Spot-5 Landslide Interpretation of Normalized Difference Vegetation Index (NDVI) Satellite Imagery

Chenyuan Chiu[1,*] , Fei Shen[1,a], Peisong Zhuang[1,b] , Xinlong Zhang[1,c], Shichao Chen[2,d] and Jialong Wen[1,e]

[1]Jiaying University, School of Civil Engineering, Meizhou, 514015, China

[2]Jiaoling County, Agriculture and Rural Affairs Bureau, Meizhou, 514100, China

*maachiu@163.com,[a]453915295@qq.com,[b]1501208556@qq.com, [c]2448778295@qq.com ,[d]jlxwnb@126.com,[e]W18320885227@163.com

Abstract. Landslides and avalanches are common geologic hazards and the most destructive natural disasters at home and abroad. Therefore, utilizing different models and methods to explain the extent of landslides and avalanches is one of the basic methods to prevent and reduce possible disasters. Remote sensing probing technique has become one of the indispensable techniques for the investigation of geological disasters in domestic and foreign regions. In this study, SPOT 5 satellite images of the study area were selected and the normalized vegetation index (NDVI) and MATLAB were used to calculate the difference and to classify the vegetation area and landslide exposure area.The size of the exposed landslide area can be quickly determined to facilitate stable tracking of large subsidence areas. Management and large-scale settlement notification can also be used as basic information for the research and application of large-scale landslides in sensitive geological hazards in mountainous areas.

The study found that from 2010 to 2011, the exposed ground area and destructive collapse area of landslides showed an increasing trend. The rapid response to monitoring collapse areas can be used as the basic area for investigating large-scale collapse areas in mountainous areas.

Keywords: Spot-5; Landslide; NDVI; Geological Disasters; MATLAB.

1 Introduction

Landslides are natural disasters that occur globally and trigger major destructive impacts, the effects of which include loss of life, property damage and economic upheaval [1,2].

Globally, slope displacements leading to landslides pose a risk to communities and their infrastructure. These processes are exacerbated by climate change due to unstable processes [3,4,5]. Adaptation, prediction, and monitoring strategies re-quire site-specific knowledge, which is essential for Landslide Early Warning Systems (LEWS) [6].

Among the existing methods for investigating landslides in alpine areas, field surveys and on-site experiments are the most accurate, but the measurement of large-scale

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landslides is time-consuming, costly, and labor-intensive, and prone to omissions. The use of aerial photographs has the advantage of a wide field of view, but the high cost and the large interval between images are not conducive to the immediate judgment of large-scale landslides, whereas satel-lite imagery has the advantage of providing information technology for the identification of geological materials and geological structures in the region in a short time. However, satellite imagery has the ability to obtain a wide range of information related to geological disasters in a short period of time, and it can provide the regional distribution of geological materials and geological structures, and it has a high acquisition frequency, which allows us to obtain multi-period imagery.

Remotely sensed data provide repetitive, non-intrusive, and non-hazardous remote information, which can then be processed to distinguish between stable and unsta-ble areas, and to derive seismic motions and directional vectors using tools such as Digital Image Correlation (DIC) on optical images [7] and Interferometric Synthet-ic Aperture Radar (InSAR) on radar images [8,9].

The use of remote sensing (RS) techniques for landslide hazard extraction and risk assessment has become an increasingly important research priority, not only in academia, but also at the national disaster prevention and planning level. In this study, we summarize European research on the use of remote sensing for landslide location extraction, monitoring analysis and early warning, which have improved the real-time data acquisition capabilities required for landslide hazard studies.

2 Study Sites

Satellite technology is not omnipotent, among the many remote sensing satellite image data, remote sensing satellite image has its inherent limitations, and many needs are even mutually exclusive and unavoidable; selecting the appropriate data among the limited resources in order to achieve the most efficient use. According to the topographic characteristics of the study area and the cost of acquiring satellite images, the French SPOT 5 multispectral image was selected as the method of landslide susceptibility and hazardous area extraction for landslide extent and geologic analysis.

