The Frontiers of Society, Science and Technology
ISSN 2616-7433 Vol. 2, Issue 7: 69-73, DOI: 10.25236/FSST.2020.020720

The Changes of China Earthquake Disaster Emergency Network Based on SNA

Qiaojie Zhang

Sichuang University, Chengdu 610065, China

ABSTRACT. *In the modern risk society where emergencies are frequent, improving emergency response ability is the key to achieving efficient emergency management. Using a sample of the major earthquake disasters based on Social Network Analysis, we find that the average distance weighted range and clustering coefficient of the network have significant influence on the improvement of emergency response ability. Finally, based on the above analysis and research results, we put forward some suggestions for improving the ability.*

KEYWORDS: *Sna, Emergency network, The ability of emergency response, Ucinet*

1. Introduction

With the increase of complex uncertainties in modern risk society [1], major emergencies and public crises occur frequently, so efficient emergency management appears to be indispensable. From a practical perspective, as a public service, the government should play a leading role [2], and China has gradually formed a unique “fist model” to deal with crises at the national level based on its historical experience in responding to unconventional emergencies. In theory, the “networked” model with multiple nodes is considered to be the emergency management organizational structure that best adapts to changes in the external environment due to its more sensitive characteristics to the external environment [3].Research in the field of Social Network Analysis (SNA) which Studies overall network characteristics or individual node location characteristics has rapidly developed in the last two decades. Based on this, the research uses the SNA method to explore changes in the national earthquake emergency network with Chinese characteristics, which has positive significance in practice and theory.

2. Overview of the Network about Emergency Network

SNA has recently emerged as an important topic in emergency management. Its empirical application in this field provides a way of thinking and analysis tools for exploring solutions to complex emergency management problems. From the perspective of research content, SNA methods are widely used abroad in the field of emergency management. For example, scholars such as Moynihan [4] focused on responding to uncertainties in crisis response networks and studying the mutual learning of the agents in the network; Hossain et al. [5] explored the relationship between the characteristics of social networks and the degree of network collaboration using network structure data; Abbasi et al. [6] collected emergency response network data based on simulation experiments to explore the role of social media in rescue. From the perspective of research methods, scholars mostly based on a specific case of public crisis or departments with acute nature, carried out the exploration of horizontal static network structure characteristics and inter-agent relationship coordination mode, but less attention has been paid to the research on the diachronic dynamic evolution of the network.

Therefore, we adopt SNA method to measure the characteristics of government emergency network, and conducts empirical research on the relationship between emergency network and emergency response ability, so as to explore the changes of China's earthquake emergency response network and put forward corresponding Suggestions.

3. Methods

We use SNA with various software to analyze and visualize the data which was collected from the government's official website. First, select a representative emergency network for earthquake disasters to construct an adjacency matrix, process the original data through *Ucinet* to get the relationship data of the emergency network characteristics, and use software *Gephi* to draw the emergency network diagram based on this and make a summary analysis.

3.1 Ability

Unfortunately, little knowledge exists regarding the ability of emergency management. Researchers have only recently started to explore the measurement, and, in doing so, they have focused primarily on the AHP and Delphi methods for index system construction, but this method of logical judgment based on subjective experience is difficult to achieve accurate evaluation. Therefore, we intend to construct a more objective indicator to measure the emergency response ability, and consider the detailed indicators of "*Effect*", "*Speed*" and "*Information Disclosure*" as the measurement tools.

