calculation to carry on the estimate of data.

The Monte Carlo simulation method (Monte Carlo Simulation) is the way of a kind of risk valuation. Also call the mode (Risk Analysis Model) of the risk analysis [6] [7]. Its calculation method usually is the allotment, restriction condition that includes all variable factors with combine to all probably be worth to gain of solution. In continuously, it's the repetition of the system the emulation the process. Carry on the action that a subsystem imitates each time. The function of the probability allotment in the variable will be by drawing samples. Produce a new value. This kind of draw out a lately- been worth action. It is the way that imitates risk.

The Monte Carlo simulation method is with a series of expectation value and Sigma that the repetition tests to beg risk variable. Also construct by analysis a probability in the model to assign random mode sampling of mathematics statistics way. With create several hundred even up to thousand results. Is 1 kind to more approach a realistic method of the risk analysis [8-10].

When carrying on Monte Carlo simulation method. Confirm to imitate the scope of the variable first. Also decide the most suitable each variable the probability assigns. Depend on the probability allotment of that variable. Sample each variable number by random drawing samples. Combine the number of selecting by examinations the variable. Generation average value, Sigma and variation that fall into trap to calculate the value of the target function into the target type number. The number is combination also canning gain with calculation. The probability that returns to announce an emulation result assigns model.

3. OPERATE METHOD

This research aims at after above cultural heritage take into inquire into. Combine related theories and cultural heritage. Also with geography information system Arc-GIS combine the analysis of the city disaster prevention theories, space method carry on valuation with Monte Carlo simulation method. Also explain its operation method content:

1). the file sets up to make to convert with format

This stage aims at first to want to carry on analytical district map and space information to carry on a number to turn it set up to make. Because the Arc-GIS file type is to order line to face pattern. Consequently have to order, line, faces of the related analysis item carry on setting up to make. Also give a conversion. It's for the purpose of follow-up operation.

2). the calculation of the space number and space point distribute enactment

It's after turning by the format. Advanced space environment attribute in the line then sets up to make and adjusts on the operation. If the network installed and building position etc. Also convert the parts of vectors high data as mesh data. In order to analyzes a calculation to use at the space. Because part of analysis methods are the calculations that orders to carry on a space niche by observation. Then aim at a space observation to order it to carry on an allocation here. In addition to canning see the calculation of scope. Also assist with other content of the space attributes. The basis calculated by conduct and actions whole environment.

3). the space point value calculation and display data

This is mainly the data calculation that this research inquires into. With the space analyze method etc. information. Draw up by the estimate that is used as the property of the city refuge risk valuation. Through space point according to of the related calculation is after. Carry on the space information that the sketch turns to turn with data analysis and space display.

4). the space data picks and distributes a type to make selection

Respectively influence after factor make selection then carry on a space data to compile and calculate. Distribute appearance by the data influence factor data of importation here. While making a calculation it the space to allot appearance. Among them establish part at the data should notice it to assign scope and allotment type.

5). the risk analysis calculates to estimate with whole risk

Carry on the calculation of the street block dangerous degree by the individual risk valuation factor. The classification structure by the valuation of the disaster risk carries on a selection. Also carry on the whole power heavy allotment in individual the risk the valuation the factor. With the estimate of the disaster risk of conduct and actions whole's street block.

6). the disaster prevention refuge risk presents with study

Carry on the disaster prevention risk of district to be worth a total average as a result with the risk estimate calculated by whole street block calculation value it present. Also assist to wait for valuation item to show by Sigma. With inquire into its space allotment characteristic further.

4. CASE OPERATION

This research takes Xi-zhi region of river area in Kee-lung as the research object and the scope as the Figure 1. Figure 2 distribute appearance for the main building.

