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Contents

A Review of the Present Research on Debris Flow Monitoring and Early Warning

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Abstract: Debris flow is due to the convergence of a lot of water, carries special flood mud formed in a short time. The debris flow mainly developed in four areas in our county, the south eastern of Tibetan Plateau, the Sichuan-Yunnan mountains, the Loess Plateau and the north and northeast mountains. Description of debris flow generated by the hazardous conditions and to further understand the importance of monitoring and early warning of debris flow. Combining the domestic and abroad over the years of monitoring and early warning of debris flow research experience, This paper reviewed and summarized the research of debris flow monitoring and early warning at home. And abroad so far through debris flow monitoring(solid materials, water condition and debris flow movement characters etc.) , debris flow critical rainfall model and debris flow early warning technology method etc. Then the problem of low early warning rate of debris flow available at present time is analyzed. And last the advances on questions need to be solved are posed. The further research trend of debris flow monitoring and early warning is given, that is to introduce the researched work so far and promote the development of disaster prevention.

Keywords: Debris flow; Monitoring; Earlywarning; Review

1. Introduction

With the continuous development of national mountain economy, the increasing frequency of human activities, making the world's mountainous areas of debris flow hazards continue to intensify. Due to debris flow occurs when carrying a lot of mud, stones and other solid matter, while its sudden, ferocious, fast, short duration and other characteristics, and its destructive beyond the collapse, landslides and floods caused by the destruction Sexual, and thus a serious threat to mountainous and piedmont area residents safety and construction. According to statistics, we are the number of deaths due to debris flow disasters each year in the forefront of the number of deaths and deaths of floods and droughts in the country, economic losses from millions of dollars to billions of dollars.

In recent years, there have been several major debris flow disasters in China, to the people's lives and property caused significant losses. For example: 2010 8 • 7 three large valley mud disaster, resulting in the number of victims of 1287 people, the number of missing 457 people; debris flow destroyed more than 5500 houses, buried more than 1,400 acres of land destroyed, Bridge a total of eight, the county half flooded, urban power communication water interruption [1]; 2010 8 • 13 Mianzhu City, Sichuan Province, Qingping Township Wenjiagou large debris flow disaster, the formation of up to 3500m wide 350 ~ 450m Debris flow accumulation fan, which washed out the sand blocks up to 400 × 104m3, which is the past 20 years has been recorded the largest debris flow disaster. The debris flow process caused a total of seven people were killed and seven missing. In particular, the debris flow accumulation of silt down the 3.5 km downstream of the Mianyang River, forcing the main river diversion from the left bank to the right bank of about 300m, resulting in a flood flood flooded Qingping Township town, the number of victims more than 6,000 people ; 2010 8 • 13 Wenchuan earthquake in the epicenter of the town of Yingxu town of Hongchun ditch also broke off a large-scale debris flow disaster, the out of the accumulation of the Minjiang River to form a barrier lake, due to debris flow accumulation fan strong pot , Forcing the Minjiang River flooded Yingxiu town of Yingxiu town was flooded flood floods, resulting in Yingxiu town of 13 people were killed 59 people were missing affected people, more than 8,000 formation conditions of debris flow and itspeople were forced to avoid the transfer [2]. Based on the serious dangers of debris flow, it is necessary to study the monitoring and early warning.

2. Debris Flow

Debris flow is a natural phenomenon that occurs in mountainous areas. It is due to a short time to bring together a lot of water, water carrying a lot of mud, stones and boulders and other solid substances, in the steep mountains or valleys formed in the special torrent. As the debris flow flow rate, carrying stones, boulders and other devastating, so the debris flow will destroy a large number of traffic routes and housing construction. China's debris flow is mainly distributed in the following four areas: (1) the northeastern Qinghai-Tibet Plateau debris flow area. The area is mainly due to the melting of the glaciers has brought a lot of water, thus forming a debris flow. Its main a large scale, frequent outbreaks and violent and other haracteristics. (2) Sichuan-Yunnan mountain debris flow area. The area is mainly due to a large number of rainfall makes debris flow frequent occur, and also affected by human activities. (3) Loess Plateau debris flow area. The area is mainly due to heavy rain to stimulate the occurrence of loess debris flow, the outbreak of the frequency and degree of damage are not more than two kinds of debris flow. (4) North China and northeast debris flow area. The debris flow in this area is mainly affected by heavy rain or typhoon rainfall and other factors, the frequency of the outbreak is lower, larger [3].

3. Debris Flow and its Harm

3.1. Conditions of debris flow

The main conditions of debris flow include abundant hydrodynamic, steep terrain, and abundant loose material. Among them, the debris flow occurred in the necessary conditions is to have plenty of hydrodynamic. And terrain and geological conditions are also important factors affecting the occurrence of debris flow. In addition, the production of debris flow and human production and life are also closely related.

