Resistance Level of American Communities Based on Extreme Disasters

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Abstract: In recent years, extreme disasters, whether natural disasters or man-made accidents, have occurred more and more frequently in the world, which pose a great threat to the political stability, economic development and social harmony of all countries. As the world's political and economic powers, it is necessary for China and the United States to compare and analyze the resilience of their social organizations to extreme disasters. As an aggregate of individuals, community is also the basis for the survival and development of social organizations at all levels. Therefore, this paper chooses the core elements of community resilience in the United States as the entry point, and analyses the operation process of community resilience, crisis emergency measures and community resilience level in the event of extreme disasters from the qualitative and quantitative perspectives, respectively. It plays a certain theoretical value and practical role to enhance the resilience of our community and improve the operational mechanism of resilience.

1.Definition and Operational Process of Community Resilience under Extreme Disasters

Community resilience is the expansion and extension of individual resilience. Although they are different in subject, they both pay attention to the response ability and recovery process of the system after suffering irresistible sudden disasters.

The operation of community resilience requires the joint action of internal and external core factors of the community. When referring to the operational process of resilience, we must talk about the vulnerability, adaptability and recovery of communities. As shown in the following figure:

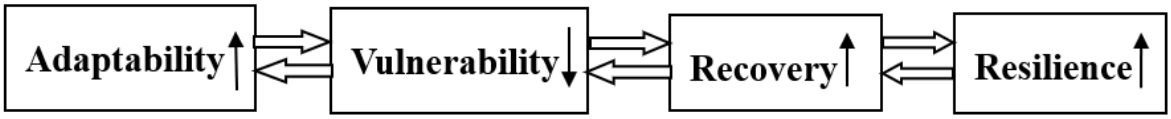

Fig 1 Resistance and Attribute Diagram

In the process of community resilience operation after extreme disasters, according to the 4R model proposed by Kendra, the system needs four attributes to generate resilience: robustness, redundancy, resourcefulness and rapidity. Robustness means that when a system is struck by a disaster, it can still maintain its operation; redundancy means that the remaining system resources can fill the gap and maintain the integrity; abundance means that the system can move diversity resources and rapidity is a priority strategy for minimizing current or potential losses in a limited time. The whole process is as follows:

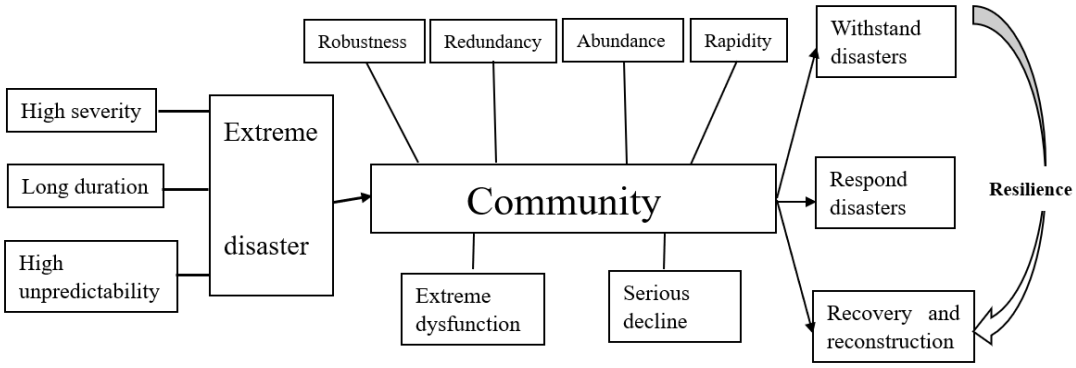

Fig 2 Operating process of stress resistance under extreme disasters

2. Analysis of Resistance Level of Communities in the United States under Extreme Disasters

(1)Qualitative analysis

After suffering from many major disasters and extreme disasters, the United States began to break through the traditional "top-down" rescue mode, instead tapping the role of individuals and communities, and actively build a self-preservation and self-rescue community system. (Figure 3).

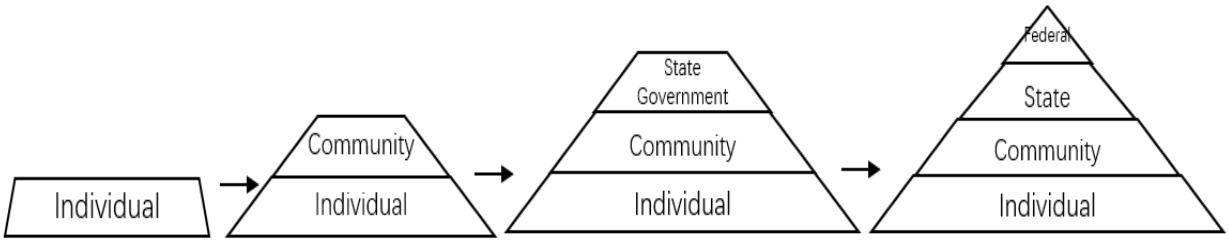

Fig 3 US emergency management pyramid

In order to be more representative and convincing, this section chooses Hurricane Katrina, an extreme natural disaster in the United States, as one of the most influential and destructive extreme disasters in American history to do some research. Hurricane Katrina came into being near the Bahamas in mid-August 2005. It crossed southern Florida and entered the Gulf of Mexico. It grew rapidly into a Category 5 hurricane. The highest sustained wind speed near the center was 150 nautical miles per hour.

(2) Quantitative analysis

According to the core factors and combined with the framework of resilience analysis proposed by Briguglioetal (2009) and the Communities Advancing Resilience Toolkit (CART, 2010), this part of the study includes four core elements: population, physics, economy and system (Table 2). For data acquisition and calculation, we select as many quantifiable and influential indicators as possible to analyze the three-level indicators.

