Applications of Computer Aided Design to Evaluate the Zoning of Hazard Prevention in Community Neighbors

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

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

Abstract: The city government will provide the enough emergence routes, parks, and so on to reduce the hurtful accidents during the escape by making the urban plan. The proportions of the Zoning of Hazard prevention will be influenced by some main policy such as the develop direction, population and some effects, and sometimes get a poor proportions. So in this study we want to use some methods such as spatial and Network Analysis to set up the Zoning of Hazard prevention and estimate the safety of these area.

Keywords: Emergence shelter, Zoning of Hazard prevention, Emergence Evacuation, Escape Behavior.

1. INTRODUTION

Along with the economy grows up and urbanization, the metropolis gathers the most part of population and property. However influence of the Taiwan geography location and meteorological condition, flooding resulting from typhoons and earthquake were frequently and greatly impacted the cities located in Taiwan. It threatens people's life and property tremendously. Because of that, we need to provide proper Zoning of Hazard Prevention to people, and decrease the damage [1].

Some of the Zoning of Hazard prevention plans are set up by P-Median in urban area. It use the shortest distance to calculate the area. But in real movement the shortest road may not be the short time one. So in this paper we want to use some way to calculate the area and treat the methods of Zoning of Hazard Prevention[2].

The present results are three parts: 1, the simulation of escape path evacuation. 2, measure the escape area of the community neighbors. 3, estimate the safety area of community.

2. THEORY

The theoretical basis of the research included GIS, Network Analysis and disaster prevention theories combine with the spatial information, systematize, and escape behavior theory to simulate the escape situations. Spatial information talks about characteristic in urban area. Systematize explain the relationship of the street networks. Escape behavior theory talks about the actions of evacuation people and simulate the escape path in the community escape path. [3]

Receiving the batter population, we combine the function of the GIS Spatial Analysis, under the disaster prevention theories, it can present a more safe model that near to the behavior of the really evacuation in mankind. Figure 1 is the structure of simulation system with GIS.

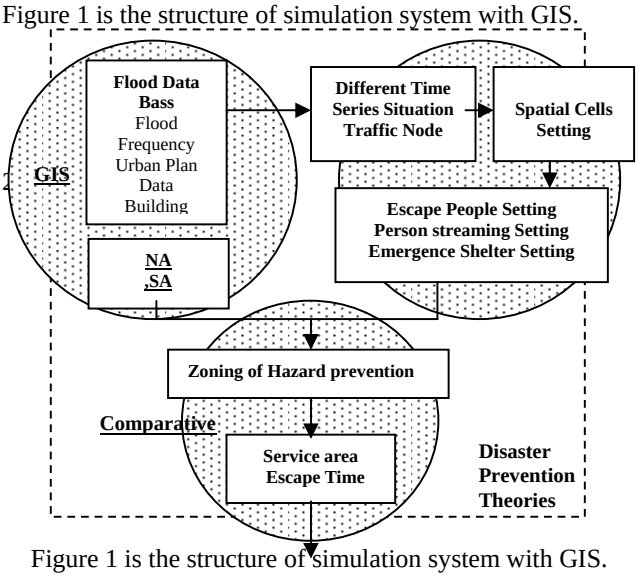

Figure 1 is the structure of simulation system with GIS.

2.2 Disaster prevention system

2.2.1 Emergence shelter

According to the level of disaster and place, the Emergence shelter should proved the functions like command post, information, disaster prevention, medical

treatment, goods saving and so on. So the setting of Emergence shelter should choice the local government, lodge to be the command post and the park, elementary school, community centre to be the Emergence shelter.

2.2.2 Emergence route

The planning of the emergence routes are depended on the different situation. The most important function is to provide people to escape to the safety place. And according to the Taipei Disaster-Prevention Planning, The roads were classified into emergency path system, rescue transport path system, fire control path system, and assist path system (8m).

