

RESEARCH ON THE COORDINATION BETWEEN URBAN DISASTER CARRYING CAPABILITY AND ECONOMIC DEVELOPMENT

Zhang Mingyuan¹, Yuan Yongbo², Zhou Jing²

¹*Lecturer, School of Civil and Hydraulic Engineering, Dalian University of Technology, Dalian. China*

²*Professor, School of Civil and Hydraulic Engineering, Dalian University of Technology, Dalian. China*

Email: zh_mingyuan@163.com

ABSTRACT:

Generally, the urban disaster carrying capability in economic developed cities were considered better than the developing cities for wealth and the better capability could help for decreasing relative loss even though absolute loss under disasters maybe higher in economic developed cities. That was to say that the urban disaster carrying capability interacted with the urban economic development. The grey relation entropy approach was used to analyze the coordination among all capabilities such as disaster defending, resistance, rescue and recovery which were assessed by a series of indexes, as well as the relational intension between the integrated disaster carrying capability and economic development level. High relational intension couldn't account for good coordination, so that based on the grey system theory, the coordination between urban integrated disaster carrying capability and urban economic development was analyzed. It was found that the coordination was not very well supposed due to the time delay of the capability to economic development. After time series parallel stepped, the consequence of delay was proved and the coordination was improved too. In the authors' view that the urban integrated disaster carrying capability interacted with the urban economy, and mean time, expediting the integrated capability to be perfect could decrease the urban relative loss under disasters.

KEYWORDS: urban disaster carrying capability; grey relation entropy; grey system; coordination; time delay

1. INTRODUCTION

The word "disaster-carrying capability" turns out in the research field of disaster as a result as following the application of "carrying capability" expanding more and more. During the research process of carrying capability, there have been three kinds of English words to explain "carrying", which were bearing, loading and carrying. 'Bear' focuses on the carrying capability in abstract ideology; 'Load' focuses on the meaning in physics, and 'Carry' not only means suffering or taking with, but also means support or holding with. As a literal translation, disaster-carrying capability means the ability to suffer from disasters, but as the expanding of acceptance of 'Carry', disaster-carrying capability contains other abilities besides suffering.

Urban place collects almost all kinds of modern elements so that it becomes the weakest disaster-carrying body when the hazards work out. This paper presents the viewpoint that the disaster-carrying capability of urban places is composed of four kinds of capability: disaster-defending, disaster-resisting, disaster-rescuing and disaster-recovering considering the time that urban place itself performance under disasters. In addition, these four kinds of capability are composed of factors of society, economic and environment during to the functional characteristics of urban place.

Considering the three functional aspects and four kinds of disaster-carrying capability mentioned above, the matrix of urban system disaster-carrying capability is set up as follows:

$$\begin{array}{c}
 \text{Functional aspects} \\
 \text{Society factor} \\
 \text{Economic factor} \\
 \text{Environment factor}
 \end{array}
 \begin{array}{c}
 \text{Capability} \\
 \text{Defending} \quad \text{Resisting} \quad \text{Rescuing} \quad \text{Recovering} \\
 \left[\begin{array}{cccc}
 & & & \\
 & & \dots & \dots \\
 & & & \\
 & & &
 \end{array} \right]
 \end{array}
 \quad (1.1)$$

This is a “double weights” matrix which means judging by functional aspects or kinds of capability separately, the influences to disaster-carrying capability of urban place are different.

The AHP method is taken to weight the four kinds of capability to disaster-carrying capability of urban place to get the result: (0.16 , 0.25 , 0.38 , 0.21). Based on the references, the estimated indexes system of urban disaster-carrying capability is set up as follow:

Table1.1 Estimated indexes of urban disaster-carrying capability

Sub-aim layer	Function layer	Index layer	Sub-aim layer	Function layer	Index layer
Disaster-defending capability	Social factors	Employment	Disaster-rescuing capability	Social factors	Medical rescue
		Education			Government emergency reaction
		Medical treatment		Economic factors	Recover of lifelines
		Social guarantee			Inner-outer Connection development

