Combination of ADEOS II – GLI and MODIS 250m Data for Land Cover Mapping of Indochina Peninsula

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Abstract: ADEOS-II GLI is a new sensor version of Japan. With 6 channels for land study identically to Landsat-TM image, moderate spatial resolution (250m), GLI image is suitable for studies on natural resource and environment in regional, country-wide and global scale. In this study, multi-temporal data classification algorithm - GASC (Graphical Analysis of Spectral reflectance Curve) was used. This algorithm was developed by Prof. Dr. Nguyen Dinh Duong in the frame work of JAXA ADEOS-II GLI research announcement. GLI images used in this study cover Indochina peninsula from April to September of 2003. The time period was not long enough to provide major phenological changes of land cover in the study area, therefore combination with MODIS 250m data to fulfill one-year cycle temporal dataset was necessary. The used images are composed of 39 GLI scenes. These images were geometrically corrected and mosaicked together to create 13 images of Indochina peninsula. These images were further combined together to create 5 cloud free monthly composites. To cover the other time period when the GLI images were not available, 21 MODIS 250m scenes of Indochina peninsula were used to derive 6 cloud free composites for months: 1, 2, 3, 10, 11 and 12 of 2003. Classification of multi-temporal dataset with all spectral channels usually requires a long computing time extensive computer resources therefore for each composite only 5 spectral channels have been selected. 250m MODIS images were extended to 5 channels by using indexes to respond the 5 channels of GLI image. Classification legend was chosen following IGBP standard with 25 classes (some IGBP classes were broken down to more detail ones). The training area selection and validation were done based on the ground truth photo database of Vietnam (with more than 6000 GPS photos covering various areas of Vietnam). Accuracy of classification of land cover was estimated about 90%.
Keywords: GASC.

1. Introduction

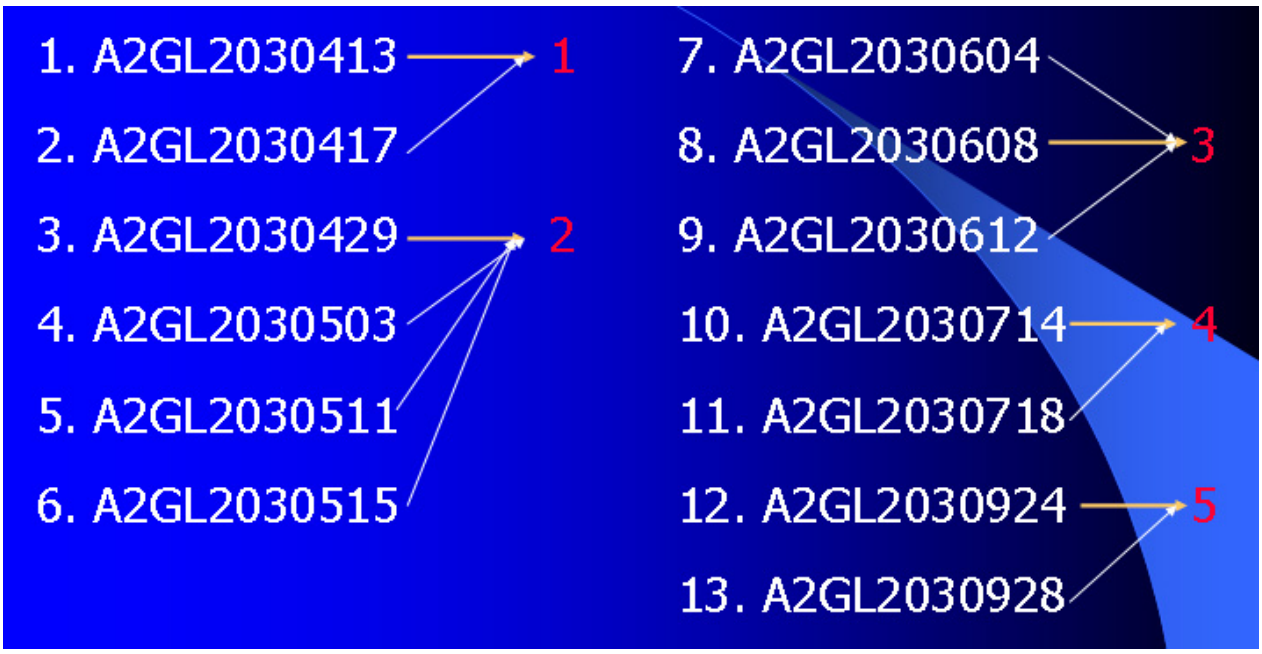
The versions of moderate resolution sensor like MODIS (USA-1999), MERIS (Europe-2001) and GLI (Japan-2002) are interested of remote sensing researchers. With short repeat cycle (2-4 days), wide swath (>2000km), high radiance resolution (36 channels), moderate spatial resolution (250-300m), these data is one of optimal solutions for studies about natural resource and environment in regional, country-wide and global scale. GLI is a sensor onboard ADEOS - II satellite of Japan that was launched in December 2002. GLI image has 6 channels for land study that are identical to Landsat-TM image. Although this satellite worked only in a short period (from January to October, 2003) but GLI images can still prove ability of it in supplying detail information about natural resource and environment in large areas. Multi-temporal Classification Algorithm developed by Prof. Dr. Nguyen Dinh Duong and others in Department of Environmental Information Study and Analysis (EISA), Institute of Geography, VAST is suited for these data. The algorithm can use a series of images for classifying to determine the change of objects following season. It can be developed continuously to classify sub-automatically a large number of images. It also can combine many types of images together for classifying to make a better result.