Table 1 Index System for Measuring Emergency Response Ability

Level 1	Level 2	Level 3
Ability A	*Effect B1*	*Direct economic loss as a proportion of the totalC1(s)*
		The proportion of deaths in the total C2(s)
	Speed B2	*Proportion of time difference between emergency response and rescue C2(s)*
	Information Disclosure B3	*Proportion of emergency information disclosure in that yearC4(s)*

At the same time, in order to make the comparison between each sub-indicator meaningful, this study normalizes the actual data collected in each index, and then assigns the results (Level 1 to Level 4) to assign values, such as In the "Economic Loss Rate" index of the detailed index, according to the actual measured proportion results, the data distribution is clearly divided by 0.1, 0.2 and 0.4. In this indicator, the larger the proportion, the worse the "effect", so the proportion of <0.1 is divided into the first level and assigned "0.4"; the proportion of 0.1> and <0.2 is divided into the second level and assigned the value of "0.6" , and so on (Table 2 for details), so that the actual data can be converted into a more meaningful index measurement value, and achieve the purpose of reflecting the gap between the index measurement of each event.

Table 2 Index Assignment Table

	Level 1	Level 2	Level 3	Level 4
C1	<0.1	0.1<X<0.2	0.2<X<0.4	X>0.4
C2	<0.1	0.1<X<0.3	0.3<X<0.6	X>0.6
C3	<0.2	0.2<X<0.4	0.4<X<0.5	X>0.5
C4	X>0.3	0.2<X<0.3	0.1<X<0.2	X<0.1
	0.4	0.6	0.8	1

Based on the existing research results, we calculate the proportion of each factor and normalizes it, objectively calculates the weight through the standard deviation method, and constructs a linear formula (Formula 1) to measure the *Ability*. Finally, in order to enlarge the difference between the cases, multiply the value by 100 to enlarge the gap for easy observation, as shown in Formula 1.

$$Ability(t)=\frac{\sum_{n=1}^{4} Cn(s)t*Sn}{\sum_{n=1}^{4} Sn}*100=\sum_{n=1}^{4} Cn(s)t*Wn*100 \quad (1)$$

where, The value range of *Ability(t)* is [0,100], it represents the emergency response ability at time *t*, and *Cn(s)t* means the *n*th (*n*=1,2,3,4) indicator during t period Index measurement value, *Wn* represents the weight of the nth variable. However, it should be noted that the lower the proportion of each refined index, the better the emergency response ability. Therefore, the measured value of *Ability* and the actual ability level show a negative correlation, thus, with larger values indicating higher *Ability* and lower true ability of case.

3.2 The Structure of Emergency Network

3.2.1 Reach

Reach provides a meaningful measure of the overall size and connectivity of a network, even when that network has multiple components, and/or component structure is changing over time [7]. Therefore, we select the average distance weighted range index to measure the range characteristics of the network.

ISSN 2616-7433 Vol. 2, Issue 7: 69-73, DOI: 10.25236/FSST.2020.020720

$$Reach=\left[\sum_i \sum_j \frac{1}{dij}\right]/n \quad (2)$$

where *n* is the number of nodes in the network, and $dij(i \neq j)$ is defined as the minimum distance (geodesic), *d*, from a focal node *i* to partner *j*. Average distance-weighted reach can range from 0–n, with larger values indicating higher *Reach*.

3.2.2 Clustering

The clustering coefficient is an indicator of the local network structure, which can measure the clustering or grouping of the main body of the network [8]. Based on the comparability of network characteristics between the enterprise cluster network and the emergency network, this paper selects the clustering coefficient based on the transitivity ratio to measure the aggregation situation in the emergency network.

$$Clustering=\frac{The\ number\ of\ closed\ triples}{The\ total\ number\ of\ triples} \quad (3)$$

where a triangle is a set of three nodes (e.g., *i*, *j*, *k*), each of which is connected to both of the others, and a closed triple is a set of three nodes in which each node is required to be connected to the other two nodes, that is, two nodes are connected to each other in a closed "triangle" shape. Clustering represents the proportion of triplets that can guarantee transitivity in the network, and its value range is [0,1], with larger values indicating higher *Clustering*.