	Economic factors	Investment of disaster-defend			Drainage system
		Supervising and forecasting infrastructure			Derive disasters
	Environmental factors	Environment protection		Environmental factors	Temporary centre of disaster-rescue
Disaster-resisting capability	Social factors	Population density	Disaster-recovering Capability	Social factors	Human resource for production
		Population situation			Economic variety
	Economic factors	Fixed infrastructure density		Economic factors	Fortune save
	Engineering disaster-resisting capability	Disaster-resisting capability of buildings			Insurance
		Disaster-resisting capability of lifeline systems			
		Association of lifeline systems			Environmental factors

2 COORDINATING ANALYSIS BETWEEN DISASTER-CARRYING CAPABILITY AND ECONOMIC DEVELOPMENT OF URBAN PLACE

The final aim of disaster management is to improve the integrating disaster-carrying capability of urban place. In common, the capability of developed city is considered stronger than developing city. That because the relative loss in developed city is smaller due to the stronger capability although the absolute loss is more. It also could to be said that the increasing extent of disaster loss is getting slower as the disaster-carrying capability getting stronger. In a word, the integrating disaster-carrying capability should coordinate with economic development.

The four kinds capability consisting the integrating disaster-carrying capability are coupling. Coupling means affiliations which present the consequence of connecting characters among system items.

3 EXAMPLE

According to the indexes system of urban disaster-carrying capability, each kind of disaster-carrying capability and the integrated capability of DL city could be gotten as following table. The coordination between economic development and integrated disaster-carrying capability also could be gotten across the decade developing process. The details taking application of grey system models are as follow:

Table3.1 Calculated data serial of each kind of disaster-carrying capability and original GDP in DL city

Year	(1)defend	(2)resist	(3)rescue	(4)recover	(5)integrate	GDP
1996	0.12	0.67	0.32	0.09	0.327	733.1
1997	0.17	0.66	0.35	0.21	0.369	829.7
1998	0.17	0.55	0.44	0.09	0.351	926.3
1999	0.49	0.55	0.48	0.24	0.449	1003
2000	0.34	0.53	0.53	0.54	0.502	1110.8
2001	0.51	0.52	0.54	0.60	0.543	1235.6
2002	0.57	0.30	0.60	0.46	0.491	1406
2003	0.67	0.32	0.76	0.75	0.634	1632.6
2004	0.65	0.32	0.76	0.87	0.556	1961.8
2005	0.76	0.34	0.67	0.89	0.648	2150

◆ Standardization of original data

$$X_i^{(0)} = X_i / \bar{X}, X_i \text{ is the original serial, } \bar{X} \text{ is the average of } X_i:$$

Table3.2 Standardization of original data

Time serial	1996	1997	1998	1999	2000
Capa(1)-stander	0.6715	0.7577	0.7207	0.9220	1.0308
GDP-stander	0.5644	0.6388	0.7131	0.7722	0.8552
Time serial	2001	2002	2003	2004	2005
Capa(1)-stander	1.1150	1.0082	1.3018	1.1417	1.3306
GDP-stander	0.9513	1.0825	1.2569	1.5104	1.6553

- ◆ Once AGO serial

Table3.3 *I – AGO*

Time serial	1996	1997	1998	1999	2000
<i>Capa – I – AGO</i>	0.6715	1.4292	2.1499	3.0719	4.1027
<i>GDP – I – AGO</i>	0.5644	1.2032	1.9163	2.6885	3.5437
Time serial	2001	2002	2003	2004	2005
<i>Capa – I – AGO</i>	5.2177	6.2259	7.5277	8.6694	10.0000
<i>GDP – I – AGO</i>	4.4950	5.5775	6.8344	8.3448	10.0000

- ◆ Set up differential equation

$$\frac{dX_1^{(1)}}{dt} + aX_1^{(1)} = bX_2^{(1)} \quad (3.1)$$

in which $X_i^{(0)} = X_i / \bar{X}$, X_i is the original serial, \bar{X} is the average of X_i , $i = 1, 2$;

