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Research on Emergency Management Ability Evaluation of Sudden Landslide Event

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Abstract

In recent years, landslides occur frequently in China, which has brought great harm to people's life and social security. Based on the relevant literature on landslide events and emergency management ability evaluation, this study constructs a set of effective landslide emergency management ability evaluation index system. At the same time, this study also comprehensively uses quantitative analysis and qualitative research methods to construct the evaluation model of landslide emergency management ability, and takes the "7.23" Shuicheng landslide event in Guizhou as an example. The results show that our government's ability to deal with sudden landslides still needs to be improved, and the government should strengthen and improve early warning and prediction, information management and public opinion supervision. This study has certain practical significance and guiding role for the research of emergency management of sudden landslide.

Key words: Landslide; Emergency management capability; Index system; Evaluation model

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INTRODUCTION

China is a mountainous country. Due to global climate changes and the increase in engineering activities in China, landslide events in China have become more frequent in recent years. Compared with the strong independence of landslide events in the past, in recent years, the continuity and sudden frequency of landslide events that have occurred in China during the same period of time have increased. For example, in the past five years, large-scale landslides have occurred in Taining City (Fujian Province), Xuyong County (Sichuan), Diexi Town (Sichuan Province), Nayong County (Guizhou Province) and Wuping County (Sichuan)in 2019. Generally speaking, the frequent occurrence of sudden landslides in China has threatened the lives and property of the people. Therefore, objectively evaluating the emergency management capabilities of landslides and strengthening the construction of emergency management systems are important events that affect the country's overall economic and social development and the safety of human life and property.

At present, the research on landslides in China is still very weak, but according to the current research on Landslides: feduqiu et al. (2016) established the analysis method of historical and potential hazards of landslides and debris flows, and constructed the analysis index system of physical exposure, disaster response capacity and vulnerability (Fei, et al, 2016). Zhang Wenfeng (2016) analyzed and studied the mountain fault effect of geological landslide disaster, and proposed to effectively predict and prevent geological landslide disaster by accurately fitting the seed points and spatial development trend of fault plane (Zhang, 2016, pp.21-24). Yu Ganliang and Jiang Wen (2017) took the landslide geological disaster of Nanjing comprehensive social welfare service center as the object, introduced the general situation of geological disasters, analyzed the causes of disasters, and gave the treatment scheme through calculation (Yu & Jiang, 2017). Pan Songtao (2017) analyzed the causes of landslide geological disasters, proposed that disaster emergency measures should be taken in each region, and established landslide geological disaster early warning mechanism (Pan, 2017). Chen Ningsheng. Liu Mei and Liu Lihong (2018) discussed mountain torrents and debris flow disasters and their watershed properties, especially introduced the concept of time to discuss the discrimination of mountain torrents and debris flow gullies in the past and in the future (Chen, Liu, & Liu, 2018). Shi Lei (2019) proposed a new sensor network early warning method for mountain and landslide disasters to realize accurate early warning of mountain and landslide disasters (Shi, 2019, pp.36-40). Based on keil5 programming software, Wang Zemin et al. (2019) studied a new landslide monitoring system by calling stm32f4xx library function to program each module (Wang, Lin, & Xu, 2019). Sheng xinjuan et al. (2019) used the comprehensive geological analysis method to analyze and study the stability of landslide (Sheng & Wei, 2019, pp.18-19). Foreign scholars pay more attention to the research of landslide, among which Robin fell (1994) conducted the research on landslide risk assessment and acceptable risk assessment (Fell, 1994). Richard M. Iverson (2000) studied the landslide induced by rainwater infiltration, and analyzed the physical processes of landslide caused by rainfall involving different time scales (Iverson, 2000). F. C Dai et al. (2002) conducted a review of landslide risk assessment and management (Michel, Oppikofer, Abellán, & Pedrazzini, 2012). Michel jaboyedoff, Thierry oppikofer and Antonio abellan (2012) conducted a study on the application of lidar in landslide investigation (Dai, Lee, & Ngai, 2002).

