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Natural Disaster Public Opinion Risk Management Based on Fuzzy Theory

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ABSTRACT
Based on the relevant theoretical foundation, a preliminary natural disaster public opinion risk evaluation index system is formulated, which consists of 4 first-level indicators, 15 second-level indicators, and 49 third-level indicators, and correlation analysis is utilized to screen the preliminary evaluation indexes, and after the screening of the indexes, the final system consists of 4 first-level indicators, 14 second-level indicators, and 23 third-level indicators. Indicator system. Taking a certain province as the research object, we synthesize the hierarchical analysis algorithm and fuzzy theory to explore the risk of natural disaster public opinion in a certain province. The natural disaster public opinion risk assessment result based on fuzzy theory is 69.48, while the corresponding affiliation matrix $S_A = \begin{pmatrix} 0.2195 & 0.3385 & 0.1444 & 0.1264 & 0.1713 \end{pmatrix}$, according to the principle of maximum affiliation degree, concludes that the natural disaster public opinion risk of the province is at the level of Ⅳ, and in order to improve the natural disaster public opinion risk management, the target strategy is proposed. This study has important reference value to promote the rationalization of natural disaster public opinion risk management, so that it can better prevent natural disaster public opinion risk.

Keywords: hierarchical analysis algorithm, fuzzy theory, correlation analysis, natural disaster, public opinion risk management

1. Introduction

Natural disasters are geological, meteorological and hydrological emergencies caused by natural forces, such as earthquakes, floods and typhoons. Risk management is a systematic approach to minimizing losses and protecting people's lives and property by identifying, assessing and controlling potential risks. With the popularization of the Internet and the rise of social media, online public opinion has become an important channel for people to obtain information and express their opinions.

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When a natural disaster occurs, online public opinion tends to form rapidly and has an important impact on the dissemination and handling of the disaster, and at this time, the risk management of public opinion requires not only the participation of the government and related organizations, but also the joint efforts of all sectors of the society [1-3].

Natural disaster online public opinion is a double-edged sword, which can disseminate positive energy and unite social forces, but also may trigger rumors and panic. Measures such as official news and feedback, media publicity, and public opinion guidance are aimed at controlling the situation as much as possible in the shortest possible time, regulating public opinion, and avoiding the spread and influence of rumors. Therefore, in the face of the risk of disaster public opinion, relevant departments need to collaborate closely, respond positively to public opinion concerns, release relevant information in a timely manner, and guide public opinion scientifically, which can curb the spread of benign public opinion as well as the triggering of negative emotions, thus stabilizing public opinion and guaranteeing the safety of the public. In this way, public opinion can be stabilized, and public safety and disaster prevention work can be guaranteed [4-6].

Literature [7] introduces a geospatial grid display method based on global segmentation network, aiming at effectively managing and displaying natural disaster public opinion information, so as to provide support for disaster relief decision-making. The method is conducive to improving the location and service of natural disaster public opinion information on the web. Literature [8] took a snow disaster as an example, selected relevant media reports using Python, and launched text analysis using natural language processing. The relationship between media content and social response was discussed, and the results showed that rumors and negative information increased the unpredictability of the disaster and the risk of social crisis. Literature [9] proposed a public opinion analysis method of emotional characteristics and intelligent recognition of public emotions to obtain the public's demands in the face of disasters, and constructed a natural disaster public opinion analysis system based on social media communication. The method showed good results in the experiment of natural disaster public opinion classification and recognition. Literature [10] mentions a time series adaptive division scheme based on text similarity, completes the dynamic time series division of online public opinion, and explores the evolution of public opinion at different stages, with a view to providing a reference for the government to implement online public opinion change detection as well as response strategies. Literature [11] used the analysis of social networks to compare various types of disaster information communication in order to understand the impact of social media on disaster risk communication. The results pointed out that risk communication has different impacts on disasters, and social media works on information dissemination for natural disasters, while it works on conveying information and emotions for man-made disasters.

Literature [12] analyzed the interactions of three groups with the help of SIR epidemic model, and studied several major events in China by collating data from social media platforms, which were classified and sampled for simulation. The results show that the government's control of public opinion in the early stage of the event outbreak is effective and feasible. Literature [13] describes the government's response after a disaster. It is pointed out that the background government, in the face of disaster, did release information about the disaster, launched rescue work, and pacified the affected people, which played a role in stabilizing the society. However, some governments failed to release information and respond to public opinion, exposing problems such as insufficient ability to respond to public opinion. Literature [14] describes the monitoring method, scope, and process of monitoring and early warning of online public opinion, designs an online public opinion monitoring and early warning system, aims to grasp the overall situation and picture of public opinion to realize effective early warning, and analyzes the prevention and treatment of public opinion crisis. Literature [15] created a SIR model and used MATLAB to simulate the propagation of public opinion triggered by disasters. An empirical research method was adopted to explore the law of public opinion dissemination after a disaster, and based on intelligence science and epidemiology to summarize the characteristics of dissemination, and put forward the government's approach to controlling public opinion.

Based on the relevant conceptual theory and the construction principle of evaluation index system, the natural disaster public opinion risk evaluation index system is initially determined, and the Pearson correlation coefficient is adopted to screen the indexes, which finally consists of 4 first-level indexes, 14 second-level indexes, and 23 third-level indexes to form the natural disaster public opinion risk evaluation index system together. Based on the hierarchical analysis algorithm, the single-level ranking weights and multi-level ranking weights of the indicators are calculated. Taking a certain province as the object of study, the affiliation matrix is constructed by combining the single-level ranking weights of the indicators and the set of comments, and then mathematical operations are carried out to obtain the results of the natural disaster public opinion risk assessment of a certain province. Finally, corresponding management strategies are proposed to make the government's risk management of natural disaster public opinion more humanized.

2. Theoretical Basis for Natural Disaster Public Opinion Risk Management

2.1. Opinion risk management theory

2.1.1. Basic definitions. Natural disaster public opinion risk management means that in response to online public opinion triggered by the outbreak of a natural disaster, the government takes a series of measures to prevent or control the development of public opinion in advance, and the relevant departments build an emergency response plan for public opinion, so as to resist the risk of online public opinion, and to maintain the stability of the society and the development of the economy [16-17]. In recent years, the natural disaster public opinion system has been gradually improved. In recent years, the outbreak of new coronary pneumonia, the real problems and network public opinion problems caused by the natural disaster public opinion risk management department put forward a serious challenge, and while coping with the risk, it also further accelerated the reform and innovation of the emergency management department, which led to a series of achievements. Publicize the progress of disaster relief in a timely manner and do a good job of disclosing information. The people in the affected areas should be appeased, and their grief should be turned into strength, so that they can actively participate in the practice of rebuilding their homes. Clarify errors and rumors on the Internet, so that the risk of public opinion on natural disasters can be nipped in the bud. The support and support of the people can only be gained if all government departments work in concert with each other and actively listen to the opinions of the general public and make corrections in a timely manner.

