Study on land cover changes using spatial NDVI variation in some provinces in Northern Vietnam

Thuy Thi Thanh Le Faculty of Symbiotic Systems, Fukushima University
Seiki Kawagoe Faculty of Symbiotic Systems Science, Fukushima University

1. Introduction

Vietnam is a developing country that obtaining huge achievements in economics and society as well. As the requirements of urbanization and economic growth, activities such as building, mining, deforestation, slope cutting for constructions and lands use changes become popular in Vietnam, especially in the North. According to the national statistic record of land (2015), agriculture land consists the largest ratio in the land use proportion. Interestingly, the Red River Delta (RRD) and Mountainous and midland area (MMA) in the north represented the highest (30.9 %) and smallest (7.1 %) proportion in the non-agricultural land. The percentage of agriculture land in RRD (65.3%) and non-use land (13.3 %) in MMA are also the smallest proportions among the six major statistical regions in Vietnam in 2015. Recently, agricultural and non-use land has converted significantly to non-agriculture land, especially for residential, industrial and infrastructure sectors. However, such conversions are often over-expectation of the the planning and managing authorities. Additionally, it would also lead to the land degradation, especially in vulnerably areas such as geological hazard prone areas or hilly terrain condition. Evaluating the land cover changes there therefore is one of the important tasks that would support the adequate decision making in land pattern planning and managing as well as early warning of land failure in future. In order to detect the land surface variation, the vegetation index, which is extracted from Landsat imagery is often applied. The primary aim of this paper is to evaluate the land cover changes in some provinces in Northern Vietnam using the vegetation index.

2. Study area

The study area covers about 3700 km2 (190 km x 195 km) in the North Vietnam. It includes entire area of four provinces (Phu Tho, Thai Nguyen, Bac Ninh and Vinh Phuc), almost all area of two provinces (Tuyen Quang and Hung Yen) and partial region of other ten provinces. The numbers of provinces belonging to MMA and RRD regions are 11 and 5, respectively. In this study area, the ground elevation tends to lower towards directions from west and north (mountainous areas) to the south and southeast (mid-land and plain areas).

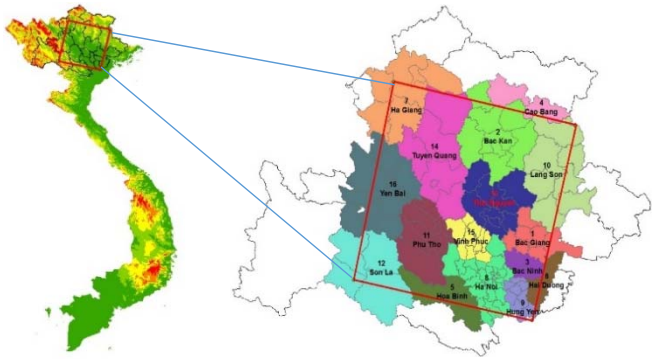

Figure 1: Studied area

3. Methodology

We utilized Landsat 8- satellite images from USGS website (http://earthexplorer.usgs.gov/) to examine the land surface changes in some areas in the North Vietnam. Landsat 8 satellite provides entire images of the earth in every 16 days using its two sensors namely Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) (USGS 2015a). Basing on the land cover mapping, the Landsat images would support the inventory of land degradation. It would visualize and map the past degradation of land surface including soil erosion, landslide, vegetation removal or land use changes (Mwaniki et al. 2015). In order to evaluate the changes in vegetation state and density by the satellite image instruments, a vegetation index is often utilized. This index describes the greenness of surface throughout the reflection of light waves by land surface. Among wavelengths of light being gathered from satellite sensors, the red light's wavelengths are strongly absorbed by photosynthetically active leaves, and the leaves reflect strongly the near-infrared light's wavelengths. In cases of death or stressed vegetation and non-vegetated surfaces they reflect less near-infrared light and more red light. The near-infrared and red light waves thus are applied to transform raw satellite data into vegetation indices (USGS 2015b). There are some indices of vegetation; however, the Normalized Difference Vegetation Index (NDVI) is applied widely. It is calculated as a normalized difference between the near-infrared spectral band (NIR) and red

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Kanayagawa1, Fukushima city, Fukushima. Fukushima University
Tel and Fax 024-548-5261

band (Red) in each cell:

$$NDVI= (NIR-Red)/(NIR+Red) \quad (1)$$

In this paper, we will examine the changes in the vegetation index (NDVI) during the period from November 2013 to October 2016 so as to be able to gain information of natural changes and failure changes in vegetation covers.