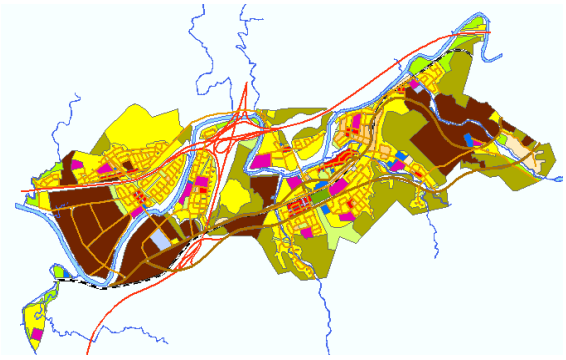

Figure 1. Xi-zhi area

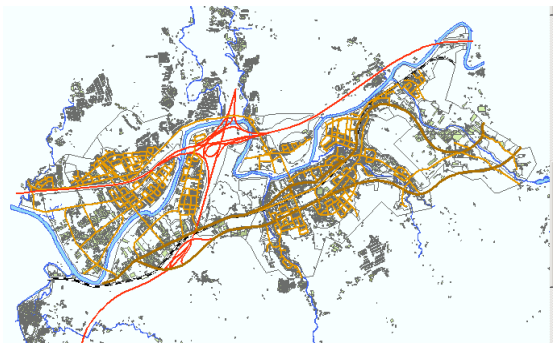

Figure 2. Xi-zhi area for building

4.1. The model of the disaster prevention network sets up

Be divided into four layer classes: road. Are an urgent channel system (20 ms), rescue to transport channel system (15 ms), the system (8 ms) of the fire fight channel with the system of the assistance channel respectively; (8 ms) On the area design of the turn of the disaster prevention refuge with junior high school, small distribute with the service radius 600

ms for design basis. Seek refuge path around the 300-500 meters. Seek refuge inside the turn area on foot time is 5~10 minutes and sex of the being within the reach of consideration and other disaster prevention resources.

4.2. The seeks refuge living space explanation and basic data to build

The close neighbors are living space that this time living space that carries on a study mainly regards school as principle is a main research type. Mainly aim to three living in space to carry on valuation in this research. Among them Figure 3 for the main school in Xi-zhi use ground and park greenly it distributes appearance. Explain the school is distributed appearance with the ground and the network of the surroundings transportation and transportation node. This research also according to close neighbors living space and establishes 600 meters as the scopes of refuge turn. Figure 4 distribute appearance for its building.

After folding after basic diagram layer set. Carry on data to convert into vector data in order to at the editor. In this part city street block carry on the allocation of space. Convert its sketch data into mesh data. Make it after turning into Arc-GIS can read smoothly. Also carry on road system and defend the calculation of the service effect of relief base. As Figure 5 the showing its contribute efforts to the police station effect diagram. Figure 6 contributes efforts to the fire station the effect distribute.

