

Review Study on the Risk Assessment of Debris Flow

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Abstract. Debris flow is a common geological disaster, with the characteristics of outbreak suddenly, ferocious, quickly, which is a serious threat to the mountainous area traffic, water conservancy and hydropower, mining and other engineering facilities and life property safety of local residents. The debris flow disaster research mainly concentrated in the debris flow disaster risk assessment, and there is less research on vulnerability assessment of hazard-affected bodies, so it is need to make a further study on debris flow vulnerability evaluation and the risk assessment of debris flow, which will be helpful for the forecast of debris flow disaster, and early warning and prevention work.

1. Introduction

Debris flow is a common geological hazard in mountainous areas. It is caused by precipitation(including rainstorms, glaciers, melting snow, etc.) in mountain valleys or hillsides, and carries a special flood of solid materials such as sand and rocks during the movement(as shown in Fig.1).The debris flow has the characteristics of sudden outbreak, fierce coming and rapid development. It often has multiple effects of collapse, landslide and flood damage, and it has great destructive force. It seriously threatens the safety of traffic, water conservancy and hydropower, mines and other engineering facilities and the safety of the lives and property of the local residents^[1].Fig.2 is the road that was destroyed by the Zhao Tong Debris flow in Yunnan province. Debris flow areas are widely distributed in the world in recent years, causing thousands of people were missed. China is a mountainous country, influenced by tectonic mineralization, its steep and loose debris is abundant, the forest coverage rate is low, heavy rain weather, often occur serious debris flow disaster. Debris flow hazards are very serious in Tianshan Mountain, Kunlun Mountain, Taihang Mountain, Changbai Mountain and other mountain areas ^[2].



Fig. 1 Debris flow picture



Fig. 2 Road destruction by debris flow



2. Study on risk assessment of debris flow

Debris flow hazard assessment is the premise of risk assessment of debris flow^[3]. In a foreign country, the study of debris flow risk stems from the 19th century, when the Russian B.H. Stark Kiril Kotev involved the problem of debris flow risk in design through the Caucasus mountains of Georgia military road^[4]. In 1977, the Japanese scholar Po-liang-chi etc. made the first probability calculation of the risk of debris flow from the three aspects of geomorphological conditions, morphology and rainfall of the debris flow^[5]. In 1980, M.T. Eldeen of Sweden merged the model of flood risk calculation, classifying the size and type of debris flow^[6]. In 1981, Hollingsworth and Kovacs adopted the scoring method to construct the basic framework of risk assessment of debris flow, and implemented the evaluation of risk degree with factor superposition method^[7]. In 1984, professor Hansen of the Royal College of University of London put forward four important contents about the risk assessment of debris flow^[8]. At home, in 1982, Wang Lixian firstly proposed the classification of the risk of debris flow^[9]. In 1986, Tan Bingyan comprehensively evaluated the severity of debris flow^[10]. In 1988, Liu Xilin made a qualitative analysis and quantitative analysis of the risk of debris flow, and established a multi-factor comprehensive evaluation model based on the eight indexes of debris flow^[11]. In 1990s, the normative research of debris flow has also been carried out throughout the country. At the same time, more scholars have introduced mathematical methods to the study of the risk assessment of debris flow in China, making the classification of debris flow more reasonable and more objective^[12-21]. With the development of computer technology, GIS technology is gradually introduced into the risk assessment of debris flow^[22-26].

3. Study on vulnerability assessment of debris flow

The vulnerability of debris flow refers to the maximum extent of damage to human society and geological environment after the occurrence of potential debris flow, and the social attribute of the debris flow. In 1976, Westage and O'eefe first recognized the importance of vulnerability^[27]. Panizza interpreted vulnerability as "the total value of all people and things in a given region as a result of natural disasters"^[28]. While some scholars defined vulnerability in certain areas and within a given period of time, due to the debris flow disaster existing in the region may result in the potential maximum loss of all people, goods and moneys^[29,30]. Published in 1992, the UN's vulnerability is defined as: "potential damage phenomenon may cause the loss of degree", and its form of expression has carried on the quantitative definition, namely the vulnerability of the values range between 0 ~ 1^[31], this definition is now gradually to the international institutions and the vast majority of scholars. After the analysis and evaluation of social vulnerability in 1996 by Jiang tong, a scholar of disaster in China, the study of vulnerability has received extensive attention and achieved fruitful results^[32]. Liu Xilin on the basis of predecessors, according to the characteristics of the debris flow disaster vulnerability is defined as: in certain areas and within a given period of time, due to the debris flow disaster existing in the region may result in the potential maximum loss of all people, goods and money^[33].

4. Study on the risk assessment of debris flow

Geological hazard risk includes the possibility of disaster occurrence, the degree of disaster (intensity) and the possible consequence. It is a function of disaster risk and vulnerability. Only natural disasters exist, and there are no disasters, which can only be called geological phenomena. And only the disaster body, no disaster, that is not the risk. There are only two situations where there is an intersection and there is a risk. Debris flow risk assessment, including the nature of the hazard risk attribute and social attribute of the two parts of vulnerability of hazard-affected bodies, it is in the disaster risk and vulnerability analysis and evaluation on the basis of further analysis of the research area of debris flow disaster probability and under different conditions of debris flow disaster harm may cause^[34]. America began in 1970 in California earthquakes, landslides and other 10 kinds of natural disaster risk assessment, it is concluded that 1970-2000, California ten kinds of natural disasters may cause a loss of \$55 billion^[35]. Harvard University professor Wilson, in 1987, published in

science, the risk assessment on the article^[36], described the essence of the risk of uncertainty, defined as the expected value, or contains probability forecast. Liu Xilin, Tang Chuan et al. on the debris flow gully mud and area, this paper explores the debris flow risk degree evaluation model is put forward and the debris flow risk zoning method, and to improve the model continuously perfect^[37-39]. In 2002, Tang Chuan et al. used GIS technology to evaluate the risk of debris flow in Yunnan province, and divided it into four levels: high, middle, low and breeze^[40]. In 2006, Tang Chuan, Zhu Jing and other data sources based on the high-resolution "fast bird" satellite images in the United States evaluated the risk of debris flow in the town of Dongchuan in Kunming^[41]. In 2009, after the Wenchuan earthquake, Qian Yongbo studied the risk assessment method and system of the debris flow in the strong earthquake zone^[42]. In 2006, Ding Jixin et al. used the concept of "disaster entropy" to grade the risk of regional debris flow disasters^[43]. In 2012, Liu Xilin et al. proposed a comprehensive risk assessment combination model based on life risk value and ecological environmental risk value^[44]. In 2013, Xu Liming carried out a study on risk assessment and prevention of debris flow in the near dam area of the east German hydropower station based on the mutation theory^[45].

5. Conclusion

It can be found that the study of debris flow disaster mainly focuses on the risk assessment of debris flow disaster, less research on vulnerability assessment of disaster bearing body, and less risk assessment research on the basis of risk and vulnerability assessment. Therefore, it is necessary to further study the methods and contents of debris flow vulnerability assessment, and then study the risk of debris flow, so as to have certain guiding significance and reference value for debris flow disaster prediction, early warning and prevention and control work.

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