3.2.3 Power

In social networks, "*Power*" can be quantitatively measured from the perspective of the "relationship" between various subjects, based on the two levels of influence and dominance, which can be expressed by various centrality and centrality indexes. The selection of measurement indicators should depend on the background of the research problem. If the focus is on the control of the interaction between network subjects, you can choose betweenness to measure [9].

$$Power=\sum_{i=1}^{n}[C_{RB}(i)_{max} - C_{RB}(i)] \quad (4)$$

Where $C_{RB}(i)$ is the relative value of the intermediate centrality of node *i*, the calculation formula is $C_{RB}(i)= 2C_B(i)/(n-1)(n-2)$; and $C_B(i)$ is the intermediate of node *i* The absolute value of centrality, the calculation formula is $C_B(i)=\sum_{j<k} djk(i)$; $djk(i)$ is the shortest number of paths connecting nodes *j* and k and passing through node *i*, of which the shortest The path length is defined as the number of edges that the shortest link between two nodes in the network needs to pass. The value range of Power is [0,1], with large value indicating that some subjects in the emergency network have increased power control over the network.

4. Results

Based on the logic of seeking differences, earthquake disasters are compared (Table 3). In the measure of emergency response Ability, the variable *Ability* tends to improve from the longitudinal comparison of the duration.

Table 3 Variable Measurement Results

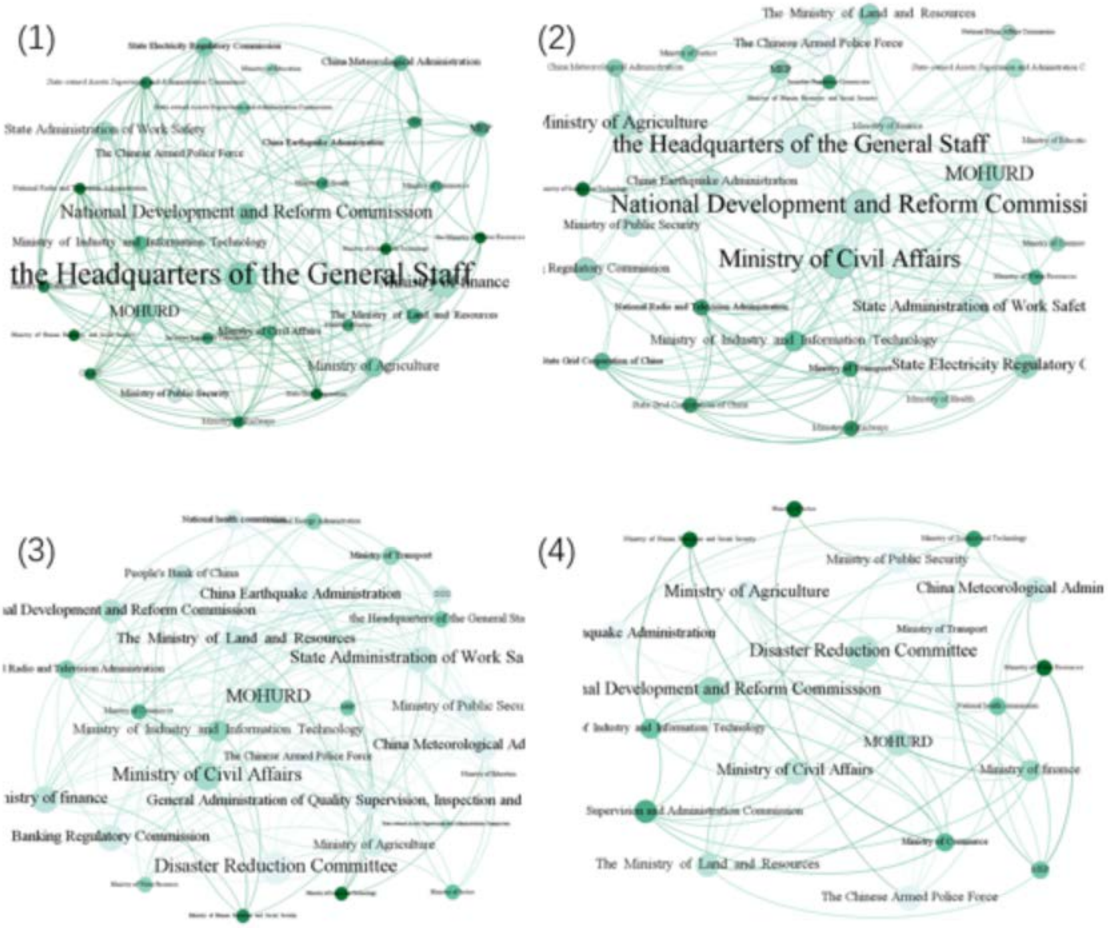
Earthquake	*Ability*	*Reach*	*Clustering*	*Power*
Wenchuan	82.35	19.4697	0.64006600856781	0.1464
Yushu	79	20.8438	0.559	0.1478
Yaan	70.98	16.3871	0.528	0.1361
Jiuzhaigou	66.12	12.9167	0.526	0.11