SPOT series satellites are sun-synchronous satellites, with an average altitude of 832 km, an inclination of 98.77 degrees from the equator, a circumference of the Earth of about 101.4 minutes, 14.2 revolutions a day, and a passage through the same area every 26 days. The orbital trajectory of SPOT satellites is one day for a circumference of the Earth, and the maximum distance between two orbital trajectories adjacent to each other on the equator is 2,823.6 km, with 369 orbital trajectories in the world. 369 orbital paths. The maximum distance between two adjacent orbital paths at the equator is 2823.6 km, and there are 369 orbital paths globally [10].

Satellite image data is a Raster geographic information, which is stored as binary data and therefore cannot be viewed by general text editing software, but must be manipulated, processed, viewed, or converted by image processing software. In this study, two French SPOT 5 optical satellite images in 2010 and 2011 were analyzed using MATLAB to classify the NDVI indices of the vegetation area and the exposed landslide area in the preliminary algorithm.

In this study, the Landslide Prevention and Control Research Project of the School of Civil Engineering, Jiaying College, Meizhou City, Guangdong Province, China, applied to the Resource Satellite Receiving Station (RSSR) of the European Center for Remote Sensing Research (CERES) to provide SPOT-series orthophoto maps of the following areas (TM2 area): UL:2679991.034, 263292.953; UR:2679991.096, 272913.102 ; LR : 2668110.912, 272913.025 , LL :2668110.850,263292.876,; Latitude: 24.1639317, Longitude: 121.1803907; Sheet Area: Area: 113,516,000 square meters; Height: 11,800 meters, Width: 9,620 meters. The pixel pitch is 10 M and the sensor incidence angle is 7.730098.

Figure 1 shows the raw values of the satellite images for each year since 2010 and 2011, including the red band, the green band, and the near-infrared band; the red portion of the satellite images reflects the vegetation zones on the surface.

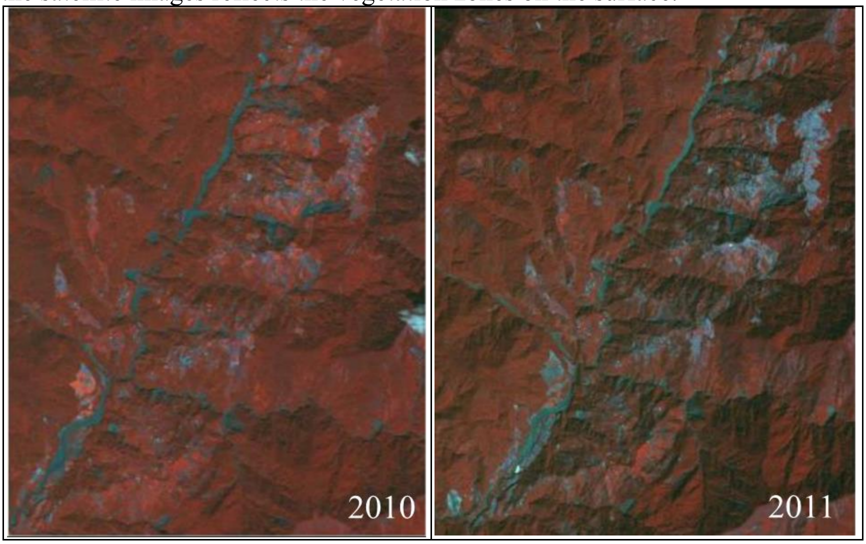

Fig. 1. 2010 ,2011 Multi-spectral Satellite Imagery

3 Materials and Methods

In this study, we used the SPOT 5 multi-spectral satellite image with a spatial resolution of 10M and a total of four bands. The first band is the green light band (BAND 1, Green, 0.5~0.59μm), which is good for the identification of green plants because the absorption by the chlorophyll absorbs less, and after reflection, the color appears green, but it is easy to confuse it with other land use, the second band is the red light band (BAND 2, Red, 0.61~0.68μm), which is strongly absorbed by chlorophyll, so it is easy to be confused with other land use.

The third band is near-infrared light (BAND 3, NIR, 0.79~0.89μm), which is not absorbed by chlorophyll, and the reflection value of plants is very high. As green plants grow more luxuriantly, the reflected infrared light decreases (absorption increases), but the reflected green light and near-infrared light increase. The fourth band is the short-wave infrared band (BAND 4, SWIR, 1.58~1.75μm), which has the characteristic of penetrating through clouds and fog, and can avoid the interference of strong light during the daytime.

