

# LAND COVER MAPPING OF VIETNAM USING MODIS 500M 32-DAY GLOBAL COMPOSITES

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## ABSTRACT

*Land cover mapping based on high resolution satellite remote sensing data as Landsat TM, SPOT HRV etc. has been widely used in practice. However, due to low temporal resolution, these images do not provide sufficient information on seasonal change characteristics of land cover that could cause misclassification and difficulties in post classification refining. The new sensors such as TERRA MODIS, ENVISAT MERIS and ADEOS-II GLI with high temporal (revisit time is from 2 to 4 days) and spectral resolution are ideal data source for land cover mapping in global and regional scale. In this paper, the author presents result on land cover mapping of Vietnam based on MODIS 500m 32-day global composite developed by the University of Maryland. Land cover classification was carried out by the GASC algorithm which was developed by the author for multitemporal remote sensing data analysis. Classification scheme is kept following IGBP standards. As result, a land cover map of Vietnam for 2002 was established. The classification result was validated using ground GPS photo database. By combination of this land cover and geographic information some other derived results were created as inventory of land cover for whole country and its comparison with national statistical year book of 2002, forest cover and environment sensibility maps. The paper has pointed out usefulness of usage of high temporal and medium spatial resolution remote sensing data for natural resource inventory and environment monitoring in country-wide, regional and global scale.*

## 1 INTRODUCTION

MODIS (Moderate Resolution Imaging Spectroradiometer) is one of the sensors onboard Terra and Aqua satellite. This instrument belongs to moderate spatial resolution sensor group that consists of sensors such as ADEOS-II GLI , ENVISAT MERIS. This is a class of sensors which are capable of observation of Earth surface and atmosphere in moderate spatial resolution, high spectral resolution with short revisit time. Data provided by these sensors are extremely useful for environmental monitoring and natural resource management in global, regional and country-wide scale. In this paper the author reports on application of MODIS dataset for land cover mapping in Vietnam. This is the first attempt of using satellite data to monitor land cover in country-wide scale in Vietnam. The analysis result has been compared with data in the official National Year Book released by the State Statistics Bureau.

## 2 MODIS 500M 32- DAY COMPOSITE

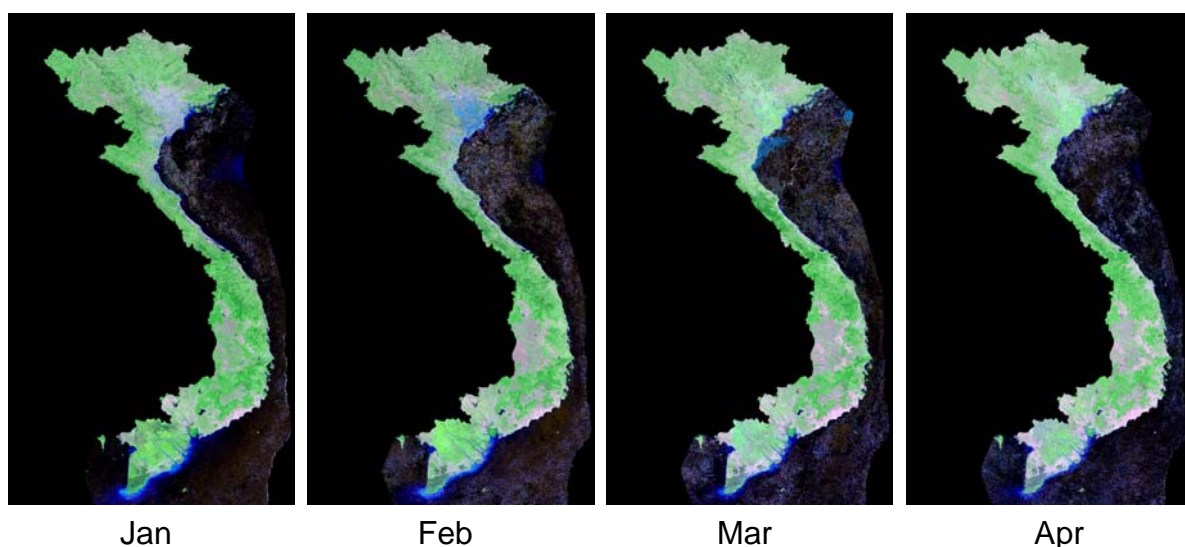
MODIS 32-day composite is a product of Global Land Cover Facility, University of Maryland. This product is derived from MODIS level 3 surface reflectance product called MOD09A1 (8-day Surface Reflectance Composites). There are eleven composites for each

Julian year from the first day to 360<sup>th</sup> day. The last 5 days of the year is included in the first period of the next year. There are seven spectral channels included in the dataset which are listed in the Table 1.