In order to make the data more intuitive, this article uses *Gephi* to visually draw the emergency subject adjacency matrix. The size of the nodes is based on *Reach* ranking, the color depth setting of the nodes is based on *Clustering* ranking, and the size of the label is based on *Power* raking.

Accordingly (Figure 1), there are significant differences between the emergency network diagrams of the four samples. First, the node size distribution of Wenchuan earthquake emergency response network is not different from that of Yushu earthquake, but the node size of Yaan earthquake and Jiuzhaigou earthquake are generally smaller than the former two. This shows that there is no significant difference between the average

ISSN 2616-7433 Vol. 2, Issue 7: 69-73, DOI: 10.25236/FSST.2020.020720

distance weighted range of the emergency bodies of Wenchuan earthquake and yushu earthquake, but the characteristics of the first two are significantly larger than yaan earthquake and Jiuzhaigou earthquake, that is, the first two average departments involved in more extensive emergency work. As for the node color distribution, the distribution of Wenchuan earthquake and Jiuzhaigou earthquake are not different, but compared with yushu and Yaan earthquake, the node color contrast degree is more significant. This indicates that wenchuan earthquake and Jiuzhaigou earthquake are larger than Yushu earthquake and Yaan earthquake in terms of clustering coefficient, it means that there is a more detailed division of labor group (*Clustering*) between the subjects in the network. About label size, the labels of individual departments in the Wenchuan earthquake emergency response network are significantly larger, which indicates that the network is controlled by the power of these departments and has a high degree of monopoly on resources and information.



Note: (1) Wenchuan earthquake (2) Yushu earthquake (3) Yaan earthquake (4) Jiuzhaigou earthquake

Fig.1 Earthquake Disasters Emergency Network

As a particularly large-scale earthquake, the emergency networks of the Wenchuan earthquake and the Yushu earthquake are generally similar, and even the *Clustering* of the former working group is better than the latter, but the overall emergency network has the power of the "*General Staff Department*" and other departments. The high degree of control (*Power*) indicates that various information and resources are subject to a high degree of "monopoly", which ultimately results in their actual emergency response level being lower than the latter. When the average distance weighted range (*Reach*) of the subjects in the emergency network is too large, it is often prone to cross-departmental responsibilities, unclear powers and responsibilities, and timely feedback of information, which affects the efficient and rapid response of emergency decisions, and finally affects the overall network ability. The Yushu Earthquake Emergency Management System has learned from the experience of the Wenchuan Earthquake, and its coordination ability of inter-ministerial linkages at the national level has been improved compared to the past, which is reflected in the reduction of the *Reach* in the emergency network.