2.2.3 Zoning of Hazard prevention

Zoning of Hazard prevention is an independence area which is not be influence from next area and when disaster occurred the people in the area dose not escape to other ones. And the zoning area can accept enough people.

2.3 Person streaming theory

The walk speed will be closed to normal speed if there is enough space. On the contrary, if there is not enough space, walk speed will be slow down even closed to stop depending on the increasing density. Dr. Tanaboriboon and Dr. Guyano think about that walk speed and body characteristics of western is differ with oriental. At the center street of Bangkok city in Thailand it was studied to survey location the ambulation of people [4]. They divide service level of ambulation into 6 rankings (A, B, C, D, E and F). And they convert walk speed base on the relationship of density and discharge like Table 1.

TABLE 1 THE WALKING SERVICES LEVEL THAT TANABORIBOON AND GUYANO ESTABLISHED.

Services level	Density (Person / Square metre)	Velocity (Metre /Second)	Flow (Person / Metre * Second)	Condition
A	≦0.42	≧1.12	≦0.47	* Don't generate conflict each other
B	0.43~0.63	1.06~1.11	0.48~0.67	* The velocity and flows become slightly slow
C	0.64~1.02	1.00~1.05	0.68~1.02	* The pedestrian needs to adjust the velocity and directions
D	1.031~1.54	0.88~0.99	1.03~1.35	* Difficult to change the direction and cross
E	1.55~2.70	0.62~0.87	1.36~1.68	* Extremely difficult to change the direction and cross
F	>2.71	<0.61	>1.69	* Can't reverse direction and cross

2.3Network Analysis

Network analysis is one kind of analysis which in depended on the model of GIS system. The analysis way is to connect the spatial feature such as polygon, line and point and calculate the type and characteristic with the connecting networks[5].

$$\min z(X) = \sum_{(i,j)\in A} C_{ij} X_{ij} \qquad (2)$$

A: The set of arc in street network

Xij: The flow of arc（i,j）

Cij: The cast of arc（i,j）

3. ESTABLISH THE RESCUE REFUGE RINGS

We study with the community neighbors. At first, we assess the Emergence route and establish the relationship of the street space. Second, we set up the cell and street networks to interpret the spatial environment. Third, we suppose some methods to simulate the Zoning of Hazard prevention evacuation and to divide the different of the Zoning of Hazard prevention[6].

3.1Establish The Platform

This research carries on the construction of the development platform of the database with the geographical information system. Collect and set up relevant databases at first, then derive the model assessed in simulation and set up the data to export into interfaces. In collection of the database, will mainly collect the urban planning map and relevant attribute data, in order to build the basic geographical information system of database which constructs the calamity area, to offer basic spatial analysis and application, but the digit picture that this stage needs to finish, change of the scope of activities via presenting the time array of this area after network analysis. So must turn attribute data and spatial data into information forms of GIS, for systematic operation, it is mainly attribute data to move the urban street network, the attribute data are with the basic graph: To spread out with point ,line and polygon, each of spatial data all has specific codes and corresponding attribute value, taking network layout of traffic way as an example, its attribute data include: Serial number, length, driving speed, etc. the attribute data are stored in the data form of attribute, elected fetching the data record When, figure when it is corresponding choosing. Attribute data form and basic map is construct for escape simulation of flood disaster to take special database, digital elevation model　urban planning street map, floods water possibilities map, traffic network data, etc.

3.2 Emergence shelter

After the basic data are collected, to city taking escape stronghold is it select to go on, as take escape to choose stronghold mainly with school, park open space mainly here of the area.

3.3 Emergence route

Planning Will take escape in the route and divide into four grades mainly while urban planning of the road value

and to assess proceed of present situation , and classify the traffic network , in order to use as the follow-up network analysis.

3.4 Zoning of Hazard prevention

The escape area is divide four part to mainly to set up, the major is divide into spatial geometry and network analysis two ways.