Table 2 New Orleans Community Resistance Assessment System

First-level indicators	Second-level indicators	Third-level indicators	Sources
Population factors(41.24)	Age structure (20.46)	Proportion of aged population(11.59)	Louisiana State Census Data Center http://louisiana.gov
		Proportion of adolescent population(8.87)	
	Special population(0.02)	Proportion of disabled population(0.02)	Disability Status Report: Louisiana http://www.disabilitystatistics.org
	Education level(15.05)	Proportion of population with higher education(15.05)	Louisiana State Census Data Center http://louisiana.gov
	Medical security(5.71)	Medical coverage(5.71)	The State of Louisiana Health Insurance Charts http://www.towncharts.com/Louisiana/Louisiana-state-Healthcare-data.html
Physical factors(15.07)	Housing structure(15.07)	Structural proportion of reinforced concrete buildings(15.06)	Louisiana State Census Data Center http://louisiana.gov
		Proportion of brick-and-earth structure houses(0.01)	
Economic factors(33.58)	Housing capital(10.90)	Percentage of self-owned houses(10.90)	The State of Louisiana Area Home Supply Charts http://www.towncharts.com/Louisiana/Louisiana-state-Housing-data.html
	Employment status(13.36)	Proportion of non-unemployed persons(13.36)	Louisiana State Census Data Center http://louisiana.gov
	Income status(9.32)	Proportion of the population with income above the minimum wage(9.32)	
Institutional factors(9.86)	Municipal Service Level(9.86)	Proportion of government investment in disaster prevention and response (public safety)(9.86)	State of Louisiana Division of Administration https://www.doa.la.gov/pages/opb/state-budget.aspx

Note: The weight (%) of the corresponding indicators in parentheses

.The main calculation process is as follows: (1) Matrix X is established according to the original data and data is standardized to make the mean value of X zero; (2) Covariance matrix C of X is calculated and eigenvectors are arranged from large to small according to eigenvalues. The first k matrices consist of rows P; (3) By calculating Y = PX, the reduced dimension data Y is obtained and the contribution rate Vi calculated with the following formula: Vi=xi/(x1+x2+.....); (4) The final coefficients are normalized and the weight of each index is determined (Table 3):

Table 3 Weights of community resilience indicators standardized in New Orleans

		Coefficient in Comprehensive Scoring Model	Coefficient Translation	Weight of Indicators(Normalization)
Population factors	Proportion of aged population(X1)	0.17436546	0.41436546	0.11591187
	Proportion of adolescent population(X2)	0.07710758	0.31710758	0.088705587
	Proportion of disabled population(X3)	-0.23343586	0.00656414	0.00183621
	Proportion of population with higher education(X4)	0.29795607	0.53795607	0.15048429
	Medical coverage (X5)	-0.035791681	0.204208319	0.057123891
Physical factors	Structural proportion of reinforced concrete buildings(X6)	0.298477461	0.538477461	0.150630141
	Proportion of brick-and-earth structure houses(X7)	-0.236378547	0.003621453	0.001013042
Economic factors	Percentage of self-owned houses(X8)	0.149727393	0.389727393	0.109019776
	Proportion of non-unemployed persons(X9)	0.237463264	0.477463264	0.133562431
	Proportion of the population with income above the minimum wage(X10)	0.093037386	0.333037386	0.093161686
Institution factors	Proportion of government investment in disaster prevention and response(public safety)(X11)	0.112303565	0.352303565	0.098551081

After empowering the indicators, we calculated the average community resilience coefficients of New Orleans from 2008 to 2012. The resilience coefficients were calculated by using the weighted method. By weighting the standardized data of the indicators, we got the sub-coefficients, and then the Sub-coefficients were calculated by weighting the sub-coefficients. The total coefficient of stress resistance is obtained. The concrete formula is as follows:

$$CRI=\sum_{i=1}^{l} W_i(\sum_{j=1}^{q} W_{ij}Y_{ij}) \quad (1)$$

Among them, *CRI* is the coefficient of community resilience, l means the number of first-level indicators, W_i is the weight of the first-level indicator, q is the number of second-level indicators, and W_{ij} is the weight of the second-level indicator j in the first-level indicator i. Y_{ij} is the normalized index value. Based on the above formulas, the resilience coefficients of communities in New Orleans during 2008-2012 are shown in Table 4.

Table 4 Descriptive Statistics of New Orleans Community Resistance Index and Its Sub-Index (2008-2012)

Variables		**Average**	**Contribution rate %**	**Maximum**	**Minimum**
Total index		0.521212	100	0.579923	0.470488
Population factors	Age structure	0.16	20.46	0.21	0.12
	Special population	0.13	0.02	0.15	0.11
	Education level	0.74	15.05	0.77	0.71
	Medical security	0.75	5.71	0.76	0.74
Physical factors	Housing structure	0.47	15.07	0.66	0.29
Economic factors	Housing capital	0.59	10.9	0.63	0.58
	Employment status	0.95	13.36	0.97	0.91
	Income status	0.69	9.32	0.72	0.68
Institution factors	Municipal service level	0.08	9.86	0.13	0.05

Overall, the average value of the total index of community resilience in the United States in the past five years is 0.5212. Population and economic factors contributed the most to the resilience level, reaching 41.24% and 33.58% respectively. This further shows that the sensitivity of population structure and employment income to the resilience level is the highest, and the government can proceed from these two points to enhance the level of adversity resistance.

In this paper, the operational process of community resilience in the US under extreme disasters and the different levels are analyzed. At the same time, the corresponding index system is constructed according to the four aspects of population, physics, economy and system. Thus, the advantages of the U.S. resilience mechanism and some problems exposed are obtained and summarized. Combining some advanced disaster mitigation concepts, we hope to build a better system of resilience in the future.

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