All the above studies have constructed plans for landslide emergency management, but they are lack of certain practical test. In view of this, this study first constructs the evaluation index system of emergency management ability. Then the fuzzy evaluation method is used to construct the comprehensive evaluation model of emergency management ability; Finally, taking the “7.23” super large landslide event in Shuicheng, Guizhou Province as an example, this paper makes an empirical study and makes an objective evaluation on the current landslide emergency management in China

1. CONSTRUCTION OF EVALUATION INDEX SYSTEM FOR EMERGENCY MANAGEMENT ABILITY OF EMERGENCIES

1.1Principles for Constructing Indicator System

Objective and scientific principles. The design of the indicator system should conform to its objective reality, conform to the scientific theories that have been proven in practice, and be able to truly and comprehensively reflect the internal mechanism and essence of emergency management.

The principle of comprehensiveness and simplicity. The indicators are required to cover a wide range, which can comprehensively reflect the various factors of the emergency system and the coordination relationship between the factors. The content of the index system is required to be simple and clear, but not omission, accurate and representative (Zheng, Y2011).

The principle of practicality and comparability. The setting of indicators should consider the issue of comparability with Chinese historical data, and require measurability and clear physical meaning; basic data should be easy to investigate and collect, and the obtained indicators should be easy to compare; the connotation of the indicators should be clear and easy to understand .

The principle of relevance and dynamics. There should be a certain internal connection between the indicators. Emergency response capability evaluation is a dynamic process. Some indicators are required to fully consider the characteristics of dynamic changes. There must be not only static indicators but also dynamic indicators.

System and hierarchical principles. The emergency management system for emergencies is a complex system. Therefore, it is necessary to design the evaluation index system from the system point of view, and the indexes should be hierarchical and non-repetitive.

The principle of combining qualitative and quantitative. The indicator system should be quantified as much as possible, but for some indicators that are difficult to quantify and have great significance, qualitative indicators can also be used to describe them.

1.2 Establishment of Indicator System

At this stage, the geological disaster emergency work in each region is mainly divided into the following processes:

In the existing research, there are relatively few researches on the emergency management capability index system, and the research ideas and methods are also inconsistent. After synthesizing the relevant information, combining the actual situation and related investigation results, the emergency management capability index system was constructed.

It can be seen from Table 1 that the comprehensive index system of this article mainly includes seven aspects: emergency plan, personnel, materials, response speed, information release, aftermath ability, and reflection ability. In addition, this article also sets up secondary indicators under these seven indicators to achieve a more comprehensive evaluation of the emergency management capabilities of landslides. According to the nature of the indicators, this article divides the secondary indicators into benefit indicators and cost indicators. Among them, the smaller the cost index, the better the emergency management of this index. But the larger the benefit index, the better the emergency management of this index.

Table 1
Evaluation index system of emergency management capability for emergencies

First-level index	Second-level index	Nature of index
Emergency plan U1	Feasibility degree U1	Cost index
	Degree of comprehensiveness U2	cost index
Personnel U2	Training Intensity U3	Benefit Index
	Number of Disposable Personnel U4	Benefit Index
	Number of Professionals U5	Benefit Index
Material U3	Daily reserve material volume U6	Cost Index
	Adjustable amount of emergency supplies U7	Cost Index
Response speed U4	Start plan speed U8	Benefit index
	On-site processing speed U9	benefit index
Information release U5	Timeliness of release U10	Benefit Index
	Publish Transparency U11	Benefit Index
	Distribution channel breadth U12	Cost Index
After-care ability U6	After-care ability is strong or weak U13	Benefit index
	Remedial measures implementation intensity U14	Benefit index
Reflective ability U7	Experience summary and learning level U15	Benefit index
	Emergency plan update degree U16	Benefit index

2. EVALUATION MODEL OF EMERGENCY MANAGEMENT CAPABILITY BASED ON FUZZY EVALUATION METHOD

According to the theoretical basis of the above-mentioned index system, a comprehensive evaluation model of emergency management capability can be constructed through the use of fuzzy evaluation method.

