Researching the Relationships between the Environmental Change of Vegetation and the Activity of Debris Flows Based on Remote Sensing and GIS

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Abstract

Debris flow is a typical natural disaster, with a strong destruction role to human life and property and a great threat to the stability and harmony of human society. For researching the relationships between the environmental change of vegetation and the activity debris flows, this paper argues the main research should be the following, such as researching the impact of types change of vegetation cover on activity of debris flows, studying the impact of vegetation coverage change on the activity of debris flow, discussing time-space model of vegetation cover change impact on debris flow activity. The study of debris flow is the frontier crossing of multi-disciplinary. Application of advanced and mature techniques of RS and GIS for researching the relationships between vegetation cover change and the debris flow activity, it is high academic significance, important theoretical and social and economic significance.

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1. Introduction

In a variety of natural factors and human activities, environment of human survival and development constantly develops and evolve. In the development and evolution of environment, debris flow activity is the phenomenon of natural disasters a deterioration caused by environmental degradation, which is not conducive to human existence. Researching debris flows as an interdisciplinary, involving many other professional, such as geology, geomorphology, meteorology, hydrology, vegetation, soil conservation and engineering mechanics, research is extremely difficult, which can be said still being gradually developed.
Remote Sensing (RS) technology has the unique feature of the geological hazard survey. Debris flows in remote sensing images are clearly reflected. RS can easily and quickly obtain the topography, water and vegetation parameters in typical disaster. Sometimes it can also find the phenomenon that can not or difficult to find by the ground geological work, as well as the linkages between various phenomena, to solve some of the problem which can not solve by the conventional ground working. Geographical Information System (GIS) technology has powerful spatial analysis function, which can analyze the data extracted from RS, obtain the internal laws of these data, access the relevant information, and then provide scientific decision-making basis for the debris flow disaster prevention and mitigation.

Debris flow unexpected natural disasters occurred in mountain, its occurrence, development and evolution of mountain formation is closely relate, it is a specific phenomenon of sudden natural disasters caused by the mountain environmental degradation[1]. With the expansion of the human activities scope, the geological disasters are increasingly frequent, more and more serious degree of the harm. In China debris flow causes direct economic losses of 2 billion RMB, more than 100 casualties each year. It has a strong destructive effect, often to the roads, factories, residential, farmland, forests, etc., which has a great threat to the human life and property and the stability and harmony of human society. Therefore, prevention of geological disaster of debris flows, have become very concerned problem of all levels governments and the mountains masses.

2. Progress of Research

At present, the researching direction of debris flow is a lot, which studies the relationship between debris flow and vegetation is also an important direction. There are two main directions involving vegetation in the current research of debris flow. One direction is that the vegetation will be screened and discussed as a weighting factor by some scholars. The other direction is that the vegetation will as an important factor in studies.

2.1 The Vegetation Cover Factor in Debris Flow Hazard Assessment and Zoning

Vegetation as one of the weights to be selected in the many factors of debris flow hazard assessment and zoning, different scholars have different views. Some scholars would think vegetation as a risk weighting factor, but some scholars would exclude vegetation factors.

In China, Liu Xilin researches debris flow hazard assessment and zoning earlier, and the results are very prominent. In 1989, he firstly proposed the method of the regional debris flow risk assessment [2]. In 1995, he proposed the new method of regional debris flow risk assessment [3], and overcome the deficiencies of the earlier method, but the principles and index system is same as previous literature [2]. The method was improved in 2000 [4], and identified as the present method followed-up comparative study and application of practice [5]. In 2010, he researches the method of the debris flow risk zoning and its application [6]. In all these research results, vegetation was not as a risk factor to be discussed. Based on principles of rough set, Kuang Lehung selected indicators of debris flow hazard mapping. The vegetation index was simplified the forest coverage rate, and in the selected 9 weight, it is the last one [7]. Based on catastrophe theory, Yang Dongji studies the debris flow hazard zoning of Min County in the mountain, the weight order of the vegetation cover is 5 in the hazard index of 11 indicators [8]. Applying RS and GIS studying the the county regional debris flow risk zoning, Li Weile selected six risk indicators, without the risk factors of vegetation [9]. Based on fuzzy comprehensive evaluation method, Guo Wanming analyzes single debris flow risk of the Tao river basin in Minxian, and selected eight factors as the debris flow hazard evaluation factor. Where the weight of vegetation coverage is 0.125, ordering No.3, relative to other scholars, the study of vegetation cover in the risk of relatively heavy weight [10].
In summary, in the debris flow hazard assessment and zoning, whether the vegetation cover factor is the weight as a risk factor, different methods, different basins and different scholars has different result, and the weight order is different. Therefore, there is no inconclusive in the current academic about the vegetation cover affecting the debris flow activity.