3.4.1Spatial Geometry Analysis

Analysis with analysis and geometry of ring land that is regarded as the calculation that is rowed and had in space geometry is analyses, analysis in accordance with making and rowed and set up the space equidistantly, but several geometry analyses that separate and take escape the area with the central line in the ring land.

3.4.2Network Analysis

Network analysis is make mathematical calculations to go on with time and distance two impedance, it is analysis to go on with unit length by each impedance value of route to hinder to resist, regard place of making it as with school export when the it can be regarded, in area can reached is it appear to go on so as to a data.

4. COMPUTING RESCUE REFUGE RINGS IN SHIJI AREA

This chapter will take the Shiji City in the Keelung River Basin for case in this study. The boundary is like figure 2. We apply river digital topographic map, Digital Elevation Model, Traffic Network Data, Urban Planning Map, etc. According the functions required. We can analyze the demand of data, and build database.

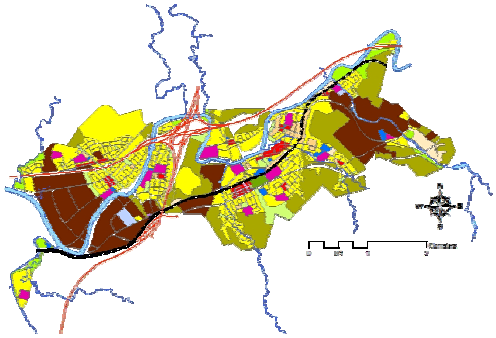

Figure 2 the urban plan of Shiji City

4.1Emergence shelter setting

To define the boundary of Urban Disaster Prevention & Rescue Refuge Rings, we take the service radius (600m) of high school elementary schools, and the range of refuge rings is about 300m~500m. The walk time of refuge rings is about 5~10 minutes and to consider other resource of Disaster Prevention & Rescue. The construction of the disaster prevention network model is like figure3.

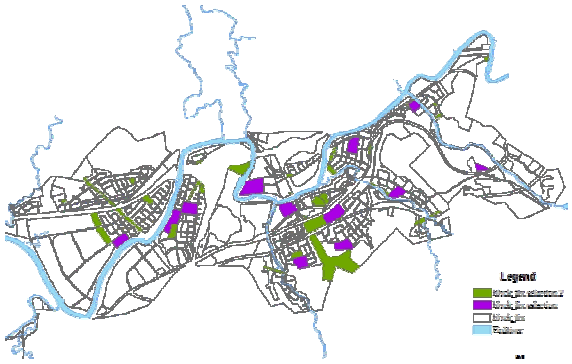

Figure 3 the Emergence shelter in Shiji City

4.2Emergence route setting

We adopt Taipei Disaster-Prevention Planning for the setting of road class. The roads were classified into four classes: emergency path system (20m) rescue transport path system (15m) fire control path system (8m) and assist path system (8m), like figure 4.

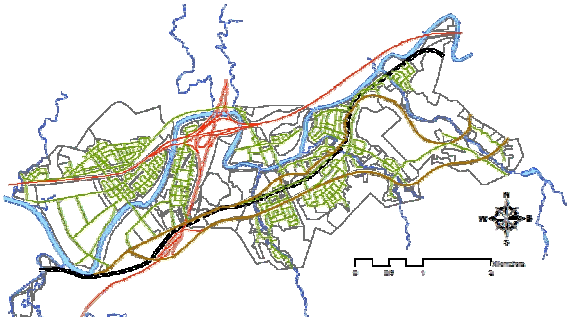

Figure 4 the Emergence shelter in Shiji City

4.3 Zoning of Hazard prevention setting

The zoning of hazard prevention are calculate by spatial and network analysis. We use schools to be the Emergence shelter and the emergence routes to calculate the area of network.

4.3.1Spatial Geometry Analysis

We use the center of schools to be the point and calculate the perpendicular bisector in the area you can use the shortest distance to the Emergence shelter. Like figure5.

