Water Disaster Risk Perception and Behavior Strategy Analysis Based on the Neurology of Consciousness

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ABSTRACT

At present, our country is in a period of high incidence of emergencies. Various types of disasters cause heavy casualties and huge economic, and expose the victims to extreme psychological shadows, bringing great emergency relief and management work. With the further development of economy and society, it is necessary to strengthen preventive measures against various risks. In this study, field research on individuals to understand the risk of flood risk perception is conducive to government departments, which helps to grasp people's perception of water risk and correctness, and can help government departments to develop relevant disaster risk prevention. In this paper, firstly, the research status of disaster risk and disaster risk perception has systematically expounded. Based on the theory of disaster risk perception, the concept and the characteristics of disaster risk have deeply discussed by combining the Electroencephalography (EEG) technology of consciousness neurology. This paper systematically analyzes the public perception of disasters, the possibility of disasters, the impact of disasters, the degree of disaster control, and the degree of disasters accepted. Using EEG and other statistical software, a structural model of disaster risk perception is obtained, which further explains the differences in perceptions of different individuals on disaster risks and thus summarizes the influencing factors of people's perception.

Key Words: Water Disaster Risk Perception, Behavior Strategy Analysis, Neurology of Consciousness

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Introduction

Since the twenty-first century, various disasters and accidents constantly warn us that risks are everywhere, and a new social form characterized by risks is coming. With vast territory and rich and diverse climate types, China ranges from the tropical, subtropical, and temperate zones, and has greater differences in climate, topography, and geology. China's precipitation distribution is very uneven, declining roughly from the southeast coast to the northwest inland. Most parts of China are controlled by the subtropical high. Like Western Asia and other countries with wide deserts, China has sparse rainfall and a hot, dry climate. Due to the special terrain advantage, China is located between Asia-Europe continent and Pacific Ocean, the world ocean, and with the influence of Qinghai-Tibet plateau, the monsoon climate is prevailing in China, rain and heat is in the same period and the rainfall is abundant, which forms the "land of fish and rice" in the south of the Yangtze River, which is in contrast with regions and countries of the same latitude in the world. Although China has this kind of climate superiority, because 50% - 90% of precipitation concentrates in May-September, and with greater

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rainfall intensity, in case of the climate abnormality, it's more easily subject to uneven drought and flood. The harm of flood disaster is especially big, and directly endangers the people's life and property safety. Mountain torrents and debris flow caused by torrential rain are sudden and strong so that usually there is no time for people to avoid, serious losses will take place once they occur, and after flooding, it's often easy to cause epidemic diseases. The occurrence of flood disaster leads to the chaos of social normal order and seriously threatens the safety of human life and property, which brings great challenges to the government emergency management and puts forward higher requirements for the study of emergency management of disaster events (Abrutyn and Mueller, 2016; Lucia *et al.*, 2016; Van Ness and Summers-Effler, 2016; Yang *et al.*, 2015; Zhi and Min, 2015). Risk refers to potential uncertainties of various disasters that may cause major casualties, property losses, ecological environment damage or serious social hazards to the society. Because the climate environment, population factor, system policy, custom, belief and geographical factor of each region are established, the risk of flood disaster has fuzzy quantitative criterion. In order to strengthen people's awareness of disaster prevention and establish a sound disaster risk management system, it is necessary to carry out actual investigation and analysis on individual and group residents' awareness of disaster risk.

With the enhancement of human cognition of flood disaster and ability of dealing with flood disaster and disaster prevention, modern concept of disaster mitigation has been raised to "mitigating the risk of flood disaster." Therefore, the international disaster research field pays more attention to study the disaster risk perception and prevention. In 2007, the International Conference on Disaster Reduction decided to strengthen disaster risk perception research in the field of future disaster research. The content of flood disaster risk perception research is through what kind of channels the public know the knowledge and information about disaster and disaster risk, and the attitude, choice and behavior that the public adopt to avoid disaster or reduce disaster loss according to the existing knowledge (Sorj, 2014). The public is the direct objects of flood disaster, also the participants of flood disaster policy making and the executors of disaster prevention and mitigation. Therefore, the public's understanding of flood disaster risk and the mastery of disaster mitigation measures directly affect their perception of flood disaster and the correctness of response measures. The research in recent years also shows that there are great differences in the adaptation and coping ability of different populations to disasters or environment. The reason behind this phenomenon lies in that there is a great difference in individual perception of sudden flood disaster events or environmental changes, which directly affects them to adopt different attitudes, and psychological and behavioral ways to cope with. Therefore, a thorough understanding of the public perception of disasters, ways of perception, and overall level of perception is a basic research to help the public understand, prevent and deal with disasters.