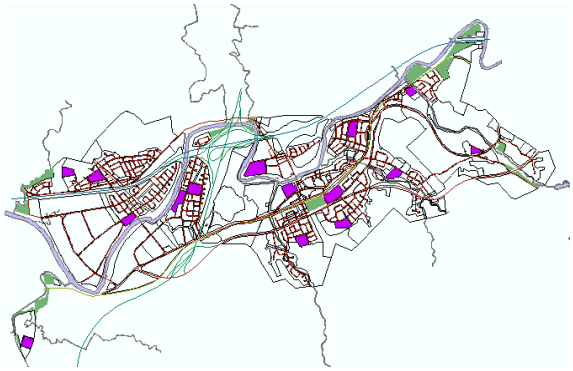

Figure 3. The main school in Xi-zhi use ground and park greenly

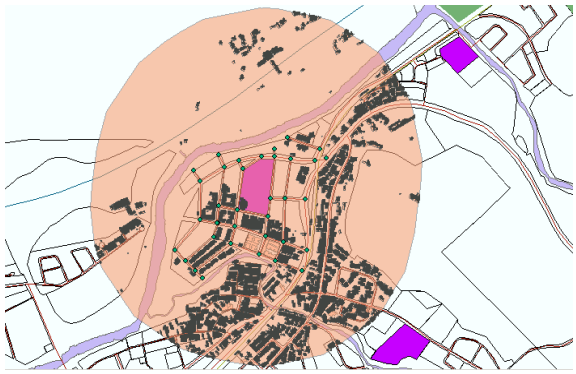

Figure 4. Distribute appearance for building

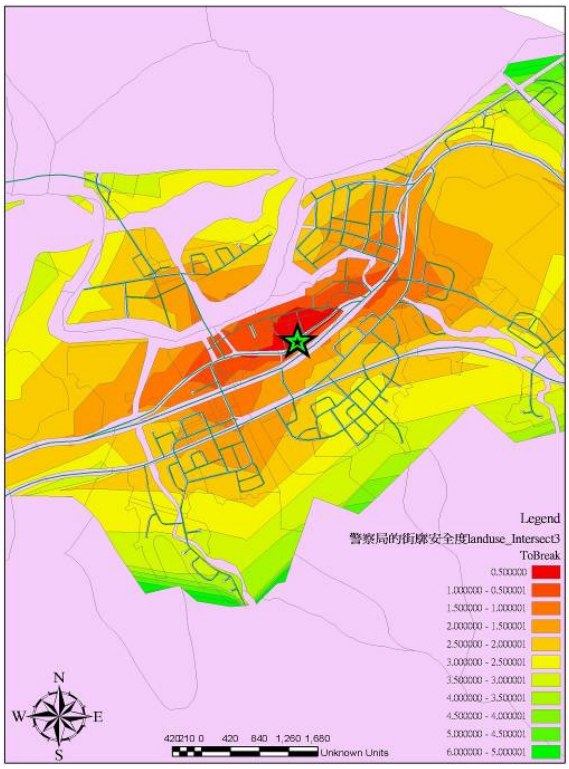

Figure 5. Police station effect diagram

4.3. The calculation of the risk factor and allotment

1. Construct internal risk factor

Construct internal risk to evaluate the item as building floor area, construct total number of floors and construct structure and construct total capacity.

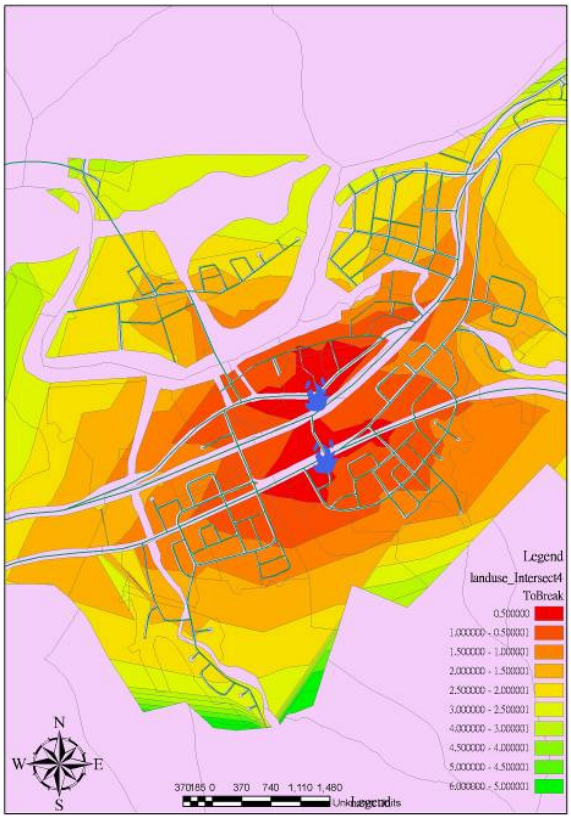

Figure 6. Fire station effect diagram

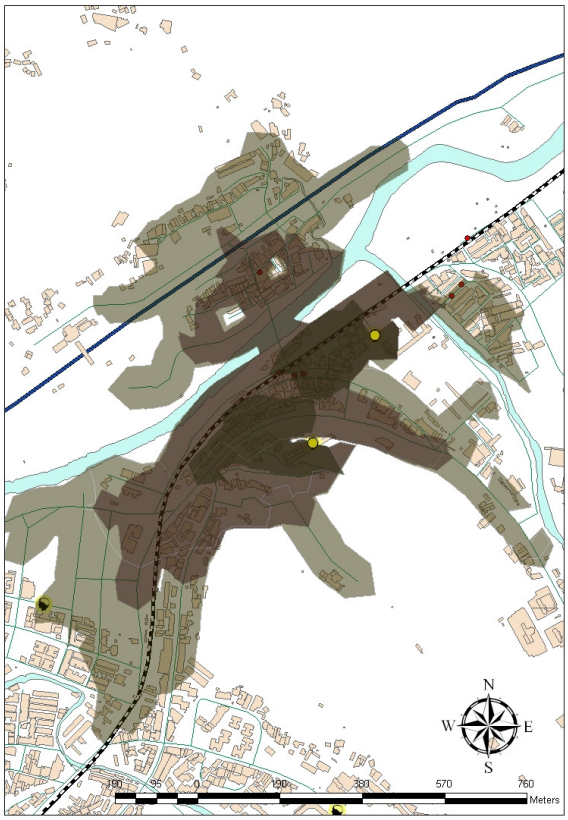

Figure 7. Allocation diagram by refuge

Carry on an operation by the building of allocation in the street block while calculating. Be whole to make link the block of the building and the street in the same street block. Also it will construct risk valuation the item carry on collect. With is the calculation that the street block suffers a stroke insurance valuation.