2.1.2. Evolutionary mechanisms. This paper focuses on studying the evolution mechanism of natural disaster public opinion, figuring out the trend of public opinion triggered by the outbreak of natural disasters, better evaluating the risk factors of natural disaster public opinion, and finally putting forward risk management countermeasures for natural disaster public opinion in a guided manner. Crisis management of earthquake online public opinion, first of all, we have to figure out that the outbreak of natural disaster public opinion would have caused crisis and risk, which threatened the life and property safety of the people in the affected areas, with houses collapsing and many people in distress, and the only reality is that the government scrambles to save the people from the disaster and does not leave behind any word as a way of preventing the potential natural disaster public opinion risk. This shows that natural disaster public opinion risk crisis management should not only pay attention to the progress of disaster relief in reality, but also pay attention to online public opinion on related topics in a timely manner, take major media platforms as a basis, track the direction of public opinion in a timely manner, and focus on bloggers with high natural disaster public opinion risk, so as to communicate in a timely manner to prevent and defuse major risks.

2.2. Characteristics of natural disaster information dissemination

Dissemination of information on natural disasters refers to the dissemination of information on natural disasters caused by the occurrence of natural disasters in society. When a natural disaster occurs, people are eager to know “what happened, where it is, what are the casualties, and the possible scope of the impact” and other information, but due to the special characteristics of natural disasters, some sensitive information is not available at the first time, which will breed panic and anxiety in the society. Information on natural disasters is distinctly different from information on other emergencies:

2.2.1. Complexity of natural disaster information dissemination subjects. Because the occurrence of natural disasters is often accompanied by huge casualties and derivative disasters and other impacts, people after a certain period of information judgment will actively seek information rather than the general state of passive acceptance of the role of producers and consumers of information is disrupted, natural disaster information dissemination in society will increase the scope of natural disaster events compared to other emergencies, natural disaster events have a strong sensitivity, the probability of people receiving the relevant information will increase accordingly.

2.2.2. Diversification of natural disaster information dissemination channels. Natural disaster information is disseminated through a variety of channels. Because natural disasters are highly social and public in nature, once they occur, they will be disseminated indiscriminately in society, attracting widespread attention from all sectors of society, and information on natural disasters will become the focus of attention of all types of media in society. People will obtain and disseminate relevant information through a variety of information channels, which will, to a large extent, increase the “contact” between people in society and cause information to spread rapidly in society, and if not guided in a timely manner, a strong public opinion will be formed in society.

2.2.3. Diversification of natural disaster information dissemination content. Diversification and change in the content of natural disaster information dissemination. After a natural disaster occurs, all kinds of information will be widely circulated in the society, people are eager to know the real information about the natural disaster, they will make full use of the network to dig out the relevant information, if the government does not carry out targeted guidance, it will cause certain turbulence and anxiety in the society. For example, after the occurrence of incident A, due to the government's untimely handling, information about the government's intentional concealment of the truth of the incident and the government's inaction, etc., was widely disseminated in the society, which brought about a great impact on the local government and the society, and the dissemination of all kinds of public opinion information brought about a great deal of negative impacts on the local and other local people.

3. Research program design

3.1. Construction of the evaluation indicator system

3.1.1. Preliminary formulation of the evaluation indicator system. The preliminary formulation of the evaluation index system is shown in Table 1. Based on the relevant theoretical foundation of natural disaster public opinion risk management and the principles of constructing the evaluation index system mentioned above, a natural disaster public opinion risk evaluation index system has been preliminarily formulated from four aspects, namely, ontology, carrier, object, and subject, which covers 4 first-level indexes, 15 second-level indexes, and 49 third-level indexes, with a total of 68 indexes as alternatives.

Table 1. The evaluation index system is preliminary

Primary index	Symbol	Secondary index	Symbol	Three-level index	Symbol
Disaster element	A1	Physical property	B1	Disaster-causing factor intensity	C1
				Special duration	C2
				Sphere of influence	C3
		Damage degree	B2	Property loss	C4
				Casualties	C5
		Social attribute	B3	Distribution of disaster victims	C6
				Government assistance situation	C7
Information characteristics	A2	Information source reliability	B4	Impact level of information publisher	C8
				Information publisher activity	C9
				Information publisher authority	C10
		Intuitive degree of information	B5	The number of plain text messages	C11
				What picture information quantity	C12
				Contains the number of video messages	C13
		Information alienation degree	B6	Number of false information	C14
				The ratio of the amount of false information to the total amount of content-related information	C15
Media communication	A3	Media influence	B7	Total flow	C16
				Daily flow	C17
				Click rate	C18
		Media Engagement ·	B8	Media volume	C19
				Micromedia quantity	C20
				Number of news websites	C21
				Number of forums	C22
		Propagation diffusivity	B9	Degree of change in the ratio of content related information to total volume	C23
				Change degree of content related information and total quantity ratio per unit time	C24
		Propagation speed	B10	Rate of change of the number of original news	C25
				Change rate of news forwarding number	C26
				Rate of change in news retweets	C27
				Change rate of the number of original microblogs	C28
				Change rate of the number of retweets	C29
				Change rate of original credit number	C30
				Rate of change in number of original posts	C31
				Change rate of the number of posts forwarded	C32
		Communication effect	B11	Timeliness	C33
				Duration	C34
Audience tendency	A4	Internet user participation	B12	Click volume	C35
				Volume of comments	C36
				Transfer volume	C37
				Number of posts	C38
		Affective distribution	B13	Positive emotions.	C39
				Negative emotion	C40
				Neutral attitude	C41
				Eating ambiguity	C42
		Age distribution of network	B14	Less than a year	C43
				One to three years	C44
				Three to five years	C45
				More than five years	C46
		Regional distribution	B15	Eastern coastal area	C47
				Central inland city	C48
				Western remote areas	C49

3.1.2. Indicator data collection. In order to ensure the objectivity and accuracy of the raw data of each index after screening, this paper utilizes the webpage crawling/information extraction software Gooseeker and combines it with the platform of “Qingbo Big Data” for data collection. The target of data collection is Baidu News, Sina Weibo, WeChat and Tianya Forum, which have a high degree of participation and interactivity among netizens, and the information content, release time, publisher, number of clicks, number of replies and their URL links of each online platform under a defined theme are collected.