**Table 1. Spectral channels of MODIS 32-day composite**

Channel	Wavelength (nm)	Description
1	620-670	Red
2	841-876	Near-infrared
3	459-479	Blue
4	545-565	Green
5	1230-1250	Short wave infrared
6	1628-1652	Short wave infrared:(similar to Landsat band 5)
7	2105-2155	Short wave infrared:(similar to Landsat band 7)

Spatial resolution of the data is 500m for all channels. On the figure 1. is example of the dataset of Vietnam for the first four months of the year 2002. Color composite was made using channels 6 assigned to red, 2 to green and 1 to blue.



**Figure 1. Example of cloud free MODIS composite of Vietnam**

The original data is in Goodes global projection. To facilitate data integration among the MODIS and other GIS database, the MODIS dataset was reprojected into latitude and longitude grid and cut according to boundary of Vietnam.

### 3 GASC ALGORITHM FOR CLASSIFICATION OF LAND COVER

GASC (Graphical Analysis of Spectral Reflectance Curve) algorithm is an algorithm developed by Nguyen Dinh Duong in the framework of ADEOS-II GLI Research Announcement for classification of land cover using multitemporal and multispectral remote sensing data (Nguyen Dinh Duong 1997). The nature of GASC algorithm is to find out spectral invariant that will help to easily classify land cover objects according to their spectral reflectance characteristics. This method assumes that different land cover object will have different spectral reflectance pattern, that should be stable for certain remote sensing sensor with fixed observing spectral channel composition. The image invariants used for classification are: modulation of the spectral reflectance curve, total reflected radiance index (Nguyen Dinh Duong 1998), channel ratios and ratios of difference to sum of radiance for all spectral channel pairs. The GASC algorithm has been developed for both single date and multi-date dataset. The multi-date GASC algorithm was applied for classification of MODIS 32-day composite. Working principle of the GASC algorithm is shown on Figure 2.

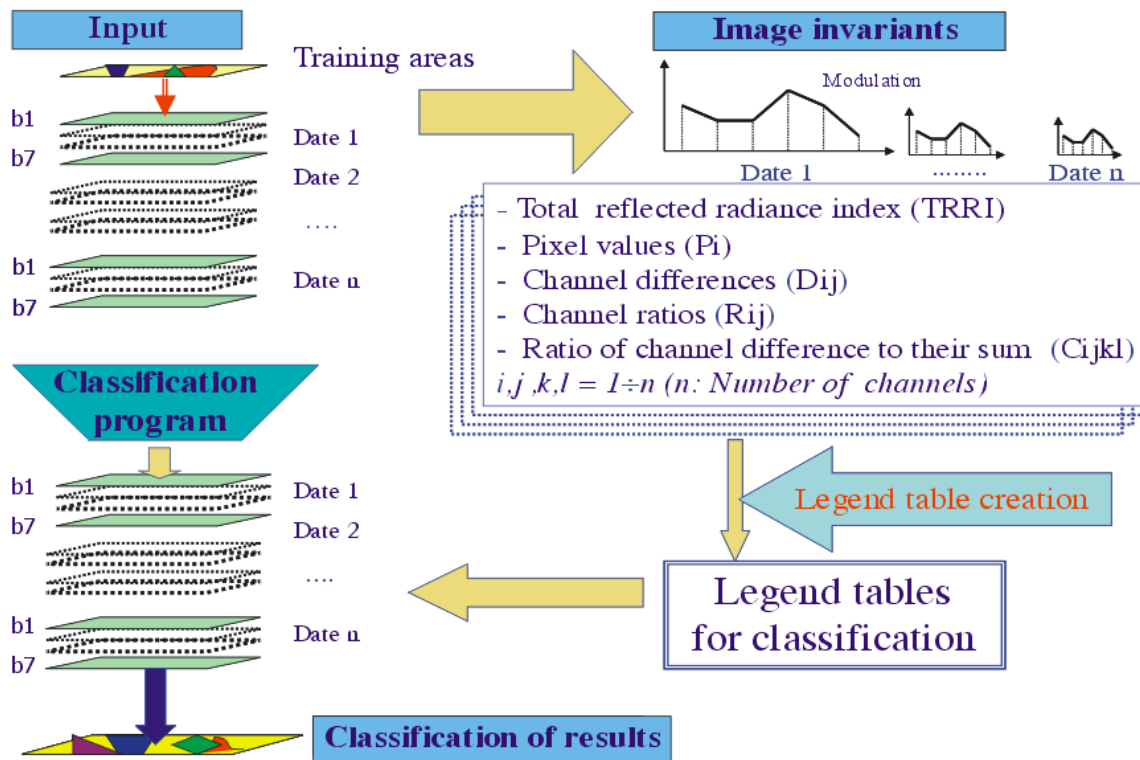
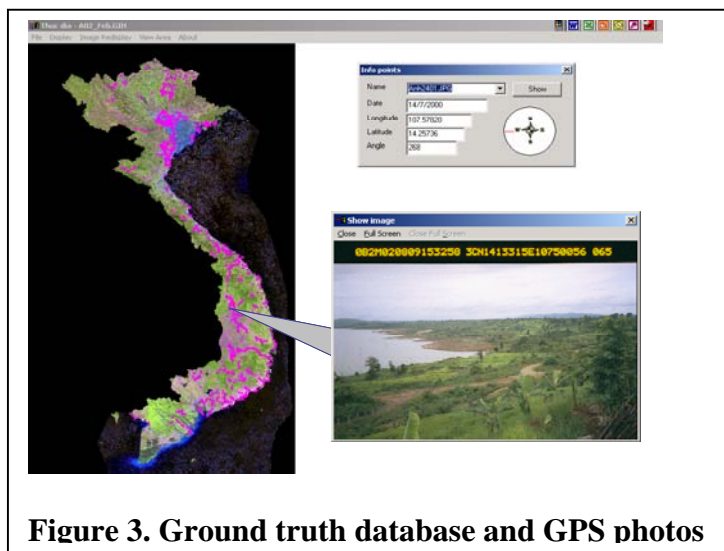