The improvement of flood risk decision-making and management system must be based on solid research. From the perspectives of sociology and management science, this research adopts the relevant theories and research methods of Electroencephalography (EEG) consciousness neurology, comprehensively considers the practice demands of the current society, and deeply explores the features of flood disaster risk management. According to the limitation and blank point of the researches on flood disaster risk management in the past, and tries to deal with the existing risk based on the empirical analysis, the investigation data, this research focuses on the public perception of disaster risk from the perspective of empirical analysis, then puts forward the countermeasures and strategies against the shortcomings of existing risk management, and tries to explore and try actively in practice.

The Related Concepts and Theoretical Overview

Risk perception

The concept of "risk perception" is the core part of the study of risk perception and cognition under the background of risk society (Dando, 2015; Sun *et al.*, 2017; Du *et al.*, 2017). Risk perception is a concept used to describe or evaluate people's attitudes, subjective judgments and responses to objective risks. Risk perception is a subjective evaluation, an intuitive judgment based on the characteristics and consequences of the risks of specific events, and an important factor to measure the degree of public psychological panic (Watson, 2017; Song *et al.*, 2016). Cognitive process mainly includes three stages such as acquisition of intuition, cognitive processing, and thinking and application. That is to say, the individual obtains the intuition feeling to the event through the environment or its own factors, gets the relevant experience through the environment stimulation, the information feedback and the adjustment, selects and condenses the experience information into the own inherent thinking, and gives the subjective judgment to the event risk to directly guide the individual to adopt the attitudes and the response behaviors such as evasion, change, or acceptance when the risk event occurs. There are many factors influencing individual risk perception, such as individual characteristics, degree of trust, experience and risk experience, nature of risk, and knowledge structure (Funder, 2014; Montolio, 2015; Du *et al*., 2018). In analyzing the influence factors of disaster risk perception difference, this research mainly focuses on such major factors as individual factors, risk communication, the nature of risk and knowledge structure.

EEG signals

EEG is an integral reflection of the electrophysiological activity of nerve cells in the brain on the surface of the cerebral cortex or scalp. Clinical practice shows that EEG contains a large number of physiological and disease information, and provides the basis for clinical diagnosis for doctors but also effective treatment for some brain diseases (such as epilepsy, brain tumors, and mental state treatment). It is widely used in clinical diagnosis of brain diseases such as epilepsy, clinical examination, EEG or poisoning, less attention, alcohol, drug dependence, brain trauma, insomnia, and sleep disorders as an important auxiliary mean (Atran, 2014; Gopal *et al*., 2018). In the engineering application, people try to use the brain signal-computer interface (BCI), and use the information extraction and analysis of electroencephalogram (EEG) characteristics with different sensory or cognitive activities of human brain signal motion to extract and classify effectively, which will play a certain role, but the practical application of these methods finally provide important resource for the development of high performance EEG signal processing and analysis instrument. Commonly referred to as electroencephalography (EEG) tests, it can observe electrical activity in the brain, by placing electrodes on the scalp according to certain rules. Electroencephalogram (EEG) is the whole reflex of the electrophysiological activity of the brain in the cerebral cortex or nerve cells on the surface of the scalp. EEG is the overall reflection of electrical physiological activity of brain cells in the cerebral cortex or scalp surface and EEG research has been a very difficult and attractive task of the biomedical field. Common Db3 EEG signal decomposition as shown in figure 1.