The Normalized Difference Vegetation Index (NDVI) was first proposed by Rouse et al. (1973) based on the principle that healthy green vegetation has a strong influence on the presence of green vegetation [11]. The principle behind the NDVI is that healthy green vegetation strongly absorbs red light (Red, wavelength of 0.67 μm) and strongly reflects near-infrared light (NIR, wavelength of 0.79 μm~0.89 μm). Therefore, the ratio or difference between visible light in Red and near-infrared (NIR) wavelengths can be utilized. Therefore, the ratio or difference between the IR wavelength and the NIR wavelength in visible light is used.

$$NDVI = \frac{NIR-Red}{NIR+Red} \quad (1)$$

In the above equation, NIR is the reflectance intensity of near-infrared (NIR) light band, and Red is the reflectance intensity of infrared (IR) light band.

Satellite image data are raster geographic information and are stored in binary form, so they cannot be viewed with general text editing software, but must be manipulated, processed, viewed, or converted by image processing software. The software used for numerical simulation and analysis in this study is MATLAB, which is a commercial mathematical software from MathWorks, Inc.

In this study, we use the advantageous features of MATLAB to compute and classify NDVI of the original two French SPOT 5 optical satellite images respectively, and to graphically visualize the results of the optical satellite image computation, both of which require a large number of simulation computations by means of a complex mathematical module, and to generate complete graphs from a large number of complex mathematical operations to display the two NDVI simulation map, so as to realize the visual display of the calculation results and program design. Calculation results and program design

With the development of remote sensing technology and the operation of new earth observation systems, whether airborne, satellite or ground sensors have greatly improved the all-weather data required for landslide disaster studies. Due to the advancement of remote sensing technology in recent years, the spatial resolution of commercial resource satellite images has been advanced to the metric level, especially for panchromatic images, and the resolution can even reach less than one meter; and in airborne remote sensing, digital aerial systems are also constantly being developed. In the airborne remote sensing, digital aerial systems are also constantly being developed, including array-type digital aerial systems.

The digital aerial photo system not only improves the complicated analogical photo processing procedure in the past with the fully digitalized processing, but also retains the advantages of traditional aerial cameras in terms of resolution and interpretation. In the automatic interpretation method of landslide collapse, the most commonly used methods are supervised classification, non-supervised classification, hybrid classification, or the addition of phytoplankton change and slope factor to analyze the landslide collapse.

However, the image classification methods for extracting exposed landslides from image data, no matter supervised classification, unsupervised classification, or hybrid classification, the traditional method is based on pixel-based classifica-tion, and the spectral reflectance value of a single pixel is insufficient, which may be the place where noise is located, and it is easy to produce the image blurring and scattering signal effect, which usually occurs in the high spatial resolution of satellite images or aerial photographs.

In the literature of landslide observation studies, many complex methods of identifying and monitoring landslides have been proposed. As a result, this tends to affect the efficiency and cost-effectiveness of satellite imagery. In this study, the use of multispectral SPOT5 satellite images to calculate the normalized differ-ence vegetation index (NDVI) can initially improve the efficiency of landslide interpretation.

4 Results & Discussion

In equation (1), the characteristic of (NIR-Red) can be used to detect the amount of plant growth, and the purpose of dividing the equation by (NIR+Red) is to normalize the equation, and the purpose of normalization is to prevent the error of dividing the equation by zero, and to limit the ratio between -1 and +1 for com-parison. The purpose of normalization is to prevent the error of dividing by zero and to limit the ratio between -1 and +1 to facilitate comparison. The spectral properties of an object are the spectral reflectance of an object varies with the type of the object.

Each material on the surface has a different reflectance and scattering rate to the electromagnetic spectrum due to the different characteristics of the ground, and the NDVI index can be used to determine the vegetation change and the soil, water, and water body. The NDVI index can be used to determine the changes in vegeta-tion and the differences in soil, water and vegetation, and is commonly used in the interpretation of landslides, where the larger the NDVI index, the more vegetation there is, and the larger the NDVI index, the more vegetation there is. The larger the NDVI index is, the more vegetation there is, while the smaller the NDVI index is, the more non-vegetated the area is.