3.1.3. Standardization of indicator data. The data before and after standardization are shown in Table 2, in order to avoid the degree of variability of the variables themselves, the variability of the numerical interval on the screening of the indicators to interfere, with a view to obtaining objective and accurate results, the data after the quantification of the indicators must be standardized, and after standardization of the data of each indicator observation will be between the values of (0,1).

Table 2. Standardized data before and after standardization

1	2	3	4	5-15(Raw data)			16-26(Standardized data)		
Serial number	Primary index	Secondary index	Three-level index	6/24	...	7/4	6/24	...	7/4
1	A1	B1	C1	4	...	4	0.223	...	0.283
...		...	...	...	...	...	...	...	...
...		B3	C22		...	83	0.358	...	0.348
6	...	...	...	...	...	...	...	...	...
...	A4	B13	C35	...	...	...	0.888	...	0.639
...		...	...	...	...	...	...	...	...
42		B15	C49	0.168	...	...	0.112	...	0.126

3.1.4. Indicator screening based on correlation analysis. In order to reduce the redundancy of the indicator system, the calculated correlation coefficients between the indicators are then compared with the set threshold of significance correlation coefficient, M. If $|r_{ab}| > M$, it means that the two indicators are significantly correlated, and one of the evaluated indicators can be excluded. Conversely, if $|r_{ab}| < M$, it means that the two indicators are not significantly correlated and can be retained at the same time. The significant correlation coefficient threshold of M was calculated to give its final value of 0.84.

1) Correlation analysis of A1 disaster elements. The results of the correlation analysis of disaster elements are shown in Table 3. According to the results in Table 1, it can be seen that the disaster element indicators did not change after the correlation analysis, indicating that the indicators in this indicator set have good independence and no redundant indicators.

Table 3. Analysis of the correlation analysis of disaster factors

First level indicator	Secondary index	Retention index	Exclusion index	Correlation coefficient
Disaster element	Physical property	Disaster-causing factor intensity		0.548
		Special duration		0.713
		Sphere of influence		0.673
	Damage degree	Property loss		0.772
		Casualties		0.763

2) Correlation analysis of information characteristics. The correlation analysis of A2 information characteristics is shown in Table 4. In terms of the reliability of information sources, the consistency of the indicators of authority of the information publisher and influence of the information publisher is higher, and the representativeness of the indicator of authority of the information publisher is better. In terms of information intuition, the number of plain text information is the largest and still in the main position, but the proportion of picture-containing information and video-containing information will rise slightly with the in-depth discussion and development of online public opinion, and the consistency between the number of picture-containing information and the number of video-containing information is higher. The proportion of the number of false information related to sudden natural disasters in the total number of related information reflects the degree of alienation of information in this public opinion.

Table 4. Correlation analysis of information characteristics

Primary index	Secondary index	Reserve	Eliminate	Correlation coefficient
Information characteristics	Information source reliability	Information publisher authority	Information Publisher Impact level	0.862
	Information intuitiveness	The number of plain text messages		0.765
		Number of pictures included	Contains the number of video messages	0.844
	Information alienation degree	Number of false information and insideThe ratio of the total amount of relevant information		0.715

3) Relevance analysis of media communication. The results of the media communication relevance analysis are shown in Table 5. In terms of the reliability of the information source, the consistency of the two indicators of the authority of the information publisher and the influence of the information publisher is higher, and the representativeness of the indicator of the authority of the information publisher is better. In terms of information intuition, the number of plain text information is the largest and still in the main position, but the proportion of picture-containing information and video-containing information will rise slightly with the in-depth discussion and development of online public opinion, and the consistency of the number of picture-containing information and the number of video-containing information is higher. The proportion of the number of false information related to sudden natural disasters in the total number of related information reflects the degree of alienation of information in this public opinion.

Table 5. Correlation analysis results of media communication

Primary index	Secondary index	Reserve	Eliminate	Correlation coefficient
Media communication	Media influence	Total flow	Flow rate	0.866
	Media engagement	Total media volume.	Micromedia quantity	0.923
			Number of news websites	0.845
			Number of forums	0.917
	Propagation diffusivity	Unit time content Ratio of relevant information to total volume Degree of change	Content related information Degree of change relative to the total	0.915
		The number of original news changesvoltine	Change rate of news forwarding number	0.877
			The number of Weibo retweets changesvoltine	0.905
			Original wechat number change Conversion Rate	0.877
			Change rate of the number of wechat retweets	0.882
			Rate of change in number of original posts	0.885
			The number of posts forwarded changesvoltine	0.865
	Communication effect	Timeliness		0.715
		Duration		0.684

4) Relevance analysis of audience tendency. The audience tendency correlation analysis is shown in Table 6. In terms of netizen participation, people's evaluation and discussion of public opinion in the Internet reflect their enthusiasm for participation. In terms of emotional distribution, netizens' emotional attitudes toward public opinion are more clearly expressed. In terms of age distribution, the number of netizens between one and three years old is larger and more stable, while the number of netizens older than five years old is smaller than that of new netizens, but they are more stable in the development of public opinion and there is no lack of “opinion leaders”. In terms of geographical distribution, the eastern coastal areas are more developed, with a large number of Internet users and a high penetration rate of new media, which makes it easy for sudden natural disasters to attract attention and become hotspots, while the central inland cities are more consistent with them, and the western remote areas lag behind in terms of economic development and Internet penetration, and there is still a certain gap between the eastern areas, so public opinion is a bit lagging behind.

Table 6. Audience orientation correlation analysis

<table>
<tr><th>Primary index</th><th>Secondary index</th><th>Retention index</th><th>Exclusion index</th><th>Correlation coefficient</th></tr>
<tr><td rowspan="10">Audience tendency</td><td rowspan="3">Internet user participation</td><td rowspan="3">Volume of comments</td><td>Click volume</td><td>0.853</td></tr>
<tr><td>Transfer volume</td><td>0.907</td></tr>
<tr><td>Number of posts</td><td>0.844</td></tr>
<tr><td rowspan="2">Emotional distribution.</td><td>Positive emotion</td><td>Negative emotion</td><td>0.869</td></tr>
<tr><td>Neutral attitude</td><td></td><td>0.653</td></tr>
<tr><td rowspan="3">Age distribution of network</td><td rowspan="2">One to three years</td><td>Less than a year</td><td>0.864</td></tr>
<tr><td>Three to five years.</td><td>0.903</td></tr>
<tr><td>More than five years</td><td></td><td>0.599</td></tr>
<tr><td rowspan="2">Regional distribution</td><td>Eastern coastal area</td><td>Central inland city</td><td>0.916</td></tr>
<tr><td>Western remote areas</td><td>Western remote areas</td><td>0.638</td></tr>
</table>

3.1.5. Determination of the system of evaluation indicators. The indicator system screened after correlation analysis is shown in Table 7. There are 4 primary indicators, 14 secondary indicators and 23 tertiary indicators remaining.