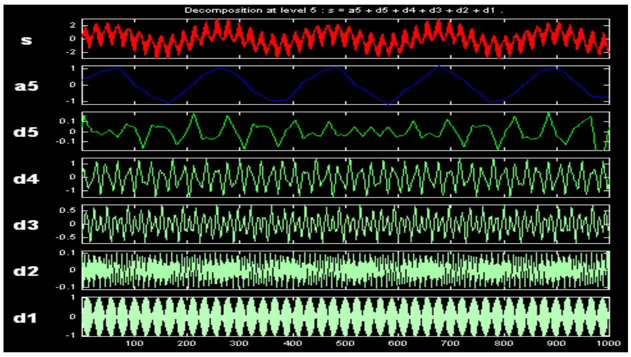

Figure 1. Common Db3 EEG signal decomposition

The Model Construction and Analysis

Sample selection

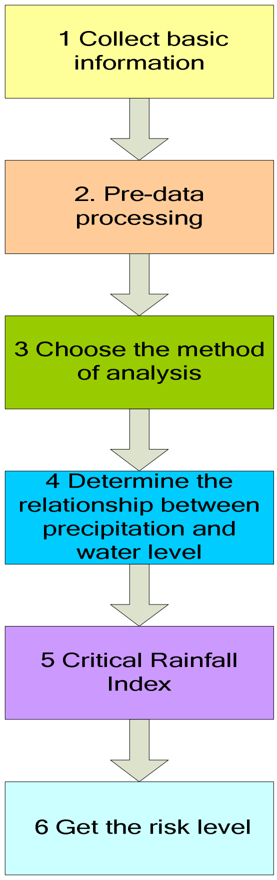

Figure 2. Flood risk level of Small River to determine the process

The rainstorm and flood in China are mainly distributed in the middle and lower reaches of the seven major rivers in the east monsoon region, where agriculture and industry are developed, population and cities are concentrated, flood can cause serious disaster, so it is the key area of flood control. There are different degrees of soil and water loss in the middle and upper reaches of the seven major rivers, which causes the downstream sediment deposition and the river channel blockage, which directly affect the flood discharge in the middle and lower reaches of China, so the seven major river basins are also the focus of soil erosion control in China. It can also be considered that flood control and prevention and control of soil erosion are the guarantee for the sustainable development of the seven rivers. Flood risk level of Small River to determine the process as shown in figure 2.

Step 1: Collect the basic data

Collect meteorological, hydrological, geographical, hidden danger points, disaster and other information according to the research needs.

Step 2: Prepare for pre-stage data processing

1) Carry out quality inspection and control of collected data;

2) Extract the basin boundary and determine the scope of the study area;

Determine basin rainfall algorithm and calculate the historical sequence of surface rainfall.

Step 3: Select the analysis methods

The methods to be adopted are determined according to the available data and methods. The main methods include statistical analysis method and hydrological model method.

Statistical analysis method: By analyzing the relationship between the flood hydrological characteristic quantity (rising water level) and the area rainfall and other related variables in the basin above the water station, a statistical model is established. According to the flood water level or flood water level rising quantity of historical flood and this statistical model, the critical rainfall of different flood grades (water level rising quantity) can be obtained. Or by establishing soil saturation and scatter diagram of surface rainfall, a critical line is determined in the map, on which there is a flood of a certain level and under which there is no flood of that level. The main statistical methods used include statistical regression, non-linear fitting, cluster analysis and so on.

Hydrological model method: Hydrological model takes watershed as a system to simulate the forming process of rainfall runoff on the watershed. The input of the system is rainfall and evaporation, and the output is the discharge process of the basin outlet section.

General principles for the selection of methods:

Before selecting the method, it is necessary to consider the integrity of the data. When the integrity of the data is higher, the hydrological model is recommended for critical surface rainfall analysis. In addition, it is necessary to analyze the characteristics of watershed, such as watershed area and confluence time. If the watershed area is larger, and confluence time is long, it's necessary to consider the effect of early precipitation and precipitation time, and dynamic critical rainfall index should be used to represent.

Step 4: Determine the relationship between rainfall and water level

After determining the analysis method, analysis and calculation are carried out according to different methods and steps to establish the relation between rainfall and water level, and conduct critical rainfall calculation.

1) General steps of statistical analysis method: The statistical method is determined based on the research area and the data condition → the data is sorted out according to the selected method → the quantitative relation between the hydrological characteristic quantity (water level, discharge, etc.) and the precipitation is established by using the historical flood process.

2) General steps of hydrological model method: Selection of hydrological model → preparation of input and validation data → calibration and validation model based on historical hydrological data → obtaining optimal model parameters suitable for the research area → hydrological model and flow-water level relationship based on the calibration → final determination of quantitative relationship between rainfall and water level.

Step 5: Determine the critical rainfall

According to historical disasters or flood control standards (warning, guaranteed water level and over-embankment height), the established rainfall-water level quantitative relationship is used to finally determine the critical rainfall of different grades.

Step 6: Verify the optimization

Through the practical service application, the rationality of the critical rainfall index is tested and evaluated, and the disaster-causing critical