NDVI vegetation index and mean-adjusted image classification were used to extract collapsed bare ground. Figure 2 shows the NDVI index classification results for the entire mountainous area in the case study. The dark red blocks represent more lush vegetation growth, and the dark blue blocks represent higher water content in the bare ground. After MATLAB calculation, as shown in Table 1, the bare land area of the study area was 20,041.525 ha in 2010 and 21,551.500 ha in 2011, and the vegetation area decreased from 5,144.512 ha to 3,532.32 ha, and the water area of the river valley increased from 1,052.938 ha to 1155.5 ha.

Table 1. The areas of the merged groups.

Years	Potential Landslide Area (ha)	Vegetation Areas (ha)	Water Area (ha)
2010	20,041.525	5144.512	1052.938
2011	21,551.500	3,532.32	1155.155

Without changing the spectral characteristics, the NDVI index of the whole mountainous area was divided into three categories. The NDVI index of the panoramic image was determined by radiometric correction and sharpening fusion preprocessing without changing the spectral features, and the influence of topography was eliminated by using the sample area system sampling method. The sample system sampling method was used to improve the accuracy assessment of the automatic extraction of bare ground by using the manually counted bare ground area of each period as the ground truth, indicating that the image segmentation program of this study has good effect and applicability for the automatic extraction of bare ground in multi-period images.

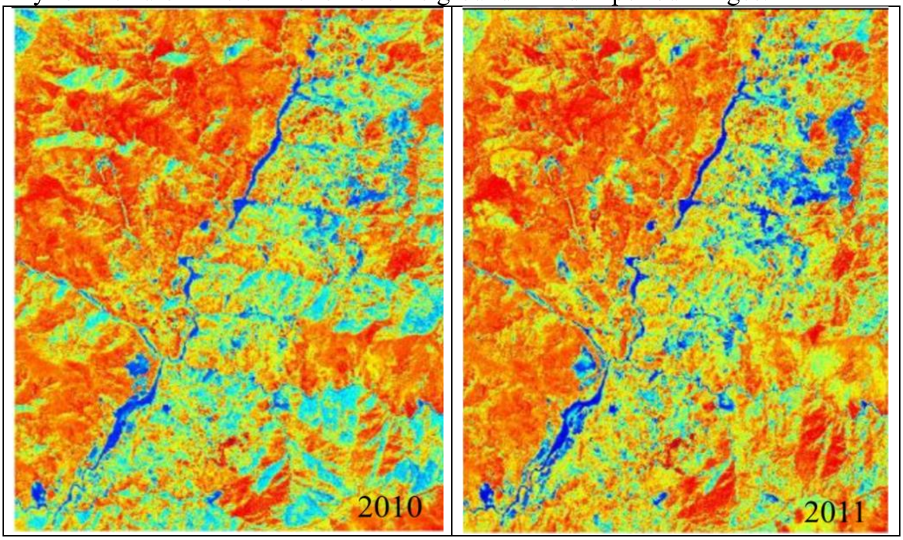

Fig. 2. 2010 ,2011 NDVI digital image map

5 Conclusions

Using two SPOT satellite images at different times, areas with NDVI changes greater than a certain value were identified as collapsed land by both NDVI calculation and Image Differencing. The results showed that different trust zones produce different vegetation changes. areas between different confidence zones, therefore, the results of considering the topographic effect were better than those without considering it. In terms of raw data values, the image The best results were obtained with the scaling method for the raw data values, while the results were better with the raw difference ratio for the radiological values. The results were determined by detecting the changes in the exposed area and deciding whether to change or not by simple linear regression.

The results of change detection are controlled to a certain level of accuracy by operating between different confidence zones, and based on the fact that satellite images are affected by terrain effects. The accuracy of the data is affected by the generation of shaded areas due to the influence of geomorphic effects, therefore, the shaded areas are deducted from the satellite images in both phases, and only the shaded areas are used in the satellite images. Therefore, we deducted the shaded part of the satellite images and explored the changes of the non-shadowed areas only. The results showed that the results of considering the topographic effect were better than those of not considering the topographic effect.

The results showed that the results were better than those without considering the landform effect, and the histogram correction method was used to correct the atmospheric effect, but the results were better than those without considering the landform effect. In the correction of atmospheric effects, the histogram correction method was used to correct the atmospheric disturbances, but it did not have much effect on the accuracy of change detection.

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