$X_1^{(1)} = \{X_1^{(1)}(1), X_1^{(1)}(2), \dots, X_1^{(1)}(10)\} = \{\sum_{k=1}^1 X_1^{(0)}(k), \sum_{k=1}^2 X_1^{(0)}(k), \dots, \sum_{k=1}^{10} X_1^{(0)}(k)\}$ is the once AGO result of integrated disaster-carrying capability abbreviated by Capa;

$X_2^{(1)} = \{X_2^{(1)}(1), X_2^{(1)}(2), \dots, X_2^{(1)}(10)\} = \{\sum_{k=1}^1 X_2^{(0)}(k), \sum_{k=1}^2 X_2^{(0)}(k), \dots, \sum_{k=1}^{10} X_2^{(0)}(k)\}$ is the once AGO result of GDP;

- ◆ Estimation of parameter

$$\hat{a} = (B^T B)^{-1} B^T X \quad (3.2)$$

$$B = \begin{bmatrix} -\frac{1}{2}(X_1^{(1)}(1) + X_1^{(1)}(2)) & X_2^{(1)}(2) \\ -\frac{1}{2}(X_1^{(1)}(2) + X_1^{(1)}(3)) & X_2^{(1)}(3) \\ \dots\dots\dots & \dots\dots\dots \\ -\frac{1}{2}(X_1^{(1)}(9) + X_1^{(1)}(10)) & X_2^{(1)}(10) \end{bmatrix} = \begin{bmatrix} -1.0503 & 1.2032 \\ -1.7895 & 1.9163 \\ -2.6109 & 2.6885 \\ -3.5873 & 3.5437 \\ -4.6602 & 4.4950 \\ -5.7218 & 5.5775 \\ -6.8768 & 6.8344 \\ -8.0986 & 8.3448 \\ -9.3347 & 10.0000 \end{bmatrix} \quad (3.3)$$

$$X = (X_1^{(0)}(2), X_1^{(0)}(3), \dots, X_1^{(0)}(10)) \quad (3.4)$$

$$= (0.7577, 0.7207, 0.9220, 1.0308, 1.1150, 1.0082, 1.3018, 1.1417, 1.3306)$$

$$a = -0.6275, b = -0.4381 \quad (3.5)$$

According to the theory of Grey system, $-a$ is defined as the system development coefficient, b is defined as driven coefficient, they are for analyzing the unitary function, coordination and connecting and dynamic relationship among the factors of a system. As long as the value of $-a$ is greater, the developing ability inside system is stronger. According to the calculating result, the self-developing ability of integrated disaster-carrying capability of DL city is strong but alogically, GDP which is related with the capability restrains its development ($b = -0.4381, b < 0$). What has been proved, we suppose that there is hysteresis between the formation of the capability and the economic development, and then the analysis was under work after shifting the time serial of the capability forward by two years to complete the coordination with GDP.

Moreover, the coordination between each kind of capability which are disaster-defend, resist, rescue and recover and GDP are analyzed separately to get the results as follow:

- (1) disaster-defending capability : $a=-0.4574$; $b= 0.3936$
- (2) disaster-resisting capability : $a=-0.2258$; $b=0.2666$
- (3) disaster-rescuing capability : $a=-0.3726$; $b=0.3532$
- (4) disaster-recovering capability : $a=-0.5162$; $b=0.4272$

According to the results, each kind of capability is with strong self-developing ability and driven by the GDP. It also could be gotten that the association among the four kind capabilities are strong through the analysis of grey association. Then we conclude that the four kind capabilities contain each other that decelerate the integrated capability when they compose it.

According to the result of trending analysis which is taken application of Daniel trending examination and Grey forecasting model GM(1,1), the growing rate of the integrated capability is 6.97% when the rate of GDP is 13.53%. That means the integrated capability should be improved as more as we can also the investment.

4 CONCLUSIONS

The development of disaster-carrying capability in urban place depends on the economy which is not saying that the more developed the economy is, the better the capability must be. The key is whether it is coordinate between the capability and economic development as well as the developing trend.

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