Hydrological and meteorological conditions. The first condition for debris flow is abundant hydrodynamic. Water is an important component of debris flow and a major carrier for handling loose material. If in a short time, enough hydrodynamic handling of debris flow in the material, then the debris flow will not happen. And a large number of water mainly from the rainfall, glaciers or snow melting, alpine lakes and reservoirs such as sudden dike and so on. Second, the level of temperature or temperature changes repeatedly, but also on the rock (soil) have a degree of weathering crushing effect.

Terrain conditions. Debris flow formation of space conditions mainly refers to the terrain of the form and slope. Debris flow usually occurs in areas with large terrain slope and large terrain cutting density, and the steep slope directly affects the distribution and aggregation of loose debris developed by debris flow. For the typical debris flow basin can be divided into three areas: the formation area, circulation area and accumulation area. Among them, the formation of the area for the three sides of the mountain, one side of the export of the scoop or funnel-like wide area. Slope is basically controlled between 30 ° and 60 °. The plants on the slope are sparse and the slopes are easily cut. According to the slope statistics of the debris flow in Yunnan Province, the debris flow is developed at an average slope of 25 ° ~ 50 °, especially the slope of <45 ° is easier to weather the accumulation of loose debris. When the slope of 25 ° ~ 45 ° slope of the residual dirt and the internal friction angle equal to the slope, the majority of such slope in the limit equi librium state. Second, the circulation area is mostly narrow and deep valley. The valley is steep, the slope is larger, and there are many steep and water. The debris flow accumulation area is generally located in the mountain or mountain basin edge, terrain and other areas. As such terrain open flat, so that the flow of debris flow greatly reduced, and finally stopped down to form a fan, cone or ribbon and other accumulation [4].

Geological conditions. As the debris flow occurs in the geological structure is complex, broken folds and other more developed, strong tectonic movement, seismic intensity and other areas, so the surface rock crushing, collapse, landslides and other adverse geological phenomena to provide a rich solid material. Second, those rocky structures that are prone to weathering, joint development, loose, and weak are also provided with sufficient debris.

Human activities. With the continuous development of social economy, human development and development of mountain areas has gradually increased. Because of the irrational exploitation and utilization of land, the destruction of the original structure and balance of the surface, resulting in the loss of soil and water, a large area of landslides, landslides and other undesirable phenomena. Second, the human in the mining, construction projects in a large number of slag, spoil pile, so as to the formation of debris flow provides a wealth of loose material, and further promote the production of debris flow [5], for example: Shenzhen Guangming New District Hengtai Yu Industrial Park The large debris flow / landslide is due to the huge amount of artificial accumulation of slag, the accumulation of steep slope, the formation of an unstable body, combined with the impact of the rain that day the morning, resulting in the accumulation of residual soil collapse [6], resulting in The occurrence of a large debris flow / landslide.

3.2. Debris flow hazards

Bridge, dams, houses, vehicles and some fixed equipment As the debris flow carrying a lot of mud, stones andothe-r solid substances, and its fluid has a certain degree of c- onsistency, speed and other characteristics, so that the d- ebris flow with inertia force, large transport capacity, d- estructive, poor sorting and other undesirable character- istics The According to the size of the debris flow, nature and damage to the object, etc., can be divided into the fo- llowing forms of debris flow hazards: (1) scouring. As the debris flow in the circulation area faster, so that the circulation area of the slope of the soil and gou of mud and so on to carry, while the hillside soil layer has also been erosion and thinning to form a sloping slope. And due to debris flow bank slope, river bed erosion, making the coastal facilities, transportation and water conservan- cy projects caused damage. (2) impact. As the debris flo- w carrying a large number of stones, and sometimes even boulders and other solid substances with great kinetic energy, so in the process of migration on the will cause serious impact. (3) blocked. Debris flow in the process of migration will appear to block their own flow or into the main river, the emergence of clogging dam and other issues, so that the upper reaches of the water level, drowned the river on both sides of the region. When the dam dam in the event of dam, it will form a larger scale debris flow, making the downstream at risk. (4) silt buried. When the debris flow into the gentle section, due to its flow rate slowed down or even stopped, carrying a large number of solid matter subsidence, so that the accumulation area occurred in the phenomenon of silt. When the accumulation of mud accumulated by the accumulation of alluvial fan, will form a navigable river rapids, hinder the navigation, and the main river to the other side, so that the other side of the erosion, serious slopes will occur when the phenomenon of instability [7]

4. Monitoring and Early Warning of Debris Flow

4.1. Research on monitoring content of debris flow

Debris flow monitoring is the first means of debris flow research. It is the basis of debris flow theory research, experimental research, mechanism analysis, physical process, mathematical simulation and early warning. The debris flow warning is based on the monitoring results, and the key issue that needs to be solved is (Where) What happens to the size of the debris flow? This involves the necessary conditions for the formation of debris flow (source and terrain conditions) in what combination to the outbreak of debris flow. Therefore, for the debris flow monitoring, the main content can be divided into the elements and transport scouring, etc.) monitoring, fluid characteristics (material composition and physical Chemical properties, etc.) monitoring [8]. In order to prevent debris flow disasters and minimize the threat to the lives and property of the masses, the Ministry of Land and Resources and the relevant disaster reduction departments have taken a number of debris flow monitoring measures to gradually improve the monitoring of debris flow.

