CHANGE DETECTION OF LANDSLIDES AND DEBRIS IN SOUTH TAIWAN AFTER “MORAKOT” TYPHOON BASED ON HJ-1-B SATELLITE IMAGES

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1. INTRODUCTION

The 0908 typhoon “Morakot” heavily attacked Taiwan. It brought strong rainfall which not only caused water level rise in several reservoirs and rivers, but also triggered a large number of landslides, debris flow, collapse and other geological disasters. All of these changes resulted in flooding, and for the worst, several villages were buried.

In this paper, using NDVI(Normal Differential Vegetation Index) subtractive method, together with a combined symbol coding method of the least related bands, changes in south Taiwan after “Morakot”, mainly geological disasters and hydrology changes were detected based on HJ-1-B (Environment and Disaster Monitoring Satellites Constellation 1) remote sensing data. Kobayashi Jiasian Township Xiaolin village which was wholly buried in the debris flow disaster and its vicinity were chosen for the study area. The areas where geological disasters and hydrology (including reservoirs and rivers) changes occurred were fast detected, and then the results were analyzed quantitatively. The results showed that NDVI subtractive method could well detect the number and size of landslides and debris, also the enlarged area of reservoirs and rivers. According to the accuracy testing, NDVI subtractive method was proved to be a fast and effective approach for monitoring and assessment of typhoon-induced changes.

2. DATA AND METHOD

2.1. Data

HJ-1-B remote sensing data was chosen for the primary data source. HJ-1-B is one of the HJ-1 constellations launched by China in September 2008. The main task of HJ-1-B is to monitor disasters, environmental damage and pollution in large-scale, all-weather and all-time. The HJ-1-B remote sensing data include blue, green, red and near-infrared band.

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For the 0908 typhoon "Morakot" initiated on August 3 and vanished on August 11, 2009, data on August 19 was chosen for t2-phase(after Morakot), and data on June 7 for t1-phase(before Morakot).

2.2. Method

In this paper, NDVI subtractive method was used for change detection of the landslides and debris in south Taiwan. The subtractive method was modeled as

$$Dif = NDVI_{t2} - NDVI_{t1} \qquad (1)$$

Where $NDVI_{t1}$ and $NDVI_{t2}$ were respectively calculated from remote sensing data on June 7 and August 19, and *Dif* was the difference images between two phases[1~3].

Additionally, a combined symbol coding method of the least related bands was designed to separate the different types of changes[3].

There were mainly four steps for the change detection.

Step 1, the images on June 7 and August 19 were both preprocessed. This preprocessing included image mosaic, histogram matching, accurate registration, cutting and mask operation[4~7]. It should be highlighted that, these operations, especially accurate registration and mask, immediately influenced the accuracy of final detection result. So, the accuracy of registration should be limited in up-to one pixel error. And mask operation should make sure that the processed images of two phases were both cloudless.

Steps 2, according to NDVI subtractive method, the processed images of two phases were computed, and then the difference image Dif was obtained. The Dif image here was composed of both changed and unchanged information.

Step 3, by histogram stretching and continuous adjusting the change threshold value, the changed areas in Dif image were best extracted by modeling in ERDAS.

Step 4, by using combined symbol coding method, together with visual interpretation, the different types and direction of changes were separated. Finally, all of these types of changes were analyzed quantitatively, for example, the number and size of increased landslides and debris, the increased area of major reservoirs and so on.

