MONITORING OF VEGETATION GROWING ENVIRONMENT IN THE MINING AREA OF THE MOUNT LYELL USING HYMAP IMAGES

Bing Zhang, Di Wu, Quanjun Jiao, Qingting Li

Center for Earth Observation and Digital Earth, Chinese Academy of Sciences, Beijing, 100080, P.R.China

1. INTRODUCTION

Mining activities have caused serious heavy metal pollution in soil and water resources. The weathering mullock and mining tailings transport the heavy metal in polluted areas into ambient soil, rivers, and groundwater, which destroys the surrounding ecosystem. The menace of heavy metal elements in minerals can lead to botanical variety and impact vegetal growth. With the development of remote sensing, the pollution to the ecosystem and the damage to vegetation can be effectively diagnosed and monitored by remote sensing technology. The hyperspectral data provides an effective tool for monitoring vegetal species [1], vegetation growth [2], and the biochemical information [3-4]. A growing number of studies in recent years have focused on how to use remote sensing for dynamic monitoring and effective evaluation of vegetation growth and its growing environment in mining areas, which provide a scientific basis for making policies of environmental treatment in mining areas.

The vegetation indices have been used to monitor the vegetation information, evaluate the vegetation cover, growth activity, and biomass. Among these indices, NDVI, is considered to be an effective index for monitor the vegetation and changes of ecological environment. However, NDVI is saturate at high vegetation density area and sensitive to the environmental background, which makes NDVI more suitable for monitoring vegetated area with medium density. Thus, NDVI is not suitable for monitoring the vegetation in mining areas. This has also been validated by analyzing the NDVI images in the study area in this paper: The vegetation growth is not well reflected and the regions with relatively poor vegetation growth condition could be hardly distinguished from environmental background because of the fast saturation of NDVI. In this study, two new vegetation indices – Vegetation Inferiority Index (VII) and Water Absorption Decorrelative Index (WDI) were developed for monitoring vegetation growth condition and growing environment in the mining area with Hymap image. We intent to develop tools for fast and quantitative monitoring vegetation growth conditions and for effective evaluation of vegetation growing environment in the mining area.

2. TRIAL PLOT AND DATA

Tasmania, the sole island state of Australia, is located in the south of the main island. It is abundant in mineral resources. The biggest reserve of mineral resources is found in the craggy western part. The Lyell Mountain lies near Queens-town in the west of Tasmania Island. The mountain is abundant in copper, silver, and gold, which have been exploited since 1885 and has produced large amounts of copper pyrite, quartz, hematite and dolomite [5-6]. Intensive exploitation during hundreds of years has brought an inevitable negative effect on the ecosystem in this area, including a drop in the water level, submergence of ground, soil acidification, decreased vegetation coverage, and vulnerable ecological environment [7].

The aviation hyperspectral data for year 2003, is obtained from the HyMap imaging spectrometer developed by the Australian Integrated Spectronics. The spectral range of HyMap imaging spectrometer is 400nm~2500nm. It has 128 wave bands ranging from visible light, near-infrared light and short-wave infrared to shortwave infrared with the spectral resolution of 10-20mm. The instantaneous field of view is 1~3mrad and the viewing angle is 30~65° [8]. This instrument is equipped with navigational positioning system, positioning and attitude parameter recording device, and triaxial stabilizing gyroplatform. The company also developed a 6S-based special module for atmospheric correction of images. This instrument is suitable for ground-object identification and environmental monitoring with the characteristics of high signal-to-noise ratio (500:1), high spatial resolution, and hyperspectral resolution.

3. METHOD

With regard to rapid saturation of NDVI index, the integration of reflectivity at green peak and near infrared is adopted in this paper to represent vegetation growth condition. This method has the advantages of keeping the absorptive features of visible light and the reflective characteristics of near infrared waveband while the specific contribution of growing environment to vegetal spectra is increased. On these bases, two new vegetation indices–Vegetation Inferiority Index and Water Absorption Decorrelative Index were developed. Analyses based on the biogeochemical effect of vegetation in the mining area and the comprehensive analysis of the vegetation spectrum and vegetation indices are used to monitoring vegetation growth.

4. RESULTS

Our results show that VII can effectively monitor the vegetation growth condition in the mining area, which is more sensitivity to vegetation growth condition than NDVI. We applied Hyperion-derived VII over Dexing copper mining area, Jiangxi Province, China and verified that VII is a better indicator than NDVI. WDI can effectively identify the area that contains hematite, especially the hematite areas that are covered with sparse vegetation. The two indices (VII and WDI) proposed in this study are effective indicators for monitoring ecological environment and is applicable to evaluate vegetation conditions and its environment in the mining area.

5. REFERENCES

[1] D. Davidson, S. Achal, S. Mah, R. Gauvin, M. Kerr, A. Tam, et al., "Determination of tree species and tree stem densities in northern Ontario forests using airborne CASI data". *Proceedings of the Fourth International Airborne Conference and Exhibition, Ottawa*, 1999, 178−196.

[2] N.T. L.,Miller, J.R. Moorthy, I. Panigada, C. Zarco-Tejada, P. J. Mohammed, et al, "Bioindicators of forest sustainability: Using remote sensing to monitor forest condition," In L.J. Buse, and A.H. Perera (Ed.), *Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries,* Ontario Forest Research Institute, Ontario Ministry of Natural Resources, Forest Research Information, 2003, 155, 75–77.

[3] P.J. Zarco-Tejada, J.R. Miller, J. Harron, B. Hu, T.L. Noland, N. Goel, et al. "Needle chlorophyll

content estimation through model inversion using hyperspectral data from boreal conifer forest canopies," *Remote Sensing of Environment*, 2004a, 89, 189−199.

[4] P.J. Zarco-Tejada, J.R. Miller, A. Morales, A. Berjón, and J. Agüera, "Hyperspectral indices and model simulation for chlorophyll estimation in open-canopy tree crops," *Remote Sensing of Environment*, 2004b, 90(4), 463−476.

[5] O.L. Raymond, "Pyrite composition and ore genesis in the Prince Lyell copper deposit, Mt Lyell mineral field, western Tasmania," *Australia.Ore Geology Reviews*, 1996, 10: 231-250.

[6] K.D. Corbett, "New mapping and interpretations of the Mount Lyell Mining district, Tasmania: a large hybrid Cu-Au system with an exhalative Pb-Zn top," *Econ. Geol.*, 2001, 96, 1089-1122.

[7] A.G. Gault, D.R. Cooke, A.T. Townsend, J.M. Charnock, and D.A. Polya, "Mechanisms of arsenic attenuation in acid mine drainage from Mount Bischoff. Western Tasmania," *Science of the Total Environment*, 2005, 345, 219– 228.

[8] T.D. Cocks, R. Jenssen, A. Stewart, I. Wilson, and T. Shields, "The HyMap airborne hyperspectral sensor: The system, calibration and performance," *1st EARSEL Workshop on Imaging Spectrometry [C]*, Zurich, *6–8*.