Research Article
Researching the Relationship between Vegetation Cover Change and Debris Flow Activity Based on GIS and RS

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Abstract: To investigate the relationship between vegetation cover change and debris flow activity, we conducted an experiment in the Minjiang River from 2000 to 2008 year. Researching time was divided into 4 periods and image acquisition time as the division point. The vegetation index change rate of the vegetation cover and the frequency of debris flow activity were acquired respectively for the four periods. The inverse law was found that the frequency of debris flow activity and the change rate of the vegetation index. When vegetation cover increases, the frequency of debris flow activity reduces; when the vegetation index reduces, the frequency of debris flow activity increases.

Keywords: Debris flow, GIS, relationship, RS, vegetation cover

INTRODUCTION

Debris flow is the process of the material flow, which results from the inside and outside geological forces acting on the material of the earth surface or a certain depth of underground. Debris flow is vulnerable to a variety of impact of topography, geological structure, hydrology, climate, vegetation and human economic activity and other factors (Feng *et al*., 2009); Debris flow is a sudden natural disaster occurred in the mountains. Its occurrence, development are closely related with the process of mountain formation and evolution. It is a unique natural disaster phenomenon of the mountain environment degradation. The vegetation as an internal factor impacting the activity of debris flow, how the changes of vegetation cover impacts the debris flow activity and how high the degree of influence is, currently there is no conclusive in academic.

LITERATURE REVIEW

Liu (1989), Liu and Tang (1995) and Liu (2000) discussed the hazard assessment and zoning of debris flow in the earlier and the achievements are also very outstanding, but the outcome of these studies did not discuss the vegetation as the factor of affecting the debris flow activity. Fangqiang *et al*. (2008) studied the relationship between debris flow and the underlying surface factors in southwest of china, including relative height, fault density, layer and land use. The literature expounded the relationships of the factors of the underlying surface and debris flow activity in detail. However, the relationship between vegetation and debris flow activity always did not been summarized. Guo and Jiao (2010) Wanming analyzed the risk of debris flow based on the method of fuzzy comprehensive evaluation in Tao River valley of Minxian, which the vegetation cover as a factor of the debris flow risk assessment, the weight of vegetation coverage was 0.125 and the order was No. 3. Kuang *et al*. (2006) selected the indicators of debris flow risk zoning based on the method of rough set theory, which the vegetation indicators was simplified the forest vegetation coverage and the weight was the first order inverse in the nine indicators selected. The dense vegetation usually considered can inhibit, reduce debris flow activity and reduce the frequency of debris flow, or even eliminate the possibility of debris flow conformation, eliminate the debris flow activity. But in a major debris flow and landslide disasters, there is another fact that under heavy rain the massive debris flow occurs in many areas of high vegetation cover. The area of Xinping County, Yunnan Province is about 300 km^2. The vegetation coverage was more than 50%, but there occurred a century scale debris flows on 2002-08-14 (Chen *et al*., 2003). The forest vegetation is very good in Puge County of Sichuan Province, which the

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forest coverage rate is 70% or more and the main forest tree species are Yunnan pine, alpine oak and fir and also the channel covered shrubs and herbs, but a large-scale debris flows broke out under the excitation in heavy rain on 2003-06-20 (Liu *et al*., 2003). In summary, the relationship between vegetation and debris flow activity requires to be profoundly understood.

Vegetation as an important factor of underlying surface, how it affect the debris flow is very important. Minjiang River area with complex geological conditions, new structure movement strongly, earthquake actively, great topography, uneven distribution of rainfall, which is very favorable for the development of debris flow. And long-term irrational human economic activities such as over-harvesting of forests, deforestation, cultivation on steep slopes, unreasonable spoil and other damage to the environment caused the strong, exacerbated the occurrence of debris flow. Debris flow is widely distributed on the history of the region, which makes the Minjiang River has become one of the more serious area of debris flow activity. Study the relationship between the changes of vegetation cover upper reaches of Minjiang River and the debris flow activity is great significance.