During the Yaan earthquake, although the central government set up an earthquake relief headquarters, the

ISSN 2616-7433 Vol. 2, Issue 7: 69-73, DOI: 10.25236/FSST.2020.020720

actual emergency rescue activities did not have absolute dominance in power control. At the same time, the central government moderately “backed” and decentralized more power to the local [2], This makes the coordination between the various departments of the central government more balanced and the efficiency of emergency decision-making higher. Correspondingly, in the emergency network, compared with the previous earthquake emergency network, the biggest improvement of Yaan Earthquake is not only reflected in the reduction of *Reach* between the main bodies, but also the *Power* has been greatly reduced. In the emergency rescue of the Jiuzhaigou earthquake, coordination and balance among the central departments and clear powers and responsibilities, while there is no absolute power center, the degree of clustering has increased, indicating that the concentration of labor division and cooperation has increased.

5. Discussion

From the perspective of longitudinal comparison, China emergency response capacity of earthquake disaster generally shows a trend of volatility improvement, which shows that it has gradually improved in practice and reflection. At the same time, the characteristics of emergency networks are greatly similar. There is a situation of “stable” in the structure.

Furthermore, *Clustering* and *Reach* were both significantly related to *Ability*. Therefore, to improve emergency response ability, not only do we need to set up a corresponding working group to promote the formation of clustering in the network, but we should also pay attention to the intersection of functions between the working groups, that is, the division of responsibilities of each department should be clear to reduce The average distance weighted range of the network (*Reach*) to achieve the purpose of high efficiency.

While the network characteristics of the above is largely influence the main factors of emergency response ability, but based on the “authoritarian” political tradition of China, there may be the main body of high degree of power control in the network, thus to information, capital and other resources in the “monopoly” impact on circulation. It will undoubtedly reduce the coordination of network cooperation, resulting in emergency network for emergency response sensitivity and lower adaptive capacity. Therefore, in order to avoid the emergence of more absolute power centers in the emergency network, the *Power* size in the network should be controlled, which is one of the key factors to achieve good network-style cooperation.

There were several limitations to the study. First, we used only major earthquake disasters as research samples, and the insufficient number of samples may lead to some deviations in the conclusion. Another limitation is that the research object of this paper is the response network of earthquake disasters, so the applicability of the conclusions to other types of emergencies needs to be further verified, which will be a worthwhile and intriguing direction for future research.

References

[1] B. Robert, C. Lajtha (2002). A New Approach to Crisis Management. Journal of Contingencies and Crisis Management, vol.10, no.4, pp.181-191.

[2] Zhang Haibo, Tong Xing (2015). Change of China's emergency management structure and its theoretical generalization. Chinese Social Sciences, no.3, pp.58-84+206.

[3] N. Kapucu, M.-E. Augustin, V. Garayev (2009). Interstate Partnerships in Emergency Management: Emergency Management Assistance Compact in Response to Catastrophic Disasters. Public Administration Review, vol.69, no.2, pp.297-313.

[4] A. Abbasi, N. Kapucu (2012). Structural Dynamics of Organizations during the Evolution of Interorganizational Networks in Disaster Response. Journal of Homeland Security and Emergency Management, vol.9, no.1, pp.12-13.

[5] L. Hossain, D.C (2012). Kit Guan. Modelling coordination in hospital emergency departments through social network analysis. Disasters, vol.36, no.2, pp.338-364.

[6] S.K. Mohammad-Ali Abbasi, Jose Augusto Andrade Filho, Huan Liu (2012). Lessons Learned in Using Social Media for Disaster Relief--ASU Crisis Response Game. Berlin:Heidelberg: Springer Berlin Heidelberg.

[7] M.A. Schilling, C.C. Phelps (2007). Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation. Management Science, vol.53, no.7, pp.1113-1126.

[8] D.J. Watts (1999). Networks, Dynamics, and the Small‐World Phenomenon. Amer. J. Sociol, vol.105, no.2, pp. 493-527.

[9] L.C. Freeman (1979). Centrality in Social Networks Conceotual Clarification. Social. Netwks, vol.1, no.3, pp.215-239.