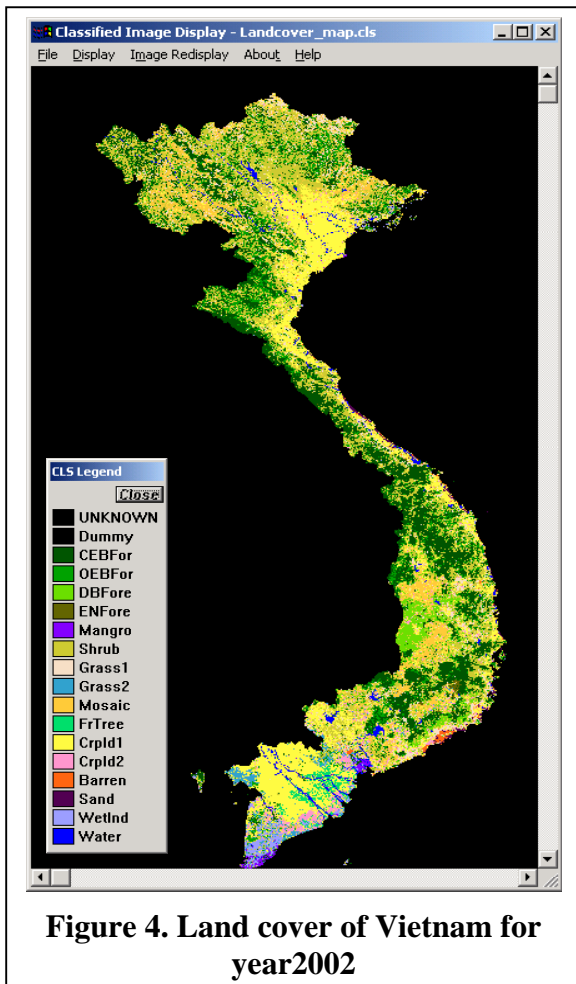
Figure 2. Principle of GASC algorithm for classification of land cover

### 4 LAND COVER OF VIETNAM FOR THE YEAR 2002

The input data for classification of land cover is composed of: MODIS dataset of year 2002, ground truth database. The ground truth database contains more than 5000 GPS photos collected in Vietnam since 1997. The Figure 3. shows linkage between MODIS data and the ground truth database. The database is used for land cover category sampling. Fifteen classes according to IGBP standard have been defined: close evergreen broad leaf forest, open evergreen broad leaf forest, broad leaf deciduous forest, coniferous forest, mangrove, shrub, grass land, grass wetland, mosaic, agricultural land, one crop agricultural land, bare land, sandy surface, wetland and water body. The figure 4. shows land cover map of Vietnam for year 2002. The map has been