2.2 Vegetation Cover Environment Impact on the Debris Flow Activity

Watershed earth surface, such as topography, geological rock structure, land use, water and vegetation factors, topography, geological structure of rock, is very important to the debris flow activities. Many domestic and foreign scholars have done a lot of work, also received a large number of achievement. There are many study of land surface vegetation cover impacting on the debris flow activity [11-13], but important research is very little.

Literature usually thinks that lush vegetation can inhibit, reduce debris flow activity and reduce the frequency of debris flow, or even eradicate the possibility of debris flow, eliminate debris flow activity [14-15]. Vegetation subjected to large-scale serious damage, such as cut, steep slope mountain deforestation and forest fires, can stimulate the outbreak of debris flow [16]. But in the great disasters of debris flow and landslide, there is another fact that a large scale debris flow occurred in many areas of high vegetation, causing serious harm, heavy casualties and damage to property. In Puge County, Sichuan province, forest vegetation was good, the forest coverage rate was 70% or more, but a large scale debris flow outbreak in 2003 [17]. In 2004, debris flow occurred in Yingjiang of Yunnan province, and result in 59 deaths and disappearance of 158.57 million RMB for property damage. Yingjiang has high natural vegetation cover, and vegetation cover almost 100%, but debris flow is still a serious outbreak [18]. Overseas, large-scale debris flow outbreaks in areas with high vegetation cover are also many instances. In 1999, at Avila Mountain in Venezuela, excited by heavy rainfall, debris flow outbreak at more than 20 groove [19], the vegetation coverage of the area is more than 90%, and the forest coverage rate is more than 75%, but good forest cover failed to prevent the occurrence of debris flow.

To the relationship between vegetation and debris flow activity, previous studies did the following work. Chen Xiaoqing discuss prevention and treatment of debris flow in the good vegetation area, and thinks that the impact of vegetation on debris flow includes the inhibition and promote to debris flows [20]. Applying remote sensing technology, Qiao Yanxiao researches environmental factors of debris flow development in northwest Hebei. That debris flow occurred in areas with poor vegetation cover accounted for 62. 1%, and that occurred in the middle of vegetation conditions is 24.5%, and that occurred in the area of vegetation in good condition is 13.4%[21]. The results show very clearly that the different vegetation condition influence on the debris flow is different, and the difference was tremendous. But the literature statics debris flow occurred in history by the statistical and present vegetation cover, which is not science. Debris flow happened in history, the correlation is not high with the land surface vegetation cover. The vegetation cover is changing in the timeline, especially in areas of human strong activities.

3. Problem

Debris flow activity should have an important relationship with vegetation type and coverage, but there are a number of problems at present research achievement.

The importance of vegetation impacting on debris flow activity is not conclusive. In the study of debris flow hazard assessment, in the process of determining risk assessment factors, whether vegetation factor can be selected, or the vegetation factor determined the weights, in the current literature, there is no unified view. Hence the relationship of vegetation and debris flow need to be studied, and clearly research the importance of vegetation impacting on debris flow activity.
Research methods are not enough scientific. Even the debris flows have been frequently happened in history, these occurred debris flow with the current vegetation type and vegetation cover is not high correlation. Many of the current literature analyze the debris flow occurred in the history with the present and static vegetation situation, which is not enough scientific research methods. So the relationship between debris flow activity and vegetation should be studied by more scientific method, which uses dynamic perspective to research the past events.