Table 7. The index system selected by correlation analysis

<table>
<tr><th>Primary index</th><th>Symbol</th><th>Secondary index</th><th>Symbol</th><th>Three-level index</th><th>Symbol</th></tr>
<tr><td rowspan="5">Disaster element</td><td rowspan="5">A1</td><td rowspan="3">Physical property</td><td rowspan="3">B1</td><td>Disaster-causing factor intensity</td><td>C1</td></tr>
<tr><td>Duration</td><td>C2</td></tr>
<tr><td>Sphere of influence</td><td>C3</td></tr>
<tr><td rowspan="2">Damage degree</td><td rowspan="2">B2</td><td>Property loss</td><td>C4</td></tr>
<tr><td>Casualties</td><td>C5</td></tr>
<tr><td rowspan="4">Information characteristics.</td><td rowspan="4">A2</td><td>Information source reliability</td><td>B4</td><td>Information publisher authority</td><td>C10</td></tr>
<tr><td rowspan="2">Intuitive degree of information</td><td rowspan="2">B5</td><td>The number of plain text messages</td><td>C11</td></tr>
<tr><td>Number of pictures included</td><td>C12</td></tr>
<tr><td>Information alienation degree</td><td>B6</td><td>The ratio of the amount of false information to the total amount of content-related information</td><td>C15</td></tr>
<tr><td rowspan="7">Media communication</td><td rowspan="7">A3</td><td>Media influence</td><td>B7</td><td>Total flow</td><td>C16</td></tr>
<tr><td>Media engagement</td><td>B8</td><td>Media volume</td><td>C19</td></tr>
<tr><td>Propagation diffusivity</td><td>B9</td><td>Change degree of content related information and total quantity ratio per unit time</td><td>C24</td></tr>
<tr><td rowspan="2">Propagation speed</td><td rowspan="2">B10</td><td>Rate of change of the number of original news</td><td>C25</td></tr>
<tr><td>Change rate of the number of original microblogs</td><td>C28</td></tr>
<tr><td rowspan="2">Communication effect</td><td rowspan="2">B11</td><td>Timeliness</td><td>C33</td></tr>
<tr><td>Special duration</td><td>C34</td></tr>
<tr><td rowspan="7">Audience tendency</td><td rowspan="7">A4</td><td>Internet user participation</td><td>B12</td><td>Volume of comments</td><td>C36</td></tr>
<tr><td rowspan="2">Affective distribution</td><td rowspan="2">B13</td><td>Positive emotion</td><td>C39</td></tr>
<tr><td>A neutral attitude.</td><td>C41</td></tr>
<tr><td rowspan="2">Age distribution of network</td><td rowspan="2">B14</td><td>One to three years</td><td>C44</td></tr>
<tr><td>More than five years</td><td>C45</td></tr>
<tr><td rowspan="2">Regional distribution</td><td rowspan="2">B15</td><td>Eastern coastal area</td><td>C48</td></tr>
<tr><td>Western remote areas</td><td>C49</td></tr>
</table>

3.2. Hierarchical analysis and fuzzy comprehensive evaluation

3.2.1. Hierarchical analysis. Hierarchical analysis is a composite analysis method, which can quantify and analyze the subjective information, i.e., the subjective consciousness and judgment of the participants in the problem under study, and the special structure of hierarchical analysis is very effective in analyzing and solving some complex problems, which can be well combined with the present study [18-19]. In the process of natural disaster public opinion risk evaluation, it is especially important to determine the degree of influence of each indicator on the evaluation target, i.e., the weight, which directly affects the success of natural disaster public opinion risk evaluation. As an important method to solve the multi-objective decision-making problem, combining with the characteristics of the hierarchical structure of the evaluation index system, this paper adopts the hierarchical analysis method to determine the weights of the indicators, and its calculation process is shown in Figure 1.

In this paper, the calculation of indicator weights is mainly carried out through four steps. First, the hierarchical structure is constructed based on the evaluation objectives. Secondly, the experts conduct seminars according to the index importance scale to determine the relative importance of the indexes and give the judgment matrix. Third, calculate the maximum eigenvalue of the judgment matrix and its corresponding eigenvector. Finally, the judgment matrix is subjected to consistency test; if the matrix meets the requirements, the normalized eigenvectors can be used as the weights of the indicators; otherwise, the matrix needs to be reconstructed until it meets the consistency test.

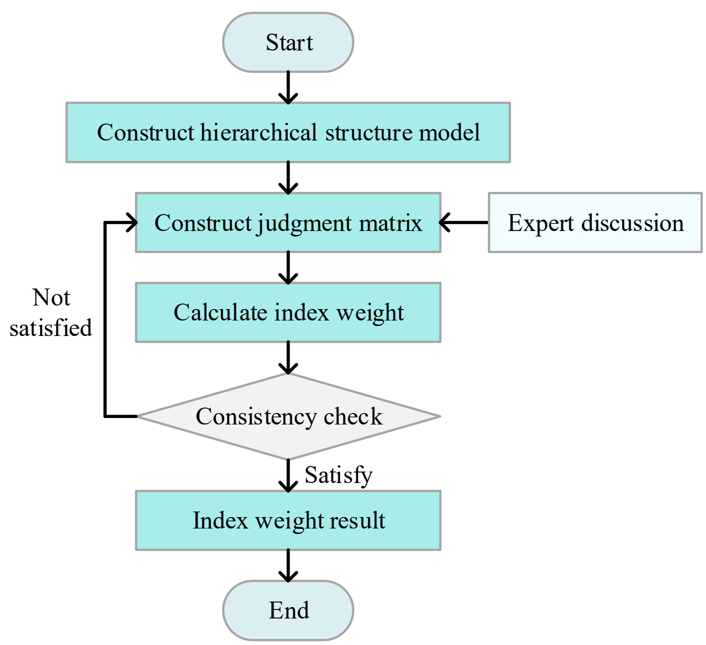

Fig. 1. Index weight calculation process

3.2.2. Fuzzy integrated evaluation. The concept of fuzzy theory, which aims to use mathematical knowledge to study and parse fuzzy problems in everyday life, as it can help to solve many problems that cannot be explained exactly and can yield unexpected results [20]. An in-depth study of fuzzy mathematics is important for us to understand things better. Fuzzy theory has an exalted position in evaluating things because it combines qualitative and quantitative methods of analysis, leading to more reliable and credible conclusions. Fuzzy evaluation is a unified evaluation method based on the principles of fuzzy mathematics, which aims to evaluate problems or events that cannot be explained accurately through specific evaluation criteria. Fuzzy evaluation contains six main elements as shown below:

1) Factor set A. It is a fuzzy evaluation system that considers all the elements together.