４． Results

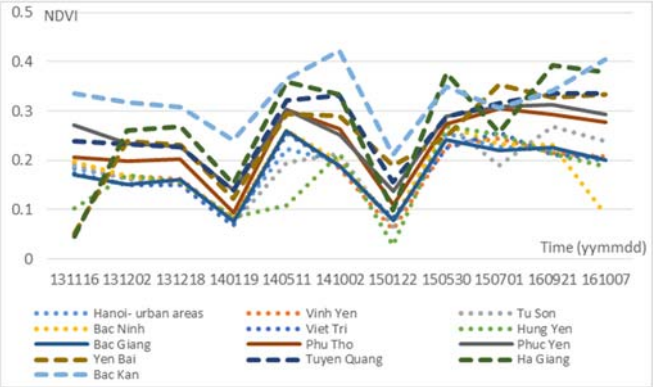

Figure 2: NDVI variations in some cities in the North

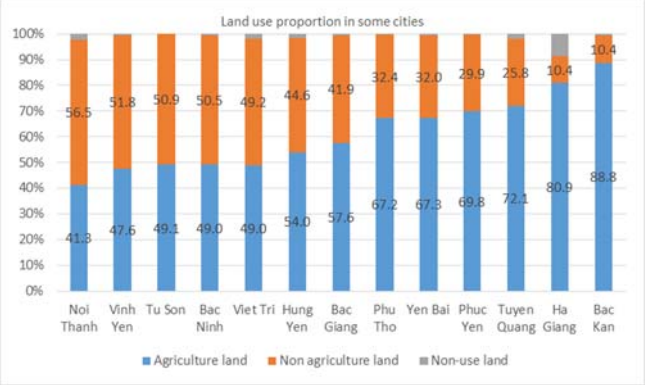

Figure 3: Land use proportion in some cities in the North

The average NDVI values in each sub-region show the moderate vegetation index when the highest average amount is just slightly higher than 0.4. In January, it also declines to below 0.1 in some provinces (Hai Duong, Hung Yen) in plain region. In general, the vegetation index varies among sub-regions. NDVI values area greater in mountainous area than those in plain area in Red River Delta. In all regions, NDVI in January is the lowest in a year. The peak values are seen in May in Red River Delta region; while in mountainous and mid-land areas, it often hits the peak in October. Considering influence of land use pattern, we examined the NDVI variations in cities in the studied area. There are two major regions in the NDVI variations in the examined time. Metropolitans with the non-agricultural proportion of higher than 40% always obtain the lower NDVI values (0.03 – 0.28) all year around. The higher NDVI values (0.05 – 0.42) are seen in cities having lower proportion of non-agricultural land (Figure 2).

５． Discussion and conclusions

There are factors that can bring about the variable of NDVI values from mountainous regions to delta region in this area such as changes in vegetation cover due to harvesting and growing stages and changes due to land failures and other activities. With regards to vegetation cover, in the RRD, rice is main crop in spring season (January - May) and autumn season (June - October) while dry crops are often chosen for winter time. The MMA often has forest cover with the small areas for paddy field, corns and other dry crops. There are also rapid transformation of land purposes in the North when agricultural land and forests in many areas have been replaced by residential and industrial sectors as well as roads and other infrastructure works. For example, paddy area decreased by 33,450 ha and 2,800 ha in RRD and MMA after 5 year from 2010 to 2015 (Department of Land Management 2015). Among ten provinces with total 13,340 ha of paddy field reduction, significant decrease in MMA could be seen in Bac Giang (2,420 ha) and Thai Nguyen (2,340 ha) while there was total rise of 10,530 ha in four provinces including Son La (5,320 ha), Bac Kan (2,910 ha) and Ha Giang (2,130 ha). The reserved forest area in MMA reduced 209,390 ha especially in Cao Bang (130,180 ha), Yen Bai (30,350 ha), Bac Kan (13,830 ha), Phu Tho (12,140 ha) and Tuyen Quang (7,680 ha). It is thus necessary to assess the distribution of NDVI in each sub-area in the research region in order to evaluate the changes in land surface due to land degradation.

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