Debris flow solid material source is the material basis of debris flow formation, should be its geological environment and solid material properties, type of spatial distribution, scale monitoring. Debris flow source area of solid material is mainly in the accumulation of trenches, mostly wide grading gravel, mud, sand, clay and so on. Among them, the majority of the source of debris flow from the collapse, landslide soil. Therefore, the monitoring of solid matter sources should focus on the spatialdistribution, accumulationvelocity and displacement of the accumulation area (unstable slope) in the debris flow basin, especially the slope of the provenance area, such as surface deformation monitoring and deep displacement monitoring. In addition to monitoring the distribution range, reserves, accumulation rate, displacement and movable thickness, it is also necessary to monitor the surface roughness of loose solids (loose soil, construction waste and other artificial slag) in the watershed. The physical properties of runoff conditions, such as loose soil moisture content, pore water pressure change process [9].

4.2. Meteorological and hydrological conditions (water source) monitoring

Water is both a necessary condition for the formation of debris flow and one of its main sources of power. The source of water in the debris flow source area is mainly composed of precipitation, surface runoff, ice and snow melt, collapse and groundwater. For the precipitation, the main monitoring of its rainfall, rainfall intensity and rainfall duration; the snow and water melt water to monitor the main amount of melting and diachronic; when the debris flow source area distribution of lakes, reservoirs, etc., should also assess its leakage, Dangerous. Among them, the debris flow caused by atmospheric precipitation is the most widely distributed. Therefore, for the precipitation, the main monitoring contents include watershed rainfall monitoring (self-rainfall gauge observation), meteorological rainfall monitoring and radar rainfall monitoring. ① point rainfall monitoring. For the small and medium-sized debris flow basin, a certain number of self-propelled rainfall meters are set up in the debris flow source area, and the rainfall process is are established. Contrast with the critical rainfall line, the release of early warning information. ② weather monitoring. According to the national and local weather stations and other published satellite cloud map to monitor the region's various weather systems, such as fronts, high-altitude slot, typhoon and other location, movement and changes, according to the cloud cloud weather forecast, early warning precipitation. ③ radar rainfall monitoring. According to the characteristics of the echo structure of electromagnetic radiation emitted by radar, the distribution and movement of rain clouds are detected, and the rainfall generation, distribution and rainfall movement and precipitation intensity in the next 24h and longer will be provided. Combined with the critical rainfall set by regional channel The amount of standard to determine the comprehensive release of debris flow warning information.

4.3. Debris flow movement characteristics and fluid characteristics monitoring

Debris flow movement characteristics monitoring, including debris flow outbreak time, duration, movement process, flow and flow rate, mud, flow surface width, climbing, the number of bursts, trenches vertical and horizontal slope changes, erosion and erosion changes and accumulation [10], through monitoring, can further calculate the depth of debris flow, sand or debris flow, off, solid total runoff, etc .; also need to monitor other dynamic elements. The characteristics of fluid characteristics include the structural characteristics (porosity, slurry microstructure, etc.) of debris flow composition (mineral composition, chemical composition, etc.) and its related physical and chemical properties (fluid bulk density, viscosity, etc.)

4.4. Early warning study on critical rainfall based ondebris flow hazard

As mentioned earlier, adequate water (mainly precipitation) is not only a necessary condition for debris flow formation, but also a determinant of debris flow excitation. Therefore, over the years, domestic and foreign researchers have sought to find the threshold / threshold for rainfall in a given area in order to monitor and monitor the risk of debris flow outbreaks.
eristics of the debris flow (such as the amount of rainfall, rainfall, rainfall intensity, rainfall duration, etc.) Rainfall, the establishment of debris flow warning model.The basic methods of these studies are mostly statistical analysis of a large number of historical debris flow and rainfall data.

4.5. Early warning research based on debris flow

Based on the early fault research of debris flow formation mechanism, the early warning index of different starting critical conditions is explored to determine the threshold of the index, and then the debris flow warning model and method are established. At present, the research is mainly based on the geotechnical point of view to establish the critical source of solid source and the results of the test based on the results of the debris flow prototype.
In addition, the debris flow disaster can also directly use the monitoring and early warning equipment issued early Threshold to warning) to sound / infrasound alarm (to capture the flash floods and debris flow frequency on the warning) and so placed in a specific basin, to reach the warning value (threshold) on the warning. The application of these technologies has been increasing at home and abroad, especially for watershed critical rainfall monitoring, such as the establishment of a telemetry intelligent rainfall gauge, debris flow infrasound alarm and camera equipment. flow is different. At present, the trend of further research is on the process of rainfall - soil seepage, Body strength in order to determine the critical value of rainfall from the debris flow formation mechanism. formation mechanism of debris flow. For different types and causes of debris flow, the rainfall caused by debris predicted. In fact, the rainfall is closely related to the debris flow Shape, type, scope of harm, etc. cannot be gauge (to reach the critical rainfall on the waters of the warning) water / mud level.

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