2) Rating set B. It divides the evaluation of things and phenomena into four levels: excellent, better, average and very poor, in order to reflect the real condition of things and phenomena more accurately.

3) Relationship Rectangle R. It is a complex structure consisting of different decision-making fundamentals in the factor set and the rubric set, which are connected with each other in terms of positive significance and negative influence.

4) Factor weight vector W. It a kind of effective tool used to describe the influence of each element in fuzzy evaluation on the object of evaluation, which can help us better understand and evaluate the characteristics and properties of the object of evaluation.

5) Fuzzy operator. A mathematical operation used to calculate the relationship between the factor weight vector and the relationship matrix.

6) Evaluation result vector U. This is an evaluation method used to measure a phenomenon or thing, which is able to be represented by a vector and is used to measure the accuracy and reliability of the evaluation.

4. Natural Disaster Public Opinion Risk Assessment Analysis

4.1. Single-level ranking weight analysis

Determination of indicator weights is the key to natural disaster public opinion risk assessment, and the scientific and reasonable nature of the weights directly determines the accuracy of the risk evaluation results. Since the contribution of each indicator to the risk of natural disaster public opinion is different, and the subjects in different regions are affected by their own environmental factors, the paper will adopt the hierarchical analysis method, based on the natural disaster public opinion risk evaluation index system, to determine the weight values of the indicators at all levels of the single-level sorting, to maximize the minimization of subjectivity in the process of constructing the weights, and lay the foundation for the subsequent fuzzy risk evaluation. The foundation is laid for the subsequent fuzzy risk evaluation.

4.1.1. Single-level ranking of first-level indicators and consistency tests. According to the hierarchical analysis algorithm for the evaluation of the evaluation index system of the first-level indicators of the single-level weight calculation, the first-level indicator comparison matrix is shown in Figure 2, while the consistency test results are shown in Table 8. Synthesizing the data in Figure 2 and Table 8, it can be clearly seen that the single-level weight values of A1~A4 are 0.2628, 0.2671, 0.2205, 0.2496, respectively, and the indicators satisfy the consistency test standard.

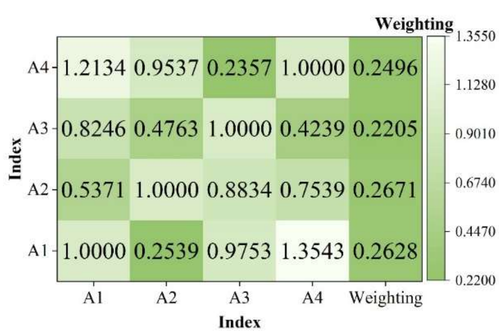

Fig. 2. Primary index comparison matrix

Table 8. Consistency test results

Index	CI	RI	CR
A1	0.007	0.9	0.00778

A2	0.056	0.9	0.06222
A3	0.03	0.9	0.03333
A4	0.034	0.9	0.03778

4.1.2. Single-level ranking of secondary indicators and consistency tests:

1) Secondary indicators under disaster element (A1). Table 9 shows the judgment matrix of secondary indicators under disaster elements, and Table 10 shows the consistency test results. As can be seen from the data in the table, the weight values of its B1 and B2 are 0.5791 and 0.4209, respectively, and have good consistency performance.

Table 9. The secondary index judgment matrix of disaster elements

Index	B1	B2	Weighting
B1	1	0.867	0.5791
B2	0.458	1	0.4209

Table 10. Consistency test results

Index	CI	RI	CR
A1	0.061	0	0
A2	0.015	0	0

2) Secondary indicators under information feature (A2). Table 11 demonstrates the judgment matrix of secondary indicators subordinate to information feature (A2), and Table 12 shows the consistency test results of secondary indicators subordinate to information feature (A2). Among the secondary indicators under information characteristic (A2), the weight value of B4 (0.4276) is the largest, followed by B6 (0.3248), and finally B5 (0.2476), and the three secondary indicators satisfy the consistency test.

Table 11. Information feature (A2) subordinate two-level index judgment matrix

Index	B4	B5	B6	Weighting
B4	1	1.8472	0.9431	0.4276
B5	2.4318	1	0.1391	0.2476
B6	0.9237	0.8269	1	0.3248

Table 12. Consistency test results of secondary indexes

Index	CI	RI	CR
B4	0.054	0.58	0.0931
B5	0.004	0.58	0.0069
B6	0.046	0.58	0.0793

3) Secondary indicators under media communication (A3). Figure 3 shows the judgment matrix of secondary indicators under media communication (A3), and Table 13 shows the consistency test of secondary indicators under media communication (A3). It can be seen that the weights of the four indicators under media communication (A3) are 0.2101, 0.2040, 0.2055, 0.1989, 0.1815, and it can also be seen that the CR value is <0.01, which indicates that their weights have good consistency.

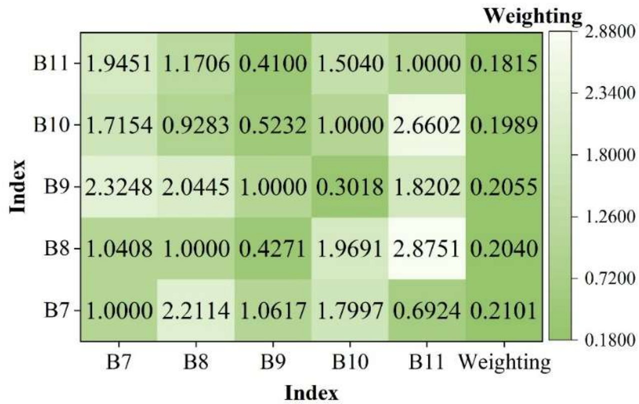

Fig. 3. Media communication (A3) subordinate second-level index judgment matrix.

Table 13. Second level index consistency test.