2. Construct external risk factor

1). network simulation

Carry on building and the external world to seek refuge risk valuation. BE evaluating scope in order to prevent the disaster refuge turn is the niche of valuation. In order to prevent the disaster base is a calculation to order. Use 50 meters as unit. Carry on each street block in the refuge turn to be within the reach of the calculation of network. Evaluate an estimate by being a whole risk. Figure 7 is the allocation diagram that the refuge orders a network with surroundings. Figure 8 is self-time sketch map.

4.4. The street block risk factor calculates

By after saying the calculation of the factor of the risk valuate pick its data. With the appearance of the space allotment that explains each disaster prevention risk valuation factor. As Figure 9. It is integrative the data here. Also convert the appearance of result rate allotment. Operate by carrying on the street block disaster prevention risk whole valuation. In the street block disaster prevention risk calculation part. Evaluate each one here factor in with assign on the average. Power the repeating gives to all be worth on the whole of the comparison carrying on the estimate of random sampling to imitate. It's just like the Figure 10.

The estimate imitated to have to set the allotment appearance of each disaster prevention risk influence factor first ago. It included an allotment type and assign scope and allotment to relate to among them etc. like Figure 11. Also carry on random emulation. More

its allotment appearances then will more is extensive in the emulation number of times. The calculation that then aims at a random allotment here carries on a data to pick as a result like Figure 12.Take it to assign appearance as the result of the estimate of the disaster risk of street block to assign curve with it on the average. It's just like the Figure 13 and Figure 14.

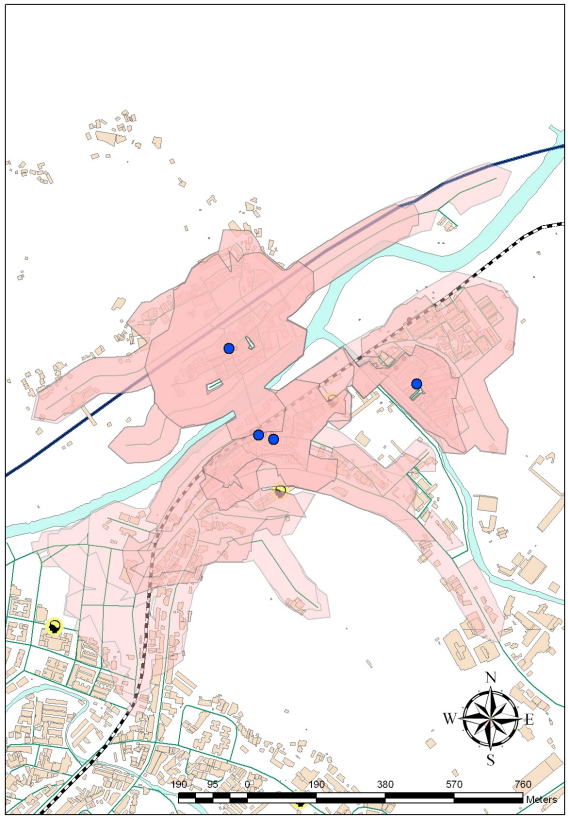

Figure 8. Self-time sketch map

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	A	B	D	E	F	G
1		OBJECTID	BAREA	ALLAREA	ELEVATION	FLOOR
2	1	81	12.14	60.70	10.66306914380	1
3	2	81	476.35	8097.95	16.00000000000	17
4	3	81	475.51	8559.18	10.79677527410	18
5	4	81	253.01	1518.06	26.04508743350	6
6	5	81	126.37	758.22	26.04508743350	6
7	6	81	120.82	604.10	26.30087307400	5
8	7	81	192.68	385.36	16.00000000000	1
9	8	81	210.26	420.52	16.00000000000	1
10	9	81	293.68	2643.12	32.32346224560	9
11	10	81	209.29	1255.74	26.57991195450	6
12	11	81	142.71	856.26	26.35319286410	6
13	12	81	589.20	2946.00	26.58572526450	5
14	13	81	527.74	4749.66	10.70876231390	9

