STUDY ON POTENTIAL OF MEDIUM AND HIGH RESOLUTION SATELLITE IMAGERIES FOR FOREST VEGETATION MAPPING - A CASE OF SEMI-EVERGREEN FOREST IN SOUTH VIET NAM

Pham Bach Viet

Department of Cartography-Remote Sensing-GIS, Faculty of Geography

HCMC University of Social Science & Humanities, 10 Dinh Tien Hoang, 1st Dist. Hochiminh City - Vietnam

Email: phambachviet@gmail.com

ABSTRACT

Forest vegetation maps usually present natural vegetation units according to a vegetation classification system of hierarchy at different levels. At a low or higher level, a unit of vegetation association will represent a vegetation type, of which details depend on map scale. Identification of a vegetation type requires field survey to collect the least information on forest vegetation structure, species composition and sketching unit boundaries based on analyzing aerial or satellite imageries. This study uses high and medium resolution satellite imageries of SPOT5 2.5m and Landsat ETM$^+$ to make the map of forest vegetation at Lo Go - Xa Mat National Park in Tay Ninh province. At the national park, the main forest type is semi-evergreen with various sub-types ranging from close to open canopies and from forest stand to shrub woodland and grasses. The study focuses on testing the potential of the two kinds of satellite imageries to make the vegetation map with the most achievable details.

The results indicate that merging the two kind of imageries shows the better results than use of a kind alone. Only use of SPOT 2.5m or Landsat ETM$^+$ some vegetation units are mis-classified or even omitted because spectral signatures and spatial resolution of these imageries only are able to differentiate one or two vegetation types corresponding to the units need to be classified.

Key words*: Forest vegetation mapping, Semi-evergreen, Satellite imagery, Landsat ETM$^+$, SPOT 2.5m*

1 INTRODUCTION

Vegetation map, particularly that of forests, introduces different vegetation types that are formed from assemblage of plant species with similar characteristics such as physiognomy, species composition, dominant species, foliage status, crown height and canopy thickness. Under defined bioclimate and environmental conditions, plant communities - vegetation association units - can be distinguished from the others. This difference is depended on a classification system of broad or narrow categories in detail. In the former of the tropical region, forest vegetation types are devided into forest/ woodland/ shrubs/ grasses/ bamboos and others, broad/ coniferous leaves, evergreen/ deciduousness, dense/ open forests, , shrubs, tree/ grass swamps, etc. The latter, a much more difficult task,

requires more details on species composition and dominant species within a forest stand to define a plant community.

Studies of forest vegetation can only describe forest types or delineate boundaries of these types to indicate their spatial distribution on a map. Mapping is one of the most significant contents of vegetation research serving effective management and conservation of natural resources, biodiversity in general. It requires primary data as aerial photos or satellite imageries of which spatial resolution determines contents and details of the map. There have been studies of vegetation mapping, in particular forests, widely used various satellite imageries, which range from low to medium, high and very high resolution. Vegetation maps at the broad categories were established based on both medium and high spatial resolution for global levels in defined periods (FAO 2001; Tomppo E, Raymond LC. and Kai 2002). Stibig and Jean - Paul (2003) used SPOT-Vegetation data 1km resolution at regional level to make the forest map for Southeast Asia. At national and local scale, countries have often used satellite imageries to map and to monitor forest resources; typically, one of those is USA (Raymond L.C 1999). Other countries do not use this technology until recent years, such as Viet Nam (Bong P.P. 1990, Cuong N.M. 1997). In order to discriminate individual species or to identify dominant plant species in a forest stand, fine and very fine resolution or even hyperspectral imageries also was applied (Affendi B.S. 2006).

This paper presents results of a study, conducted in Lo Go-Xa Mat National Park (Tay Ninh Province, Vietnam) (Fig.1), on using medium and high spatial resolution satellite imageries, namely Landsat and SPOT5 for forest mapping. This low land, relatively flat area is characterized by the main forest type of semi-evergreen tropical forests, with various sub-types that are distinguished by differences of forest structure and species composition. The study was focused on identification of boundaries of plant communities with the most possible details that meet requirements of the classification system at a local level.