Index	CI	RI	CR
B7	0.028	1.12	0.0250
B8	0.065	1.12	0.0580
B9	0.054	1.12	0.0482
B10	0.067	1.12	0.0598
B11	0.079	1.12	0.0705

4) Audience tendency (A4) subordinate secondary indicators. Based on the hierarchical analysis algorithm for audience tendency (A4) subordinate secondary indicators for single-level weight calculation, audience tendency (A4) subordinate secondary indicators judgment matrix shown in Figure 4, the corresponding consistency test results shown in Table 14. As can be seen from the chart, the weight values of the four indicators are 0.2695, 0.3678, 0.2879, 0.0748, and satisfy CR<0.01.

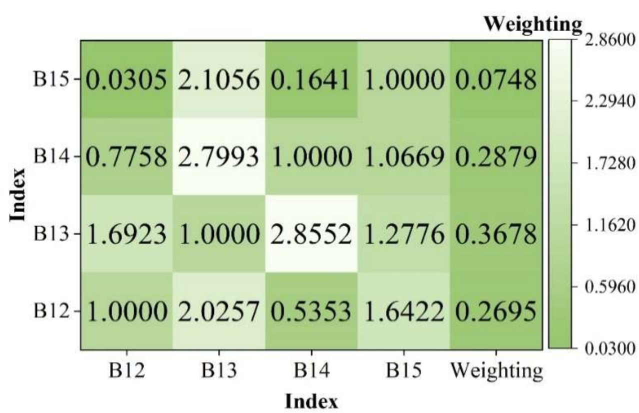

Fig. 4. A4 Subordinate index judgment matrix

Table 14. Corresponding consistency test results

Index	CI	RI	CR
B12	0.067	0.9	0.0744
B13	0.061	0.9	0.0678
B14	0.013	0.9	0.0144
B15	0.062	0.9	0.0689

4.1.3. Single-level ranking and consistency test for three-level indicators. Since the evaluation index system contains 14 items of secondary indicators, the weight calculation process of the tertiary indicators under the 14 items of secondary indicators is not given in detail, and the weights of the tertiary indicators are calculated here uniformly by the hierarchical analysis algorithm of the matlab toolbox, in addition to the consistency of which to ensure the rigor of the study, and the three-level indicator single-level sort and consistency test are shown in Table 15. Based on the data in the table, it can be seen that the distribution of the weight values of the three-level indicators single-level sorting ranges from (0.0769∼1), and 23 three-level indicators satisfy CR<0.1.

Table 15. Three-level index single-level sorting and consistency test

Three-level index	Symbol	Weighting	CR
Disaster-causing factor intensity	C1	0.0769	0.0279
Duration	C2	0.6462	0.0997
Sphere of influence	C3	0.2769	0.0448
Property loss	C4	0.7619	0.0755
Casualties	C5	0.2381	0.0071
Information publisher authority	C10	1	0.0361
The number of plain text messages	C11	0.6774	0.0341
Number of pictures included	C12	0.3226	0.0692
The ratio of the amount of false information to the total amount of content-related information	C15	1	0.0317
Total flow	C16	1	0.0409
Media volume	C19	1	0.037
Change degree of content related information and total quantity ratio per unit time	C24	1	0.0186
Rate of change of the number of original news	C25	0.4348	0.0326
Change rate of the number of original microblogs	C28	0.5652	0.0969
Timeliness	C33	0.2712	0.0129
Special duration	C34	0.7288	0.0489
Volume of comments	C36	1	0.0549
Positive emotion	C39	0.7159	0.0441
A neutral attitude.	C41	0.2841	0.0131
One to three years	C44	0.4536	0.031
More than five years	C45	0.5464	0.0378
Eastern coastal area	C48	0.5243	0.0707
Western remote areas	C49	0.4757	0.0189

4.2. *Analysis of total hierarchical ranking weights*

The total hierarchical ranking weight value of the evaluation indicator is equal to the total ranking weight value of the indicator in the previous tier multiplied by the single-level ranking weight of the current tier. Since the level 1 indicator is already the highest level and there is no upper level indicator, the total hierarchical ranking weight of the level 1 indicator is equal to the single-level ranking weight, and the results of the total hierarchical ranking weight of the level 2 indicator and the level 3 indicator will be interpreted in detail below.

4.2.1. Analysis of total hierarchical ranking weights for secondary indicators. The results of the total hierarchical weighting analysis of the secondary indicators are shown in Table 16. Taking the degree of destruction (B2) as an example, the total hierarchical ranking weight of the degree of destruction (B2) = 0.2628 for the disaster element (A1) × 0.4209 for the single hierarchical ranking weight of the degree of destruction (B2) = 0.1106, and the same is true for the rest of the 13 second-level indicator weights.

Table 16. The overall level of the secondary index is analyzed

Primary index	Total level weight	Secondary index	Single level weight	Total level weight
A1	0.2628	B1	0.5791	0.1522
		B2	0.4209	0.1106
A2	0.2671	B4	0.4276	0.1142
		B5	0.2476	0.0661
		B6	0.3248	0.0868
A3	0.2205	B7	0.2101	0.0463
		B8	0.2040	0.0450
		B9	0.2055	0.0453
		B10	0.1989	0.0439
		B11	0.1815	0.0400
A4	0.2496	B12	0.2695	0.0673
		B13	0.3678	0.0918
		B14	0.2879	0.0719
		B15	0.0748	0.0187

4.2.2. Analysis of the total hierarchical ranking weights of the three levels of indicators. On the basis of the known data of total hierarchical ranking weights of secondary indicators, the total hierarchical ranking weights of tertiary indicators are analyzed based on the hierarchical analysis algorithm, and the analysis of total hierarchical ranking weights of tertiary indicators is shown in Table 17. As an example, the total hierarchical ranking weight of disaster-causing factor strength (C1) is 0.1522 × 0.0769 × 0.0117 for the total hierarchical ranking weight of physical attributes (B1), and the same is true for the remaining 22 tertiary indicators.

Table 17. Weight analysis of the total hierarchy of secondary indicators

Secondary index	Total level weight	Three-level index	Single level weight	Total level weight
B1	0.1522	C1	0.0769	0.0117
		C2	0.6462	0.0984
		C3	0.2769	0.0421
B2	0.1106	C4	0.7619	0.0843
		C5	0.2381	0.0263
B4	0.1142	C10	1	0.1142
B5	0.0661	C11	0.6774	0.0448
		C12	0.3226	0.0213
B6	0.0868	C15	1	0.0868
B7	0.0463	C16	1	0.0463
B8	0.0450	C19	1	0.0450
B9	0.0453	C24	1	0.0453
B10	0.0439	C25	0.4348	0.0191
		C28	0.5652	0.0248
B11	0.0400	C33	0.2712	0.0108
		C34	0.7288	0.0292
B12	0.0673	C36	1	0.0673
B13	0.0918	C39	0.7159	0.0657
		C41	0.2841	0.0261
B14	0.0719	C44	0.4536	0.0326
		C45	0.5464	0.0392
B15	0.0187	C48	0.5243	0.0098
		C49	0.4757	0.0089

4.3. Determination of weights of evaluation indicators

This subsection summarizes the weights of the evaluation indicators at each level mentioned above in a table, from which the weights of the natural disaster public opinion risk evaluation indicators are determined, and the results of the weights of the evaluation indicator system are shown in Table 18. The data show that information characteristics (A2) is the most heavily weighted of the four first-level indicators.