Figure 9. The data of risk

X15

	A	B	U	V	W	X	Y	Z
3			206	207	208	209	211	213
4	建築	樓地板面積	0.7013097	0.3721717	0.151	0.063	0.4145791	0.4456673
5		總容積（人口）	0.6538093	0.3070461	0.093	0.006	0.5033537	0.588645
6		樓層數	0.360265	0.0873207	0	0.35	0.6630549	0.630077
7		構造	0.35	1	1	0.35	0.35	0.35
8	基地	坡度	0.0302455	0.096445	0.0657	0.106435	0.10145	0.0505945
9		使用分區	0.62	0.62	0.62	0.62	0.62	0.62
10	移動	可及性	0.2771468	0.302425	0.2539	0.608635	0.453195	0.75286
11		可視域	0.20418	0.3367775	0.22866	0.288685	0.293395	0.21457
12								
13		災害風險	0.3759634	0.3759634	0.3015325	0.2990944	0.4248785	0.4565517

Figure 10. Estimate the risk

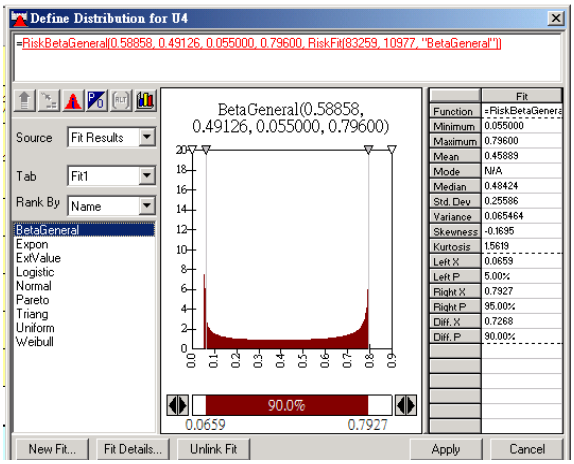

Figure 11. Influence the appearance of the factor allotment

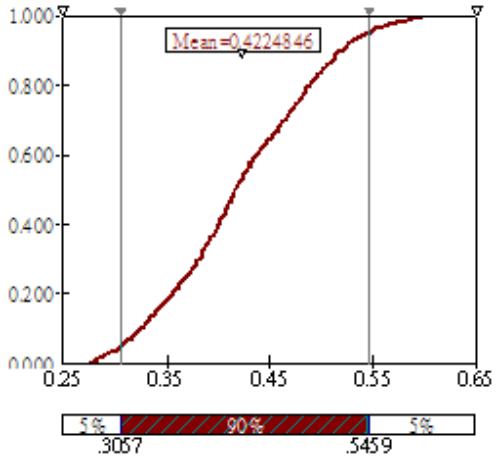

Figure 12. The simulation data curve diagram

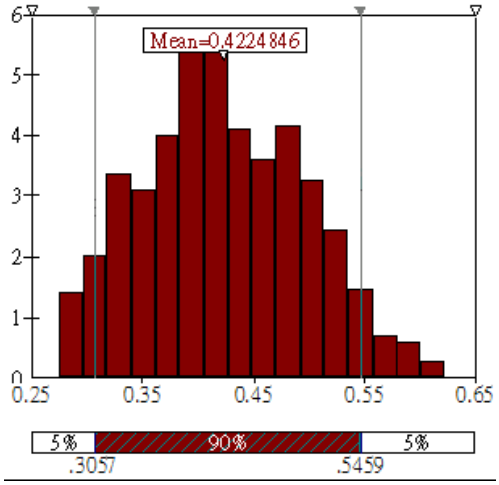

Figure 13. The emulation data distributes diagram

Figure 14. The disaster place probability diagram

4.5. The street block disaster prevention seeks refuge a risk allotment and presents

By random estimate of the data is carrying on integration. If the least be worth (Figure 15), the minimum value, the average value (Figure 16) and Sigma's (Figure 17) etc. carry on the explanation of the characteristic of the street block refuge risk. Here with count the average is each base of the result of the valuation of the refuge risk.