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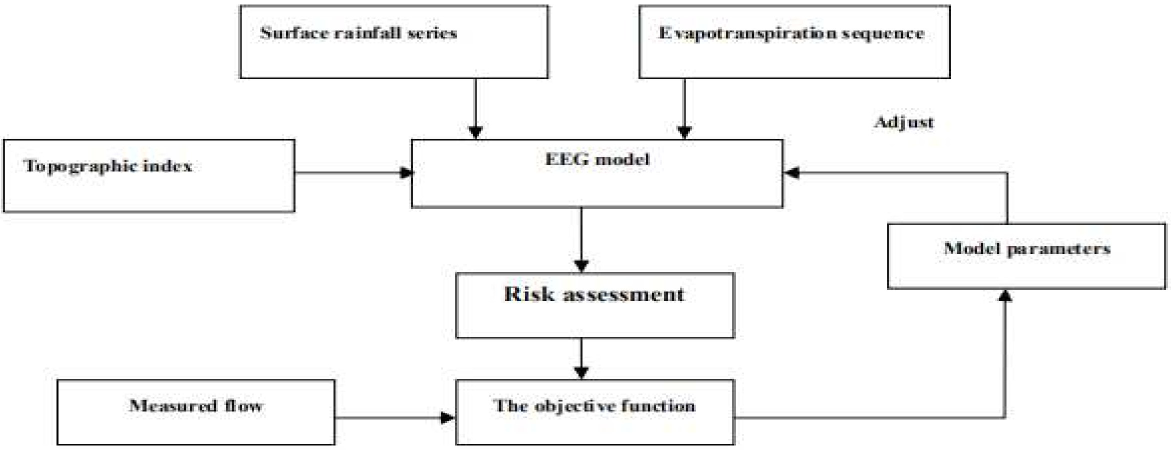

Figure 3. Awareness neural EEG hydrological model calculation flow chart

rainfall index is continuously optimized and perfected according to the test feedback.

Study on the application of EEG coherence

EEG has been widely used in the hydrological simulation of mountain torrents. The model can simulate the discharge of mountain torrents under certain surface rainfall. The model describes and explains the runoff trend and the movement of runoff along the slope under the action of gravity drainage by means of terrain index 1n(α/tanβ). In the model, the flows on the slope and the soil are calculated together, and the runoff is assumed to be equal in space, and the flow process at the outlet of the unit basin is calculated by the method of equal-flow time-line. Then the discharge process at the total outlet of the river basin is obtained by means of the channel confluence calculation, which adopts the constant wave velocity flood calculation method with the approximate motion wave.

The process of simulating watershed runoff by EEG is shown in Figure 3. Before the simulation, the hydrological module of GIS platform is used to divide the watershed boundary and calculate the watershed area, and then the model is used to extract the topographic exponential distribution, which is fixed for the determined watershed. In simulating the runoff, the flow sequence of the basin exit can be obtained by inputting the basin surface rainfall and evaporation time sequence into the EEG. Finally, the difference between the measured flow and the simulated flow is compared by using the objective function, and a set of model parameters conforming to the watershed is obtained by continuously optimizing the parameters. The result of EEG simulation is flow, and the amount directly related to mountain flood is water level, so the relationship between flow and water level must be obtained. When there are data on historical flow and water level, it is easy to find the relationship between them.

Evaluation of simulation results

The following objective functions are often used to evaluate verification and simulation results of hydrological model parameters.

(1) Deterministic coefficient (R):

$$R = 1 - \frac{\sum_{i=1}^{n}(Q_i - \hat{Q}_i)^2}{\sum_{i=1}^{n}(Q_i - \overline{Q}_i)^2} \tag{1}$$

where, Q_i and $\widehat{Q_1}$ are measured flow and simulated flow, respectively, $\widehat{Q_1}$ is the average measured flow in the corresponding period, and n is actual measured sample. The more R is close to 1, the better the simulation result is.

(2) Relative runoff depth error D_r

D_r is error of measured runoff depth and calculated runoff depth, the more it is close to 0, the higher the accuracy of the simulated runoff depth is. The calculation formula is as follows:

$$D_r = \frac{r_0 - r_e}{r_0} \times 100\% \tag{2}$$

where, r_0 is measured runoff depth and r_e is calculated runoff depth.

(3) Relative error of the flood peak D_q

The more D_q is close to 0, the better the simulation result of flood peak is:

$$D_q = \frac{Q_{f0} - Q_{fe}}{Q_{f0}} \times 100\% \quad (3)$$

where, Q_{f0} is measured flow of flood peak and Q_{fe} is simulated flow of flood peak.