Table 18. Evaluation index system weight results

Primary index	Weighting	Secondary index	weighting	Three-level index	Weighting
A1	0.2628	B1	0.1522	C1	0.0117
				C2	0.0984
				C3	0.0421
		B2	0.1106	C4	0.0843
				C5	0.0263
A2	0.2671	B4	0.1142	C10	0.1142
		B5	0.0661	C11	0.0448
				C12	0.0213
		B6	0.0868	C15	0.0868
A3	0.2205	B7	0.0463	C16	0.0463
		B8	0.0450	C19	0.0450
		B9	0.0453	C24	0.0453
		B10	0.0439	C25	0.0191
				C28	0.0248
		B11	0.0400	C33	0.0108
				C34	0.0292
A4	0.2496	B12	0.0673	C36	0.0673
		B13	0.0918	C39	0.0657
				C41	0.0261
		B14	0.0719	C44	0.0326
				C45	0.0392
		B15	0.0187	C48	0.0098
				C49	0.0089

4.4. Natural Disaster Public Opinion Risk Assessment

4.4.1. Establishment of factor sets. After the weights of indicators at all levels are determined, the specific values of each evaluation indicator need to be derived with the help of the fuzzy comprehensive evaluation method. Set evaluation indicator set $X=\{X_1,X_2,\cdots,X_n\}$, and according to the natural disaster public opinion risk evaluation indicator system, set the first-level indicator as the target level, and the second-level indicator and the third-level indicator in the same way.

4.4.2. Establishment of a rubric. For the risk assessment of natural disaster public opinion, five rubrics are set up: Level I, Level II, Level III, Level IV and Level V. Corresponding scoring criteria are further set up, specifically, 100-90 points corresponds to Level V, 90-80 points corresponds to Level IV, 80-60 points corresponds to Level III, 60-40 points corresponds to Level II, and 40-0 points corresponds to Level I. The median value of each rubric is assigned as the value of the final set of scores, which is {95, 85, 70, 50, 20}. The median value of each interval is assigned as the value of the rubric, and the final rubric set is {95, 85, 70, 50, 20}.

4.4.3. Determination of the degree of affiliation of evaluation indicators. Determining the degree of affiliation of evaluation indicators is a key link in the construction of the evaluation system, this paper adopts the questionnaire survey method to collect the results of the evaluation of the effectiveness of natural disaster public opinion risk, examines and organizes the collected database, statistically selects the data of a particular rubric and divides it by the library of evaluation data to get the degree of affiliation of the evaluation indicator.

4.4.4. Analysis of assessment results. According to the process evaluation index weights determined above, the fuzzy comprehensive evaluation is utilized to calculate the score of each evaluation index. Taking a province as the object of study, the affiliation degree of each indicator is finally collated, and the affiliation degree of the evaluation indicators is shown in Table 19.

1) Calculate the fuzzy score of three-level indicators

Due to space constraints, the process of calculating the fuzzy scores of the three-level indicators of the intensity of the disaster factor (C1) is taken as an example:

$$S_{C1} = (0.2405, 0.3716, 0.1886, 0.1479, 0.0514) * (95, 85, 70, 50, 20) = 76.06$$

The fuzzy scores of the remaining 22 tertiary indicators are the same and will not be repeated here.

2) Calculate the fuzzy score of secondary indicators

According to the evaluation index system, the subordinate tertiary index affiliation matrix of the secondary indicators is as follows:

$$B_1 = \begin{pmatrix} 0.2405 & 0.3716 & 0.1886 & 0.1479 & 0.0514 \\ 0.204 & 0.2457 & 0.1355 & 0.1781 & 0.2367 \\ 0.2639 & 0.2797 & 0.1723 & 0.1002 & 0.1839 \end{pmatrix}$$

$$B_2 = \begin{pmatrix} 0.2089 & 0.2101 & 0.1657 & 0.1805 & 0.2348 \\ 0.2304 & 0.2119 & 0.1336 & 0.1843 & 0.2398 \end{pmatrix}$$

......

$$B_{15} = \begin{pmatrix} 0.2385 & 0.3143 & 0.1975 & 0.1783 & 0.0714 \\ 0.2763 & 0.3795 & 0.1419 & 0.1007 & 0.1016 \end{pmatrix}$$

The affiliation matrix and weights (single-level ranking weights, also known as relative weights) of the 14 secondary indicators were multiplied to obtain the affiliation vector K for each of the 14 secondary indicators:

$$K_{B1} = \begin{pmatrix} 0.2234 & 0.2648 & 0.1498 & 0.1542 & 0.2070 \end{pmatrix}$$

$$K_{B2} = \begin{pmatrix} 0.2140 & 0.2105 & 0.1581 & 0.1814 & 0.2360 \end{pmatrix}$$

......

$$K_{B15} = \begin{pmatrix} 0.2565 & 0.3453 & 0.1711 & 0.1414 & 0.0858 \end{pmatrix}$$

The fuzzy scores of the 14 secondary indicators can be obtained by multiplying the affiliation vectors of the 14 secondary indicators with the set of rubrics, where the physical attributes (B1) are simply taken as an example:

$$\begin{aligned} S_{B1} &= \begin{pmatrix} 0.2234 & 0.2648 & 0.1498 & 0.1542 & 0.2070 \end{pmatrix} * \begin{pmatrix} 95 & 85 & 70 & 50 & 20 \end{pmatrix}^T \\ &= 21.22 + 22.51 + 10.48 + 7.71 + 4.16 \\ &= 66.08 \end{aligned}$$