2.1 Use Expert Evaluation Methods to Determine the Weight of Each Indicator

In order to ensure a more scientific evaluation of emergency management capabilities, first use the expert evaluation method to determine the weight values between the various indicators. In this process, let the participating experts fully discuss, and reasonably use survey data and related historical background data to determine the relative weight of each indicator.

2.2 Constructing the Evaluation Factor Set R and the Comment Set V in the Fuzzy Evaluation Method

In this process, the evaluation factor set consists of a two-level indicator system. The first-level evaluation factor set is: $R=\{U_1, U_2 \quad U_3 \quad U_4\, U_5 \quad U_6 \quad U_7\}$; the second-level evaluation factor set is: $U_1=\{u_1, u_2\}$, $U_2=\{u_3, u_4, u_5\}$, $U_3=\{u_6, u_7\}$, $U_4=\{u_8, u_9\}$, $U_5=\{u_{10}, u_{11}, u_{12}\}$, $U_6=\{u_{13}, u_{14}\}$, $U_7=\{u_{15}, u_{16}\}$,. At the same time, after decomposing these index systems, it should also meet:

$$\upsilon_i \cap u_j = \Phi \quad i \neq j, i, j \in \{1, 2, ..., 16\}$$

According to the existing research, combined with the actual situation and related investigations, the emergency management capabilities of the government and other related agencies can be divided into four levels, $V=\{v_1, \ v_2 \quad v_3\ v_4\}=\{\text{I} \quad \text{II} \quad \text{III IV}\}$. The meanings expressed in this order are excellent, good, medium and poor emergency management ability.

2.3 Establishment and Operation of Model In Fuzzy Evaluation Method

Firstly, the expert evaluation method is used to determine the weight matrix, in which the expert set is $I_j=\{I_1, I_2, .. \quad I_k\}$ the opinion of the second expert, and the expert's evaluation value on the impact on the, in which. It can be represented by the following table

2.4 Establishment and Operation of Model in Fuzzy Evaluation Method

Firstly, the expert evaluation method is used to determine the weight matrix, in which the expert set is $I_j=\{I_1, I_2, .. \quad I_k\}$, I_j is the opinion of the j-th expert, and x_{ij} is the evaluation value of Expert I_j on the impact of U_i on R, including $0 \leq x_{ij} \leq 1$. It can be represented by the following Table 2:

Table 2
Evaluation value of influence degree of primary index on evaluation factor set

Expert / Thefirst index	I_1	I_2	……	I_k
U_1	x_{11}	x_{12}	……	x_{1k}
U_2	x_{21}	x_{22}	……	x_{2k}
U_3	x_{31}	x_{32}	……	x_{3k}
U_4	x_{41}	x_{42}	……	x_{4k}
U_5	x_{51}	x_{52}	……	x_{5k}
U_6	x_{61}	x_{62}	……	x_{6k}
U_7	x_{71}	x_{72}	……	x_{7k}

According to the above table, formula

$$\partial(R/U_i)=\frac{\sum_{j=1}^{k} X_{ij}}{\sum_{i=1}^{7}\sum_{j=1}^{k} X_{ij}}$$

is satisfied。

Since the index system is composed of two-level indicators, it is also necessary to determine the impact degree evaluation value of secondary indicators on primary indicators, and set y_{ij} as the impact degree evaluation value of u_i on U_i determined by expert I_j, $0 \le y_{ij} \le 1$, The evaluation form is shown in Table 3.

Table 3
Evaluation value of impact degree of secondary indicators on primary indicators

Expert / The Secondary index	I_1	I_2	……	I_k
u_1	y_{11}	y_{12}	……	y_{1k}
u_2	y_{21}	y_{22}	……	y_{2k}
……	……	……	……	……
u_{16}	$y_{16,1}$	$y_{16,2}$	……	$y_{16,k}$

According to the above table 3,we can know formula is satisfied.