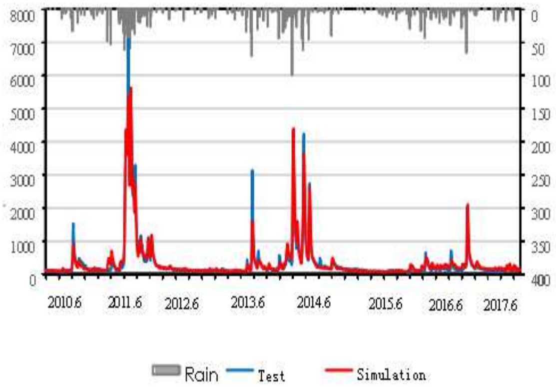

Figure 4. EEG model at Wangjiaba station calibration and verification results

Case analysis

In this study, the parameters of the EEG model are determined and verified by using the daily meteorological and hydrological data of the basin above Wangjiaba. Figure 4 shows that the deterministic coefficient of simulating the daily runoff depth of Wangjiaba station by the determined EEG model is more than 0.9, and the flood process can also be better captured. The results of the model simulation are consistent with the reality, and the daily runoff process of the basin above Wangjiaba can be well simulated.

The EEG model is based on the self-correlation characteristics of the river hydrological system, that is, the river hydrological characteristics are related to the last periods (especially the previous period), which requires that the relationship between the hydrological characteristics at t time and the hydrological characteristics before t time should be taken into account, and T is generally closely related to the confluence time of the watershed. In this study, the quantitative relationship between rainfall and water level in the study area is established by using EEG model and actual measurement. When the calculated river flood reaches the warning, guaranteed or embankment water level, it is deemed that the surface rainfall at this time is the critical (face) rainfall of the corresponding flood level. Since the rising water level of all previous flood processes of Wangjiaba is generally above 22 meters, and the water levels and rainfalls different from the previous period are substituted into the model by using 22 meters as the starting water level. Based on the critical conditions of 27.5 meters of warning water level, 29.3 meters of guaranteed water level and 30.4 meters of embankment elevation at Wangjiaba Station, the corresponding critical rainfall values at various levels under water levels different from previous periods can be obtained respectively (Figure 5). Since the original flow-water level relationship is no longer applicable when the river is overtopping, the critical rainfall value calculated by EEG is not given. Here, we give the results of a threshold analysis of rainfall with a time effect of 24 hours, in which the smaller value of the two methods is taken as the threshold value, the results as shown in table 1. It should be noted that the rainfall value here refers to the surface rainfall in the basin above Wangjiaba.

Figure 5 shows the rainfall at the boundary surface - the statistical relation curve of the previous water level, and the corresponding risk level identification can be drawn.

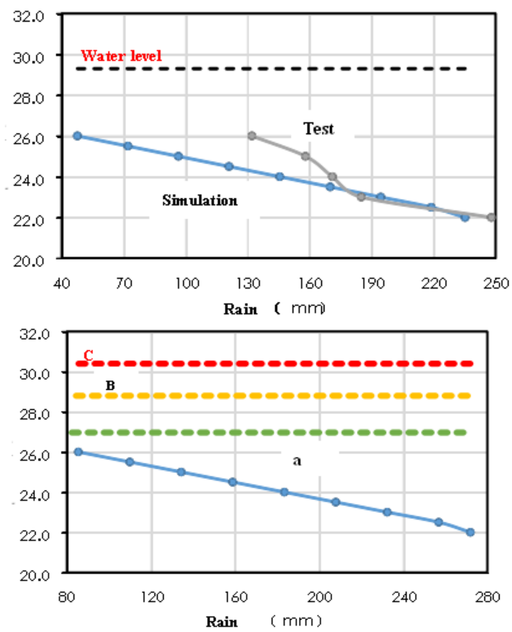

Figure 5. Different levels of floods above Wangjiaba (a warning; b assurance; c embankment)

Table 1. Risk Identification and Rain Gauges

Pre-water level value (m)	24 hours Critical (surface) Rainfall (mm)		
The first day	III	II	I
22	146	235	271
23	89	185	232
24	72	145	183
25	35	96	134
26	15	47	85

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Conclusions

In recent years, the research on the risk perception of flood disaster has become a research hotspot in the field of water logging disaster emergency. Especially in the field of natural disaster research, many domestic scholars have made fruitful research results and provided some theoretical basis for the emergency rescue of natural disasters. Judging from the current domestic scholars' research, individual, and group behaviors generally focus on water logging disasters, and lack of further division of disasters. In the study of disaster risk prevention and disaster incident handling, there is usually no systematic connection and in-depth analysis of individual risk perception. Based on the EEG risk perception in the event of water logging disasters, this paper further enriches the research on disaster risk perception and provides reference for enhancing the risk perception of floods emergency management of disaster events. In this paper, water logging disaster under the disaster risk as the research object, by risk perception of the theoretical research results, in-depth study of individual risk perception factors and behavioral characteristics and behavior. The research contents include the aspects of risk perception theory, field investigation of water logging risk perception, influencing factors of water logging risk perception bias and so on.

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