3) Calculate the fuzzy score of the first-level indicators

According to the evaluation index system, the subordinate second-level index affiliation matrix of the first-level index is as follows:

$$A_1 = \begin{pmatrix} 0.2234 & 0.2648 & 0.1498 & 0.1542 & 0.2078 \\ 0.2140 & 0.2105 & 0.1581 & 0.1814 & 0.2360 \end{pmatrix}$$

$$A_2 = \begin{pmatrix} 0.2452 & 0.2862 & 0.1987 & 0.1293 & 0.1406 \\ 0.2080 & 0.2688 & 0.1306 & 0.1252 & 0.2675 \\ 0.2529 & 0.3102 & 0.1812 & 01820 & 0.0737 \end{pmatrix}$$

$$A_3 = \begin{pmatrix} 0.2599 & 0.3797 & 0.1961 & 0.1474 & 0.0269 \\ 0.2256 & 0.3124 & 0.1927 & 0.1278 & 0.1415 \\ 0.2976 & 0.2051 & 0.1667 & 0.1382 & 0.1924 \\ 0.2719 & 0.2707 & 0.1519 & 0.1523 & 0.1523 \\ 0.2159 & 0.2397 & 0.1818 & 0.1834 & 0.1792 \end{pmatrix}$$

$$A_4 = \begin{pmatrix} 0.2159 & 02397 & 0.1818 & 0.1834 & 0.1792 \\ 0.2492 & 0.3480 & 0.1643 & 0.1244 & 0.1152 \\ 0.2348 & 0.2889 & 0.1389 & 0.1136 & 0.2238 \\ 0.2565 & 0.3453 & 0.1711 & 0.1414 & 0.0858 \end{pmatrix}$$

The affiliation vector of the level 1 indicators is obtained by multiplying the affiliation matrix of the 4 level 1 indicators and the weight matrix:

$$K_A = W_A^T * A = \begin{pmatrix} 0.2195 & 0.3385 & 0.1444 & 0.1264 & 0.1713 \end{pmatrix}$$

The fuzzy scores for the four secondary indicators are obtained by multiplying the affiliation vectors of the four primary indicators with the set of rubrics:

$$S_A = \begin{pmatrix} 0.2195 & 0.3385 & 0.1444 & 0.1264 & 0.1713 \end{pmatrix} * \begin{pmatrix} 95 & 85 & 70 & 50 & 20 \end{pmatrix}^T = 69.48$$

The result of the natural disaster public opinion risk assessment based on fuzzy theory is 69.48, and based on the principle that the first-level indicator affiliation matrix $S_A = \begin{pmatrix} 0.2195 & 0.3385 & 0.1444 & 0.1264 & 0.1713 \end{pmatrix}$ obeys the principle of maximum affiliation, it is summarized that the natural disaster public opinion risk of the province is at the level of Ⅳ.

Table 19. Evaluation index membership

Primary index	Secondary index	Three-level index	V	IV	III	II	I
A1	B1	C1	0.2405	0.3716	0.1886	0.1479	0.0514
		C2	0.204	0.2457	0.1355	0.1781	0.2367
		C3	0.2639	0.2797	0.1723	0.1002	0.1839
	B2	C4	0.2089	0.2101	0.1657	0.1805	0.2348
		C5	0.2304	0.2119	0.1336	0.1843	0.2398
A2	B4	C10	0.2452	0.2862	0.1987	0.1293	0.1406
	B5	C11	0.2094	0.2789	0.1306	0.1217	0.2594
		C12	0.2051	0.2476	0.1305	0.1324	0.2844
	B6	C15	0.2529	0.3102	0.1812	0.182	0.0737
A3	B7	C16	0.2599	0.3797	0.1861	0.1474	0.0269
	B8	C19	0.2256	0.3124	0.1927	0.1278	0.1415
	B9	C24	0.2976	0.2051	0.1667	0.1382	0.1924
	B10	C25	0.2771	0.251	0.1711	0.1635	0.1373
		C28	0.2679	0.2859	0.1372	0.1436	0.1654
	B11	C33	0.2386	0.203	0.1721	0.1347	0.2516
		C34	0.2131	0.3932	0.1775	0.1723	0.0439
A4	B12	C36	0.2159	0.2397	0.1818	0.1834	0.1792
	B13	C39	0.2656	0.3538	0.1538	0.1065	0.1203
		C41	0.2043	0.3333	0.1906	0.1696	0.1022
	B14	C44	0.2559	0.24	0.1525	0.1058	0.2458
		C45	0.2172	0.3295	0.1276	0.1201	0.2056
	B15	C48	0.2385	0.3143	0.1975	0.1783	0.0714
		C49	0.2763	0.3795	0.1419	0.1007	0.1016

5. Conclusions and Strategies

5.1. Conclusion

This paper determines the evaluation index system with the help of fuzzy theory and hierarchical analysis algorithm, and proposes the management method through the natural disaster public opinion risk assessment with a certain province as the research subject.

1) A comprehensive and non-redundant public opinion risk assessment index system is finally established through layer-by-layer derivation and analysis.

2) The fuzzy scores of the third-level and second-level indicators in the study area are 76.06 and 66.08, respectively, and the fuzzy score of the first-level indicator is finally calculated, with a value of 69.48. Based on the fact that the affiliation matrix of the first-level indicator $S_A = \begin{pmatrix} 0.2195 & 0.3385 & 0.1444 & 0.1264 & 0.1713 \end{pmatrix}$ obeys the principle of the maximum degree of affiliation, it is inferred that the natural disaster public opinion risk in the province is at a level of IV, and in order to improve the government's management of the risk of natural disaster public opinion, a series of The management strategies are proposed to improve the government's management level of natural disaster public opinion risk.

5.2. Strategies

The public is often at a loss in the face of major natural disasters, and if the government fails to manage online public opinion in a timely manner, rumors and panic are more likely to emerge, which will not only have an impact on rescue and relief work, but also make it difficult to maintain social stability. To do a good job of managing the risk of online public opinion on major natural disasters, the government needs to start with four aspects: disaster elements, information characteristics, media dissemination, and audience tendency. When a natural disaster occurs, the government should understand audience tendency in time in order to form the correct media communication value according to the disaster elements and information characteristics, respond to the needs of the audience in time, strengthen the audience's knowledge of the disaster elements of the natural disaster, and guide the audience's attention in a set direction by combining the disaster elements, information characteristics, media communication, and audience tendency. Grasp the initial time of the event, intervene early in the development of online public opinion, and do a good job of setting the agenda for public opinion, so that the government's opinion can be mainstreamed and the dominance of online public opinion can be grasped. After the end of a major natural disaster, there should also be continuous tracking and observation of online public opinion. Only by using the Internet as a window for understanding public opinion and helping the public to solve important and difficult problems can we cope well with online public opinion in a major natural disaster, so as to comprehensively strengthen the level of governmental governance and make the risk management system of natural disaster public opinion more perfect.

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