DATA SOURCE AND DATA PROCESSING

Data source: Minjiang River is located in the transition zone of the hills and mountains to the Northwest Plateau in Sichuan, which is a mountain canyon area of the eastern edge of Qinghai-Tibet Plateau. It is located 30°45'-33°09'N, 102°35'-103°56'E, including all of the Songpan, Heishui, Li county and parts of Wenchuan, Maoxian county. The length of the river basin is 337 km and the area is about 22,000 km^2.

The remote sensing data collected is mainly Landsat TM/ETM data, which is across 3 scene of the TM/ETM data and orbit numbers are 130/37, 130/38, 130/39. The collection of TM/ETM data include five periods, which are March 30, 2000, April 5, 2002, March 9, 2004, April 19, 2007 and April 5, 2008. All TM/ETM remote sensing data Collected is 15 scene and period. The data mainly come from the website free data of the U.S. Geological Survey.

Major data of debris flow collected is the information of debris flow activity, which is the time, location, number of casualties, house damage, damage to farmland and other losses in the study area from 2000 to 2008 year. Data sources are mainly database records of mountain hazards in Chengdu Institute of Mountain Hazards and Environment, Chinese Academy of Sciences.

Data processing: Fifteen scene and period of remote sensing data were processed and the vegetation index
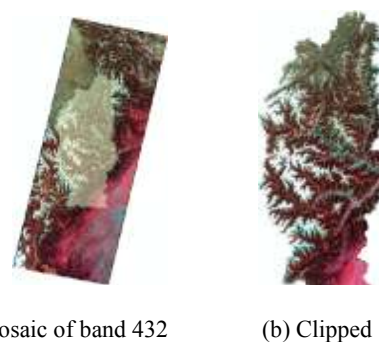

(a) Mosaic of band 432   (b) Clipped

Fig. 1: The remote sensing image of researching area

(a) 20000330   (b) 20020405   (c) 20040309
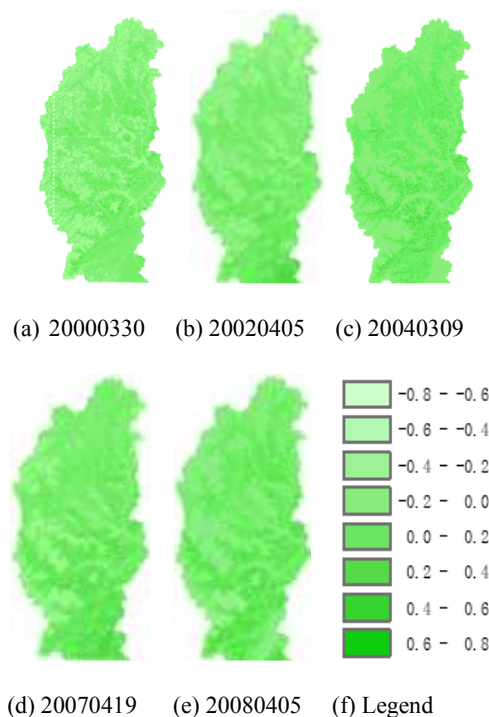

(d) 20070419   (e) 20080405   (f) Legend

Fig. 2: NDVI of researching area in different time

was extracted in this work, which included atmospheric correction, surface radiometric correction, geometric correction, mosaic, clipping, color composite and Normalized Vegetation Index (NDVI) extracted.

The data was lost because of the Scan Line Corrector (SLC) off in three periods of 2004, 2007, 2008. The repair work was done in this data processing.

The mosaic image of researching area and image clipped were shown in Fig. 1.

Normalized Difference Vegetation Index (NDVI) extracted: For the scope of the study area, the mosaic of remote sensing images were clipped, which mainly band 3 and 4 were clipped. The basin boundaries of the Minjiang River upstream were obtained from the DEM of research area which were used to clip the data. After the clipping, the Normalized Vegetation Index (NDVI) was extracted, as shown in the Fig. 2.