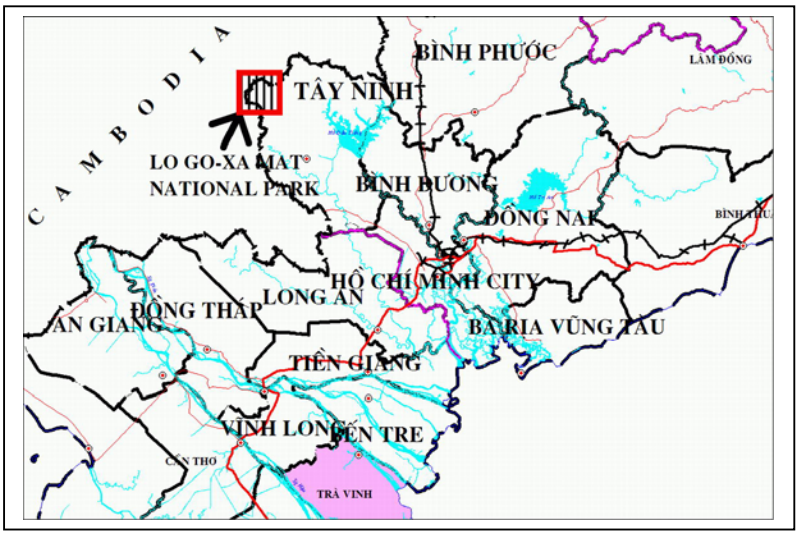

Figure 1: Location of the study area

2 METHOD

2.1 Data

The satellite data used are listed in Table 1.

Table 1: Satellite imageries

No	Satellite	Date	Spectral bands	Spatial resolution	Sources
1	Landsat ETM^+ (WRS2, scene no. p125r052)	13.02.2002	Multi and Pan	28.5m and 14.25	Global Land Cover Facility (GLCF) - NASA Program
2	SPOT5	19.01.2003	natural color composite	2.5m	Dept. of Science-Technology (DOST Tay Ninh Province) and The University of Natural Science-HCMC

2.2 Method

All maps and satellite images were georectified in VN-2000 projection (datum WGS-84) which was defined by the Remote Sensing Centre of the Ministry of Natural Resources and Environment. Field works are necessary because they support to identify forest types and their boundaries. A prior classification system has to be prepared to define types and association units.

Field data collection

In order to identify plant species name, forest structure and forest types, field works by transect method were undertaken with assistance of botanists from the Institute of Tropical Biology (VAST). At forest stands, forest stratification, tree height, coverage (in percent), dominant species of the emerged and forest canopy strata were also noticed. Sites of surveyed forest stands were positioned by using hand held GPS.

Identification of Forest types

Categories of classification system for plant communities were referred from UNESCO (1973), land cover classification system of Di Gregorio (2000) and forest description from Trung (1998) with minor modifications. This is the hierachical system, at which classes are arranged from high, broad level to low, narrow level prepresented for units of plant communities. Table 1 indicates the system, the first column expressed for broad cover types and the second for detail level.

Discrimination of forests and woodland is based on tree density at the stand. Tree savannah is defined by two main elements: a herbaceous vegetation layer and a sparse trees layer. Closed or open forest is defined by the element of a closed or open trees layer, which is mainly applied for the forest canopy stratum. For the emerged layer, continuous or sparse horizontal distribution is considered because it is relevant to forest types and it also affects spectral reflectance on satellite images. In addition, environmental features were also considered, particularly edaphic condition that is the presence of water over extensive periods of time on a specific area.

Table 2: Classification system and map units

Cover types	Phenological features	Canopy	Plant association units
Forest	Evergreen Semi-evergreen	Open Closed	Plant communities (Association units with dominant species)
Woodland	Semi-deciduous	Open	Plant communities
Bamboos			
Grasses/ Shrub (Savannah - Trees/ Grasses- woodland mixed)	Evergreen Semi-evergreen	With trees Without trees	Grass/ Plant communities
Others (forest plantation)			Plant name

Image processing and intepretation

To direct the field works, Landsat image was initially processed to indicate sites needed to be check on the field and to outline possible boundaries of forest types. Selected bands of Landsat images were merged with SPOT 2.5m by spatial enhancement and layer-stacking techniques. For each, they yielded different image composites, based on which interpretation was done. Combination of visual and digital image interpretation was performed to get best outcomes. These had been checked with data collected from field works and the most consistent result was choosen and it was later verified to survey data again.

Although there were two acquired dates of Landsat and SPOT data used in this study, this difference did not influence much on image interpretation because this period is dry season, forest status and environmental condition does not change much in terms of phenology.