**Figure 3. Ground truth database and GPS photos**



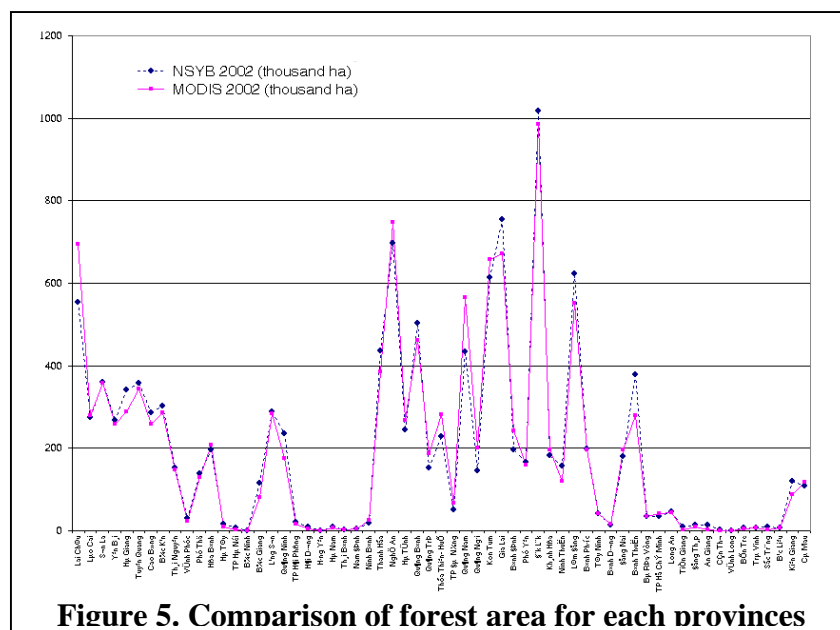
**Figure 4. Land cover of Vietnam for year 2002**

established by the described methodology and validated by using high resolution satellite image as Landsat TM and field GPS photos. 50 points have been selected for validation among them 43 points were in good accordance between the map and the field, 7 points did not match up. The accuracy of the classification could be estimated around 85%. This land cover map is the first country-wide one established by satellite data or another words by direct observation so it reflects objectively physical status of the land cover. Up to now in Vietnam the land cover map in country scale is created based on data provided by local governments (from district level). There was almost no way to verify the data. The author has tried to compare information on land cover derived from this map with data from National Statistical Year Book (NSYB) 2002. On the table 2 is area of each land cover categories computed from the map. On the figure 5 is a graph showing comparison of forest area between MODIS data and NSYB 2002. In the NSYB there are only forest and non-forest area, so the categories: close evergreen broad leaf forest, open evergreen broad leaf forest, broad leaf deciduous forest, coniferous forest, mangrove

have been merged to one class forest area. In general, the MODIS land cover data is in good agreement with data in NSYB 2002. There are some differences but for most provinces they are only in 10% which is generally accepted as accuracy of remote sensing classification (if NSYB is taken as reference).

**Table 2. Land cover of Vietnam computed from MODIS dataset 2002**

No	Land cover category	Area (ha)	Percentage (%)
1	Close evergreen broad leaf forest	7351000	20.8
2	Open evergreen broad leaf forest	3908800	11
3	Broad leaf deciduous forest	1096725	3.1
4	Coniferous forest	167250	0.5
5	Mangrove	143250	0.4
6	Shrub	8247650	23.3
7	Grass land	1493575	4.2
8	Grass wetland	439875	1.2
9	Mosaic	3536075	10
10	Agricultural land	7642175	21.5
11	Bare land	132925	0.4
12	Sandy surface	138300	0.4
13	Wetland	425550	1.2
14	Water body	624025	1.8



## 5 CONCLUSION AND DISCUSSION

The research result is very positive since it pointed out possibility to establish independent methodology to monitor land cover from space. The data derived from analysis of MODIS data is valuable for many environmental research including disaster mitigation and prevention. The following conclusions have been made:

- The moderate resolution remote sensing data provides large spatial coverage that is not possible in case of high spatial remote sensing data such as Landsat TM, SPOT etc. The large spatial coverage enables to observe region or whole country in the same time, almost same atmospheric conditions which simplifies much data processing and analysis.
- The spatial resolution 250m is good enough for environmental research in macroscopic level since it enables mapping in 1:500,000 scale. For this scale the qualitative analysis is more important than quantitative one.
- Recently the NOAA data has been widely used for global and regional environmental monitoring. However, due to low spatial and spectral resolution, it was difficult for application in country-level natural resource management. The MODIS data with two channels with 250m and five channels with 500m resolution specially designed for land observation has overcome the NOAA data and it is getting used operationally.
- In the past, to accomplish coverage of high spatial resolution remote sensing data of Vietnam it is needed a little bit long time (probably several years) due to cloud coverage so application of remote sensing in country-wide scale is some time difficult. The MODIS data is available in short revisit time (2 to 4 days) is offering possibility to create cloud free composite which is essential for establishment of multitemporal dataset that is the most important for environment monitoring.
- The MODIS data is free on the Internet and receiving facility is also cheap in comparison with high spatial resolution remote sensing as SPOT, Landsat TM etc. This advantage gives developing countries as Vietnam a chance to develop capacity in remote sensing technology with modest budget by themselves.

## 6 ACKNOWLEDGEMENT

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## 7 REFERENCES

- Nguyen Dinh Duong, 1997. *Graphical Analysis of Spectral Reflectance Curve*. Proceedings of the 18<sup>th</sup> Asian Conference on Remote Sensing, Kuala Lumpur, Malaysia.
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