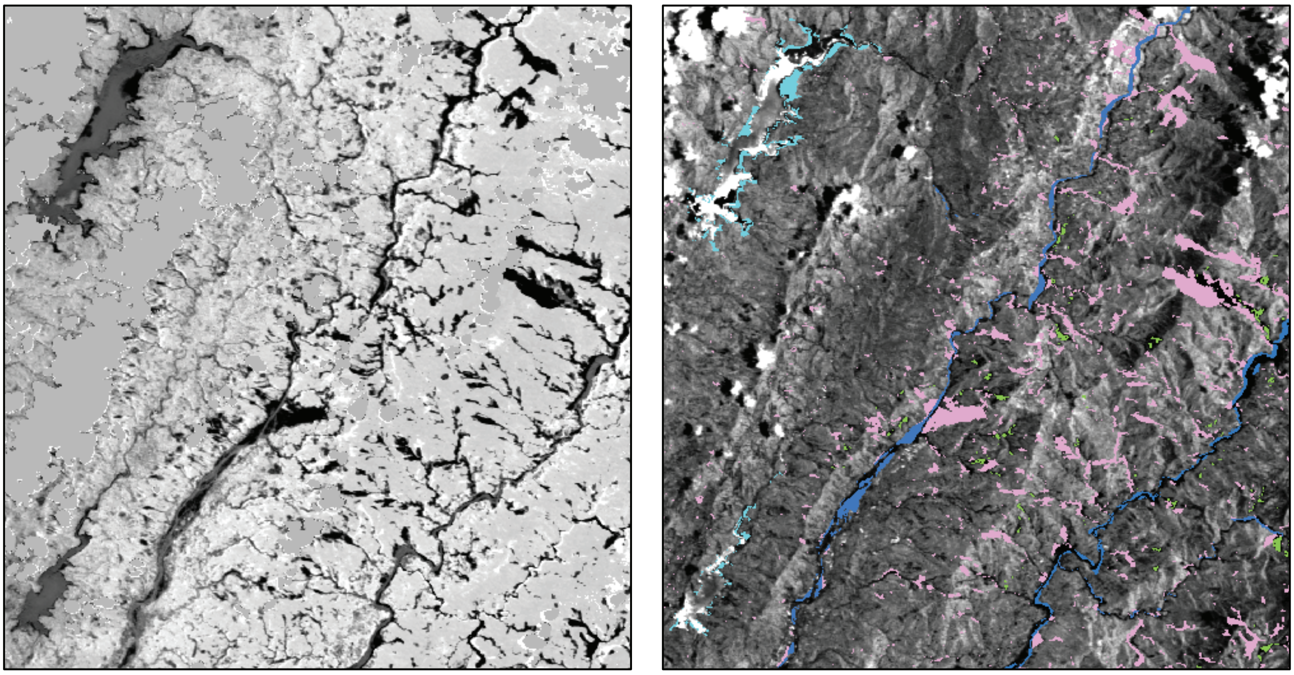
3. RESULT AND CONCLUSION

3.1. Result

According above steps, the detection result using images on June 7 and August 19 were shown in Figure 1.

Figure 1.a was the *Dif* image computed with NDVI subtractive method. The histogram of *Dif* image showed that, the values of subtractive NDVI ranged from -1.894737 to 1.4444, the Mean -0.037966 and the Std. 0.43824. According to the principle of NDVI subtractive method, 0 in *Dif* image represented absolutely unchanged area.

Fig1.b was the image symbolizing different types of changes extracted with combined symbol coding method (the background was image on June 7).



1.a 1.b

Fig.1 Detection result using data on June 7 and August 19

3.2. Conclusion

According to visual interpretation in original images on June 7 and August 19, the detected changes shown in fig.1 could be divided to several types, including increased bare soil (pink part) which represented landslides, debris and collapse, missing bare soil (green part) which represented pre-existing landslides, reservoirs change (cyan part) and river change (blue part).

Some conclusions were made as following:

First, in the study area, the landslide, debris and collapse increased more than 300 site after the "Morakot" typhoon, with a total area of 37.2798 km2. Most of these changes distributed along the ridges and rivers. The debris which buried the whole Xiaolin village became the largest debris, with an area of 2.3031 km2. In addition, some pre-existing landslides converted to vegetation in t2-phase image.

Second, areas of the two major reservoirs increased significantly, in which the larger one, Tsengwen Reservoir increased 4.2696 km2, and the other one increased 0.7389 km2.

Third, several major rivers widened significantly and the water turned highly turbid, which was caused by heavy rainfall, massive landslides and debris rushing into the rivers. So, it was difficult to extract the increased width of rivers, for their DN values in Dif image were too close to the bare soil. In this paper, the statistics of increased area of rivers were done by visual interpretation.

The statistics of the different types of changes were shown in table 1.

Table1. Statistics of the different types of changes

Change types	Pixel	Percent（%）	Area (km^2)
Reservoirs change	5565	9.2544859	5.0085
Bare soil (increased landslide, debris, collapse)	41422	68.8839739	37.2798
Missing bare soil	2707	4.5016879	2.4363
Rivers change (widen ,turbidity)	10439	17.3598523	9.3951

According to the accuracy testing, NDVI subtractive method was proved to be a fast and effective approach for monitoring and assessment of typhoon-induced changes.

4. REFERENCES

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