Table 1: Statistics of NDVI

Temporal	Pixels num.	Min.	Max.	Total	Mean	S.D.
20080405	26574424	-0.49	0.53	332512.13	0.012	0.13
20070419	26574424	-0.70	0.44	-2458327.81	-0.090	0.15
20040309	26574424	-0.65	0.67	401962.67	0.015	0.14
20020405	26574424	-0.63	0.44	-3443669.13	-0.120	0.15
20000330	26574424	-0.75	0.45	-4688860.56	-0.180	0.13

Min.: Minimum; Max.: Maximum; S.D.: Standard deviation

Table 2: The change rate and the normalization of NDVI

Temporal interval	Months	Change	Change rate (/M)	Normalization
20000330-20020405	24	0.060	0.0025	0.29
20020405-20040309	23	0.135	0.0059	0.69
20040309-20070419	37	-0.105	-0.0028	-1
20070419-20080405	12	0.102	0.0085	1

Table 3: Debris flow activities frequency and normalized

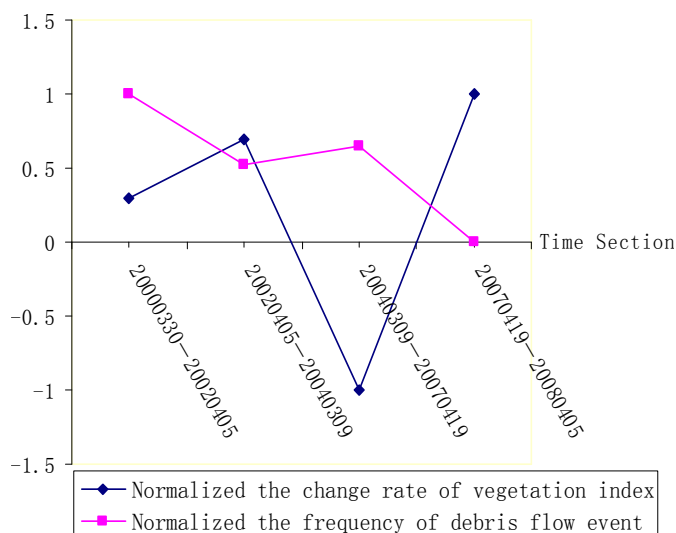| Temporal interval	Months	Debris flow	Frequency (/M)	Normalization
20000330-20020405	24	1	0.042	1
20020405-20040309	23	1	0.043	0.52
20040309-20070419	37	2	0.054	0.65
20070419-20080405	12	0	0	0

Fig. 3: The change law of vegetation index and frequency of debris flow event

METHODOLOGY

Statistical analysis of NDVI change rate: In this study, the NDVI extracted of 5 temporal remote sensing data were counted and analyzed, as shown in the following Table 1.

The average value as the vegetation index of each temporal remote sensing and the months of the temporal interval as the each data change interval, the change rate of the vegetation index was counted and normalized, as shown in the following Table 2.

Statistical analysis of debris flow activities frequency: The mountain disaster database records of the Chengdu institute of mountain hazards and environment of Chinese academy of sciences showed that the debris flow was total of 4 times in research area in March 30, 2000 to April 5, 2008. The temporal interval of remote sensing image as the statistical interval, the debris flow occurrence frequency was counted and normalized, as shown in the following Table 3.

Law of the debris flow activities and vegetation index change: The change rate of vegetation index and the frequency of debris flow activities were counted and analyzed in the study area, as shown the following Fig. 1. Shown as the diagram, debris flow frequency decreases with the vegetation index increase and the opposite is also established, as shown in Fig. 3.

CONCLUSION

Debris flow activities affected by vegetation coverage change, the debris flow activities decrease with the vegetation coverage increase and the debris

flow activities increase with the reduction of the vegetation cover. But this research has the following shortcomings, the experimental time span is not long enough and the results are whether stable, so the further research summary is need. And the temporal of remote sensing data not strictly uniformly on the same day, the change rate precision of the vegetation index requires further verification. The vegetation is one of many factors of affecting debris flow activities, the contribution of vegetation cover change on debris flow activity changes did not discuss.

ACKNOWLEDGMENT

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