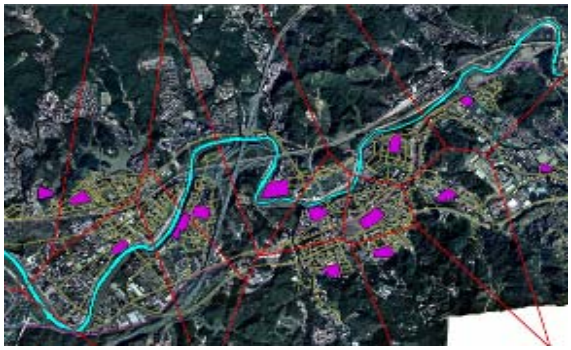

Figure 5 Calculate by Spatial Geometry Analysis

We also use buffer to calculate the same distance area to be the refuge rings. In figure 6, we use the distance of 500m to display the area of near ones. some area cover the same place and some place are not covered.

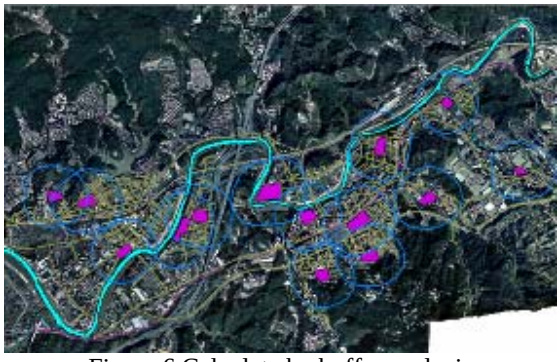

Figure 6 Calculate by buffer analysis

4.3.2Network Analysis

In this study, we use distance and deliver time to be the cast of the weighting. By distance we calculate the network with 500m, like figure 7.

Figure 7 Calculate by network Analysis (distance)

About the deliver time, we use 10 minutes to display the service area, like figure 8. some area have different level emergence routes, so in this service area the distance of road will be change by difference level routes.

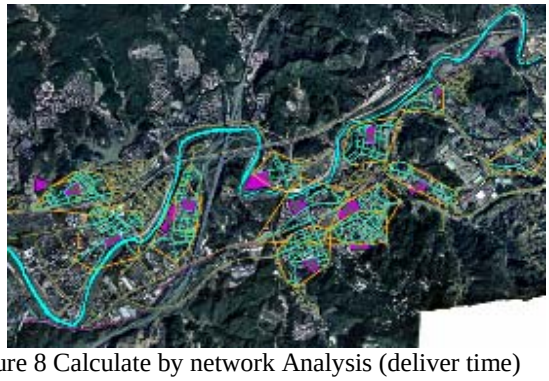

Figure 8 Calculate by network Analysis (deliver time)

4.3.3Zoning of Hazard prevention

When look into the large scale, we can find the refuge rings with different shapes. In figure9-12 , we can find the relationship between the Emergence shelter and Zoning of Hazard prevention.

Figure 9 Calculate by spatial geom.etory analysis

Figure 10 Calculate by buffer analysis (300, 500m)

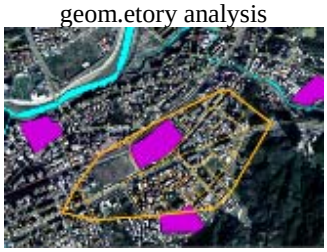

Figure 11 Calculate by network analysis (10min)

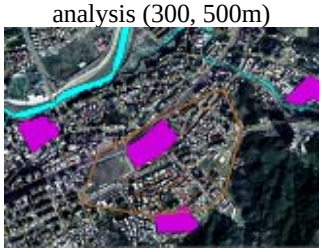

Figure 12 Calculate by network analysis (500m)

In figure 13, we can compare with this area of Zoning of Hazard prevention, we can find the different area and facility.