3 RESULTS

Regarding to the defined classifivation system, image processing, interpretation and field works were focused on discrimination of vegetation units and definition their boundaries.

3.1 Outcomes of Analysis and Interpretation from Satellite Images

- Landsat ETM$^+$

Tasseled Cap transform was applied to yield 6 indexes, of which the brightness, greenness and wetness were the most efficient indexes to discriminate cover types. Composit of NDVI, InfraRed bands also showed similar result. At forest stands, differences of spectral

reflectance of visible bands are low than infrared bands that increases from near IR to mid IR bands (bands 4, 5 and 7) so that these bands were selected to compose for interpretation.

Discrimination: most of main cover types (high tree density), swampy areas (be waterlogged in rainy season), bamboos, waterlogged area, dense and old forest plantation can be separated. Open and closed canopy can be identified as it relates to forest stratification, particularly if forest stands have an emerged strata. Differences of forest vegetation units of forest category can be separated.

Indiscrimination: woodland (low tree density), savannah - trees and mixed bamboo-shrubs were not able to separate.

Boundaries of cover types and vegetation units were able to identify.

- SPOT5

Discrimination: forests, woodland. savannah-trees and plantations were obviously observable. Forest stand with low trees and almost one layer, individual cluster of trees and tall trees, forest stands with emerged stratum and dense shrubs could be separated.

Indiscrimination: Units of forest category were observable but they were insufficient to separate.

Boundaries of cover types were separately identified.

- Landsat ETM$^+$ and SPOT5

The green band of SPOT5 color composite was used as the high resolution data to transform Landsat composite images on spatial resolution by HSV sharpening. This transform yielded the output RGB image better than by layer-stacking. The Landsat composite images involved in enhancement were optional, they could be near IR, mid IR and band 3 or Tasseled Cap transform bands.

Discrimination: spatial pattern of emerged stratum was observable as continuous or sparse pattern. Indiscriminated details of Landsat and SPOT were complementary.

3.2 Forest Vegetation Map

Based on criteria of the classification system and image interpretation, number of the plant community units were identified as Table 3.

Evergreen units are composed of *Melaleuca* and others that are hardleaved evergreen trees, scrubs. Semi-evergreen units with dominant tree species are defoliaged partly in dry season as *Dipterocarpaceae* (included *Dipterocapus, Vatica, Anisoptera* genus) or nearly complete in a short period as *Lagerstroemia*. There are two woodland types, dominant plants compose of a tree layer and a shrub/ grass layer. Two units of savannah - trees are discrimianted by herbaceous species composition and density of sparse trees. Most of grasses dies off in dry season causing the surface exposed without cover. Some swampy areas with grasses, which still have water in dry season were also identified in the study area.

Table 3: Identified forest vegetation units

Cover types	Phenological features	Number of plant association units
Forest	Evergreen	2
	Semi-evergreen	6
Woodland	Semi-deciduous	2
Bamboos		1
Grasses/ Shrub (Savannah - Trees/ Grasses- woodland mixed)	Semi-evergreen, with sparse trees	2
Others (forest plantation)		1

4 COMMENTS AND CONCLUSIONS

Combination of visual and digital interpretation was selected because digital analysis alone would cause unreasonable outcomes. Forest stands are characterized by differences on layering and horizontal distribution of trees. This causes pepper and salt types on satellite imageries and digital number values were not relatively uniform. Selection of Near and Mid IR bands showed better results because this is relevant to defoliage of deciduous plant species in dry season. Although it is not complete but it makes change in leaf density at emerged and forest canopy layers, leading to differences on spectral reflectance.

The results indicated that merging the two kind of imageries showed the better results than use of a kind alone. Only used of SPOT 2.5m or Landsat ETM^+ some vegetation units were mis-classified or even omitted because spectral signatures and spatial resolution of these imageries only were able to differentiate one or two vegetation types responding to the units need to be classified.

Landsat ETM data proved advantages on spectrum of Near IR and Mid bands as applied them in vegetation studies. Limitation of this medium spatial resolution imagery could be overcome when a high spatial resolution imagery such as SPOT5 2.5m data were used incorporatively. In this study, SPOT5 image was a natural color composite so that it was also a disadvantage. If this kind of image could be an original data with full of spectral bands, image processing and interpretation could yield better results.

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