Then, defined $\partial(R/u_i)=\partial_i$ as the influence weight coefficient of u_i to R, then draw

$$\partial(U_i / u_i)=\frac{\sum_{j=1}^{k} y_{ij}}{\sum_{i=1}^{15}\sum_{j=1}^{k} x_{ij}}$$

$\partial_i=\partial(R/u_i)=\partial(U_i/u_i)\partial(R/U_i)$. Thus, the weight matrix of emergency management capability is determined as

Next, set the comment level interval. According to the existing research, combined with the actual situation and relevant investigations, the emergency management capacity of the government and other relevant institutions

$$A=(\partial(R/u_1),\ \partial(R/u_2),\ \ldots,\ \partial(R/u_{15}))$$

is divided into four levels, and the corresponding values are determined.

Then, determined the comprehensive transformation evaluation matrix, Let

be a fuzzy mapping set of P from R to V, meet the conditions

is the membership degree of V_j,which considers the

$$P(u_{ij})=(P_{i1},\ P_{i2}\ldots,P_{ij})$$

emergency management ability of emergencies from evaluation factor u_i. Thus obtained:

$$0 \le P_{ij} \le 1,\ i=1,2,\ldots,16;\ j=1,2,\ldots,4.\ P_{ij}$$

$$P_{ij}=\begin{bmatrix} P_{11} & P_{12} & \cdots & P_{14} \\ P_{21} & P_{22} & \cdots & P_{24} \\ \cdots & \cdots & \cdots & \cdots \\ P_{16,1} & P_{16,2} & \cdots & P_{16,4} \end{bmatrix}$$

Finally, Obtained the comprehensive evaluation value is According to the evaluation weight matrix of emergency management ability and the determined comprehensive transformation evaluation matrix, it is assumed that $B_j \in B$ and $B=(B_1\ \ B_2\ \ B_3\ \ B_4)$, It also corresponds to rating level $V=\{v_1,\ v_2\ \ v_3\ v_4\}$, and combined $A=(\partial_1,\ \partial_2\ \ldots,\partial_{16})$ to get $B_j=\sum_{k=1}^{16}\partial_k \times P_{kj}$.

3. EMPIRICAL ANALYSIS

3.1 Case Introduction

At 21:20 on July 23, 2019, a huge landslide occurred in Shuicheng County group, Liupanshui City, Guizhou Province, with a total area of 2 million cubic meters. The accident caused 21 houses to be buried and 13 people to die (Tian, 2019).

3.2 Model Application

The Delphi method is used to determine the weight value of each index. After discussion, the details are are shown in Table 4:

Table 4
Index weight and grade distribution of landslide events in Liupanshui City, Guizhou Province

Primary index	Weight	Secondary index	Weight	I	II	III	IV
Emergency plan U1	0.17	Degree of feasibility U1	0.5	2	2	4	2
		Degree of comprehensiveness U2	0.5	3	4	2	1
Personnel U2	0.15	Training intensity u3	0.2	2	3	3	2
		Number of disposable personnel U4	0.3	3	3	3	1
		Number of professionals U5	0.5	3	2	3	2
Material u3	0.15	Daily reserve U6	0.6	4	3	2	1
		Emergency materials available for mobilization U7	0.4	1	2	4	3
Reaction rate U4	0.17	Start plan speed U8	0.4	2	1	2	5
		Field processing speed u9	0.6	3	1	3	3
Information release U5	0.16	Release timeliness U10	0.5	1	4	2	3
		Publishing transparency U11	0.2	3	2	4	1
		Release channel breadth U12	0.3	4	2	2	2

To be continued

Continued

Primary index	Weight	Secondary index	Weight	I	II	III	IV
Aftercare ability U6	0.09	Aftercare ability u133	0.5	1	3	1	5
		Implementation intensity of aftercare measures U14	0.5	2	2	3	3
Reflective ability U7	0.11	Experience summary and learning level U15	0.3	2	1	2	5
		Update degree of emergency plan U16	0.7	1	2	4	3

In the Table 4, the indexes are further normalized, and the membership relationship vectors of all indexes are obtained by using the same calculation method. Finally, the fuzzy evaluation of two levels are calculated respectively. The details are shown in the table below:

Table 5
Comprehensive evaluation process of landslide event disposal model in Liupanshui City