Research technique need to be updated. Many literatures also use these modern techniques, but are limited to static applications. Extracting the now vegetation of study area by remote sensing, and then analyzed the relationship between historical debris flow and vegetation with GIS. Remote sensing can provide the data at the same region and in different phases, so dynamics situation of vegetation can be got at the same area. In view of this, in the study of the relationship between vegetation and debris flow, vegetation species and coverage can be dynamically monitored by remote sensing, and analyze the relationship between debris flow activity and the vegetation types and cover of different time series in the GIS platform.

4. Strategy

Underlying surface is the main controlling environmental factors of debris flow nurture. The vegetation as an important part of the land surface factors should be closely related with the debris flow activities. The paper thinks that the following research should be done addressing these deficiencies and issues (Figure 1).

4.1 Studying the Type Change of Vegetation Cover Impacting on the Debris Flow Activity

As previously described in the literature, the relationship of vegetation and debris flow outbreak was generally studied from a qualitative point of view. For these vegetation types occupied area ratio in the study area, and the area ratio change during the intermittent of debris flow outbreak is not relative depth researched. In debris flow intermittent, the area ratio change of vegetation species impacting on the debris flow activity, the research work done relatively less. Because now the RS technology matures, the type of vegetation present accurate information and vegetation types at different phases of information will be extracted from the remote sensing image in study area. The proportion of all vegetation within each phase interval and ratio change of vegetation types were analyzed in the GIS platform. The change of vegetation type proportion was dynamically monitored of in the study area. Then the relationship between debris flow activity and the change were analyzed in GIS.

In summary, applying the RS and GIS technology carry out the research, this paper statistics the area proportion of vegetation types and the area ratio change of the vegetation types, and analyzes the change of vegetation cover types impacting on debris flow activity, and fined its internal law.

4.1 Studying the Vegetation Cover Change Impact on the Debris Flow Activity

As literature, studying the relationship between the vegetation coverage and debris flow activity stays studying the relationship between the history of debris flows and the present static vegetation coverage. During the intermittent of debris flow outbreak, the change of vegetation coverage is not enough deep to study. For the study of the vegetation coverage change impacting on the debris flow activity, there have done more less research work. RS technology can obtain the accurate information of vegetation coverage in study area. Different time remote sensing data can provide change information of vegetation cover in different times of the study area. Then, spatial distribution change of vegetation cover is analyzed in GIS.
platform, which realize the dynamic monitoring the changes of vegetation coverage. Finally, it analyzes the relationships between the change of vegetation coverage and the debris flow activity.

In view of this, applying the advanced technology of RS and GIS does the research work in the study area. The change of the vegetation coverage is counted in different time intervals in the study area. The impact of vegetation cover change on the debris flow activity is analyzed, and the internal law is summarized.

4.2 Studying the Time-Space Model of Vegetation Cover Change Impacting on Debris Flow Activity

In terms of the research progress, the importance of the vegetation cover change impact on debris flow activity is not be researched. The literature achievements do not reflect the dynamic concept of vegetation
cover change. Even if there is research of the vegetation coverage impact on the debris flow, nor a unified framework of the same time-space. Therefore, the temporal and spatial relationships between the vegetation cover change and debris flow activity need to strengthen research. The spatial and temporal distribution information of the area ratio changes in vegetation types, vegetation coverage change and the traces of debris flow can be extracted by remote sensing images at different phases, and the spatial and temporal relationship between vegetation cover change and debris flow activity can be researched by the powerful temporal and spatial analysis provided by GIS. This article analyzes the temporal and spatial relationship between the vegetation cover change and debris flow activity.

All in all, based on the relationship between the debris flow activity and respectively the change of vegetation cover types and vegetation coverage, the paper builds a space-time model of the vegetation cover change impact on the debris flow activity.

5. Conclusion

The RS and GIS technologies are advanced technology, and RS technology for extraction of the vegetation change information and the activities information of debris flow also have some very successful case, so this technical route is feasible and reliable. Since the debris flow activities are controlled and induced by many factors, and this article only researches the relationship between debris flow activities and the vegetation cover change, so it is possible to have some problems. The conclusions may not be a better approximation of the real situation, so the solution is to study in the same research area. The vegetation coverage is different in different months, which affect the result of changes in vegetation coverage extracted from remote sensing image. The solution is to try to choose the same image in month, or close to the same month, so the impact of the different natural coverage can be minimized.

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