Figure 13 compare the plan of Zoning of Hazard prevention

With the data of geometry and facility, we can compare the value of plan property like table 2.

Table 2 the data of spatial information

Type	AREA	Perimeter	Road	Building	Zoning
Geometry	496759	2835	7811.9	141089	576189
Buffer-300	556097	2681	8370.1	176605	730407
NA-D500	455940	2828	9086.2	135375	604954
NA-T10	379754	2467	8234.9	119762	531208

We can use the data to calculate the efficiency of the plans, in table3, we use some formula to estimate the emergence system. We use the building coverage ratio and zoning area to calculate the service efficiency. By using the floor space index floor area ratio and Emergence shelter area to presume the population. The road and area and rate can talk about the efficiency and the area type also can be assess to the potency.

Table 3 the estimate of emergence system

We establish the master place to calculate the variation

TYPA	P*P/A	R/A	B/A	Z/A
geometry	16.17	0.0157	0.28	1.15
Buffer-300	12.92	0.0150	0.31	1.31
Buffer-600	12.78	0.0123	0.24	1.15
NA-D500	17.54	0.0199	0.29	1.32
NA-T10	16.02	0.0216	0.31	1.39

of the Emergence shelter like figure 14-17.

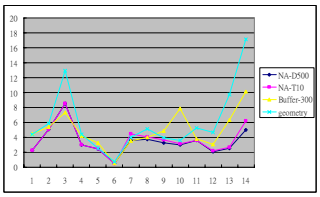

figure 14 the variation of plan efficiency

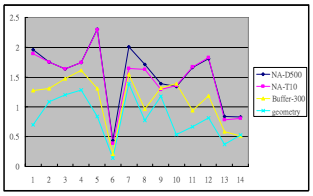

figure 15 the variation of population

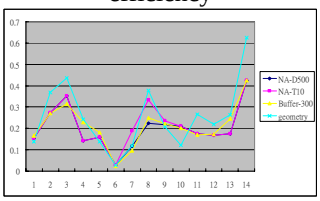

figure 16 the variation of acceptability

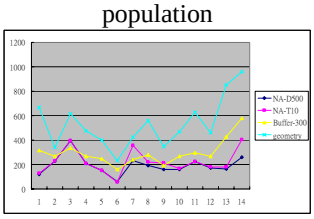

figure 17 the variation of spatial service

5. CONCLUSION

In this study, we use some methods to establish the zoning of Hazard prevention. And compare the spatial information and some data of facility. By using this number we can understand the plan of the place.

In this paper just treat the shape of the zoning Hazard prevention, some area should regulate in some spatial objects to conform the more real situation.

REFERENCES

[1] Li, Wei-Yi, ‘‘The layout of Taipei City planning disaster prevention system’’, R.O.C. city planning academic association, 1997.

[2] Tseng, Ming-Shung, Chen,Shih-Liang, “A study on the evaluation methods of the emergency routes in the urban area (Ⅱ) ”,Architecture & Building Research Institute Ministry of interior, *Research Project report*, 2000.

[3] Breaden, J.P., ‘’The Generation of Flood Damage Time Sequences’’, *University of Kentucky Water Resources Institute Paper*, : 1973,NO.32.

[4] Tanaboriboon, Y. and Guyano, J, ‘‘Level of Services Standards for Pedestrian Facilities in Bangkok: A Case Study’’, *ITE Journal*, 1989, pp. 39-41.

[5] Djokie, D. and Maidment, D.R., ‘‘Application of GIS Network Rountines for Water Flow and Transport’’, *Journal of Water Resources Planning and Management*, ASCE, 1996, 119(2): 229-241

[6] Li, Wei-Yi,, “Study on the functions of urban disaster-prevention of physical- environment in a city though comparing with the urban disaster prevention system (Ⅱ) ”,Architecture & Building Research Institute Ministry of interior, *Research Project report*,1999.