The secondary index evaluation process	The primary index evaluation process	Result
(0.2,0.2,0.4,0.2)	(0.27, 0.34,0.26,0.13)	(0.241,0.2266, 0.2841,0.2483) Normalized and obtained: (0.24,0.23,0.28,0.25)
(0.3,0.4,0.2,0.1)		
(0.2,0.3,0.3,0.2)	(0.26, 0.24,0.3,0.2)	
(0.3,0.3,0.3,0.1)		
(0.3,0.2,0.3,0.2)		
(0.4,0.3,0.2,0.1)	(0.22,0.24,0.32,0.22)	
(0.1,0.2,0.4,0.3)		
(0.2,0.1,0.2,0.5)	(0.27, 0.1,0.27,0.36)	
(0.3,0.1,0.3,0.3)		
(0.1,0.4,0.2,0.3)		
(0.3,0.2,0.4,0.1)	(0.31,0.24,0.26,0.19)	
(0.4,0.2,0.2,0.2)		
(0.1,0.3,0.1,0.5)	(0.16,0.24,0.22,0.38)	
(0.2,0.2,0.3,0.3)		
(0.2,0.1,0.2,0.5)	(0.12,0.18,0.36,0.34)	
(0.1,0.2,0.4,0.3)		

According to expert comments, set.

$$V=\{v_1,\ v_2,\ v_3,v_4\}=\{\mathrm{I},\ \mathrm{II},\ \mathrm{III},\mathrm{IV}\}=\{80,70,60,50\}$$

If more than 80 points are set as level I, it means excellent emergency management ability; 80-70 is divided into level II, indicating good emergency management ability; 70-60 is divided into level III, indicating medium emergency management ability; 60-50 is divided into level IV, indicating poor emergency management ability. The comprehensive evaluation score of this case is $B_j=\sum_{k=1}^{16}\partial_k \times P_{kj}=64.6$, It can be inferred that the emergency management capacity of the government and other relevant institutions is medium in dealing with this emergency. Said that the government and other relevant institutions still have a lot of room to improve in terms of personnel allocation, response speed, material allocation, information release and aftermath treatment in the handling of landslides in Liupanshui City, Yunnan Province.

4. SUMMARY

By analyzing the current situation and trend of sudden landslides, this paper lists typical landslides in recent years, in order to emphasize that China is facing a severe threat of landslides. The government plays a very important role in dealing with natural disasters. It should keep close contact with the people and rescue together on the United Front. At the same time, increase the publicity of natural disaster early warning and self-help, so that the awareness of self-defense and prevention is deeply rooted in the hearts of the people, and know how to protect and self-help, so as to reduce the harm to human body caused by sudden natural disasters. This paper also studies the related concepts and current situation of emergency management capability, puts forward the research content of emergency management capability, and constructs the index system of emergency management capability, which provides a certain theoretical basis for the construction of emergency management capability system and the evaluation of government emergency capability.

The index system and comprehensive evaluation model are constructed by using fuzzy evaluation method, which provides a theoretical basis and evaluation tool for the measurement of emergency management ability of government and other relevant institutions. It can provide reference for the government and other relevant institutions, so as to better improve their emergency management ability. Therefore, the first mock exam suggests that the government and other relevant agencies can apply this model rationally to reduce the greater losses caused by disasters. Although China has actively explored and studied the evaluation of emergency management capacity and made some achievements, in terms of academic research, China's emergency management focuses on classification and pays attention to single disaster management, which also leads to most of the research on the evaluation of China's emergency management capacity focusing on single emergency evaluation. At the same time, there is relatively little research on the current situation and shortcomings of the emergency management ability of the government and other relevant institutions, which is the deficiency of this paper. In the next life and study, the author will strengthen the research in this field and strive to study the emergency management ability more perfectly.

To sum up, the evaluation and Research on the emergency management ability of emergencies, taking into account the principle of combining qualitative and quantitative analysis, as well as the analysis of the occurrence and development trend of events, can better warn and deal with emergencies and minimize the losses and injuries caused by emergencies. The analysis and Research on sudden landslides also arouse people's understanding and attention to the changes of the natural environment. It requires the joint unremitting efforts of the Chinese government and people to strengthen environmental self-care and disaster early warning, maintain social harmony and stability, and promote economic growth.

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