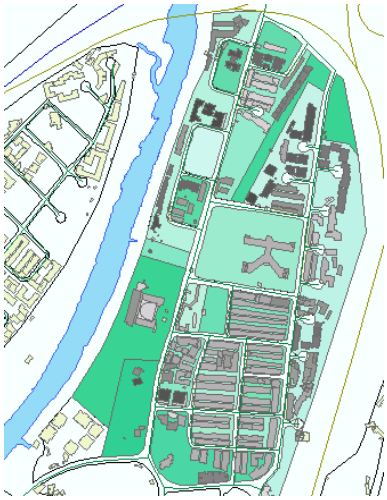

Figure 15. The street block refuge risk minimum value

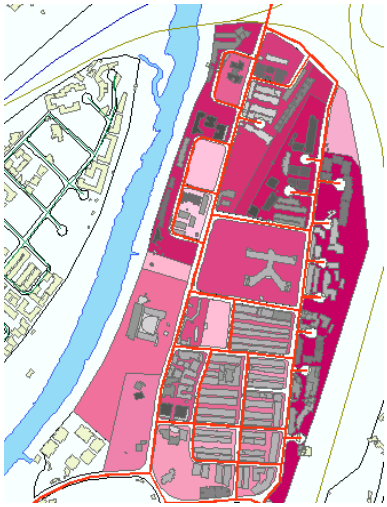

Figure 16. The street block refuge risk Average value

Figure 17 The street block refuge risk Sigma's Average value

5. CONCLUSION AND SUGGESTION

5.1. Conclusion

1. The disaster prevention and protection database establish with Chang-an community in Shi-ji.

It can integrate the information of the community space by the system platform. The whole space information of carrying on the community carries on the construction of database. With benefit in is a follow-up to operate the data calculation imitate an usage.

2. Monte Carlo evaluates the construction of method at the risk of the community disaster

Use disaster prevention refuge turn in the neighborhood as the scope carries on building and the street block disaster risk factor classification. Also assign appearance to carry on Monte Carlo simulation method to carry on random emulation by the space of its factor. Beg to take it to probably assign appearance to assign scope with it. With the allotment appearance that says further clear disaster risk.

3. Chang-an community dangerous district space distributes of recognize with valuation

It can distribute a result to carry on the risk of the community disaster to present by the emulation of the Monte Carlo simulation method number. To be also acquired easily by data with the result that the niche of the disaster risk. It's convenient to carry on the valuation of the disaster risk of community.

5.2. Suggestion

1. The thorough study risk evaluates calculation weights enactment

This research is at the calculation currently mode in with all be worth a comparison to carry on a calculation. The conversion in actual calculation should carry on weights. In order to make the calculation's result come close with actual situation. Narrow an error margin value.

2. The increment un-substantial risk valuation factor calculates

This research only aims at part of substantial factors and amount of space to carry on imitating analysis currently. Concerning divide into substantial factor to be also imitate population with the capacity allotment. The rest item can carry on collect and draw up. Carry on by combining not- substantial factor emulation.

REFERENCES

[1] Tierney, K.J., Lindell, M.K. & Perry, R.W. (2001) Eds, *Facing the Unexpected Disaster Preparedness and Response in the United States*.

[2] Yang, L., Fang, W. & Fan, W. (2003) Modeling Occupant Evacuation using Cellular Automata - Effect of Human Behavior and Building Characteristics on Evacuation, *Journal of Fire Sciences*, 21(3): 227-241.

[3] Yang, L., Fang, W., Huang, R. & Deng, Z. (2002) Occupant evacuation model based on cellular automata in fire, *Chinese Science Bulletin*, 47 (17): 1484-1489.

[4] Fisher, P. (1995) An exploration of probable view sheds in landscape planning, *Environment and Planning B*, 22:527-546.

[5] Stamps □, A.E. (2005) Isovists, enclosure, and permeability theory, *Environment and Planning B*, 32:735-762.

[6] Rubinstein, R.Y. (1981) *Simulation and the Monte Carlo Method*, John Wiley and Sons, New York.

[7] Law, A.M. & Kelton, W.D. (1991) *Simulation Modeling and Analysis*, Second Edition. McGraw Hill, New York,.

[8] Reficea, A. & Capolongo, D. (2002) Probabilistic modeling of uncertainties in earthquake induced landslide hazard assessment, *Computers & Geosciences*, 28:735-749.

[9] Shou, K J. & Chen, Y. L. (2005) Spatial risk analysis of Li-shan landslide in Taiwan, *Engineering Geology*, 80:199–213.

[10] Eged, K., Kis, Z. & Voigt, G. (2006) Review of dynamical models for external dose calculations based on Monte Carlo simulations in urbanized area, *Journal of Environmental Radioactivity*, 85: 330-343.