This study was done with 3 purposes: confirming useful ability of GLI image, affirming capable applications of GASC algorithm and proposing a method combining GLI and MODIS data for land cover mapping with a case study of Indochina peninsula.

2. Data and processing

To finish this study, we used 39 GLI scenes from JAXA (April to September, 2003), 21 MODIS 250m scenes from Institute of Physics, VAST (January to March and October to December, 2003) and more than 6000 GPS photos from EISA.

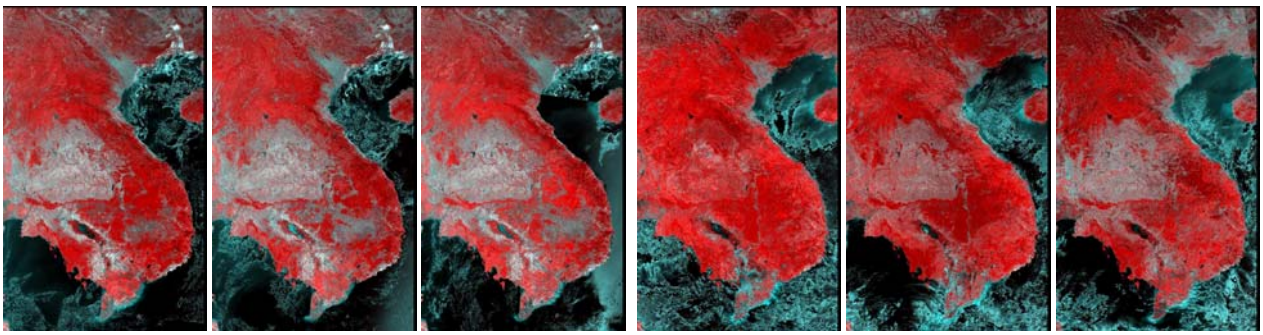
39 GLI scenes received from JAXA in level 1B. We developed a software for geometric correction and mosaicking them together to make 13 images covering all of Indochina peninsula. From these 13 images, we combined them together by a remove cloud model to make 5 cloud free composites for months: April, May, June, July and September (no have image in August). The combination and result as following:



1-April 2-May 3-June 4-July 5-September

Fig. 1: Cloud free GLI composites

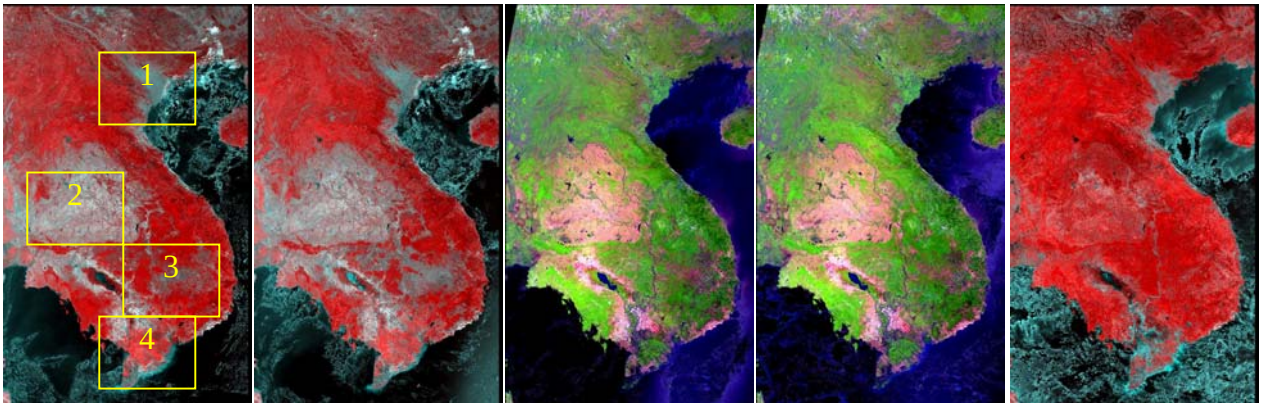
GLI images cover only from April to September, not enough to describe changes of land cover objects following season. We used MODIS 250m data covering other months in the year to get one year cycle temporal dataset. 21 scenes of MODIS 250m were combined together by a remove cloud model to make 6 composites for 6 months: January, February, March, October, November and December 2003. Result as following:



January February March October November December

Fig. 2: Cloud free MODIS 250m composites

Multi-spectral and multi-temporal classification using all of bands and all of composites requires a very strong computer processing system and a long time processing. In this study, we only use 5 bands of GLI images (without channel 20-Blue band) and chose 5 composites (2 of GLI and 3 of MODIS) of all for land cover classification. The composites as following:



January February April May October

Fig. 3: Composites chosen for classification (green composites are GLI and red composites are MODIS)

The choosing composites based on seasons that can describe phenological changes of land cover objects. In the above images we can see: from January to February, deciduous forest has a big change (yellow rectangle No. 3); from February to April is change of cultivated land in Mekong river delta and Red river delta (yellow rectangle No. 1 and No. 4); from April to May is restore of deciduous forest (rectangle No. 3); and from May to October have very big change of many objects in many regions (No. 1, 2, 3, 4).

We used 5 channels of GLI composites for classification but MODIS 250m only have 2 channels. To respond with 5 channels of GLI, we brought up MODIS composites to 5 channels by following computation:

$$b1 = b1$$
$$b2 = b2$$
$$b3 = (b2-b1)/(b2+b1)*2000 + 2000$$
$$b4 = b2/b1*500$$
$$b5 = (b1 + b2)/2$$

3. Classification

GASC algorithm was developed based on thought that each object on surface of the earth has a specific reflectance curve. These curves are drawn by spectral channels of multi-spectral images. Analysis of these curves can define the objects by remote sensing data. These curves are analysed by a series of indexes called invariants. If the invariants are combined with a time invariant of multi-temporal dataset, GASC will become a multi-spectral and multi-temporal classification algorithm. This algorithm has been confirmed in many types of remote sensing data like: Simulated GLI data from Landsat-TM, multi-temporal MODIS data. In this study, we use this algorithm to classify combination of GLI and MODIS. Outline of the algorithm is showed in following figure.

Input data includes a multi-temporal dataset and training areas. Multi-temporal dataset was prepared in above section. Training areas were collected based on ground truth GPS photo database of Vietnam. Training areas collected only in Vietnam were used to classify land cover for all of Indochina peninsula. With more than 6000 GPS photos covering various areas of Vietnam, this database is very useful for collection training areas and validation result.

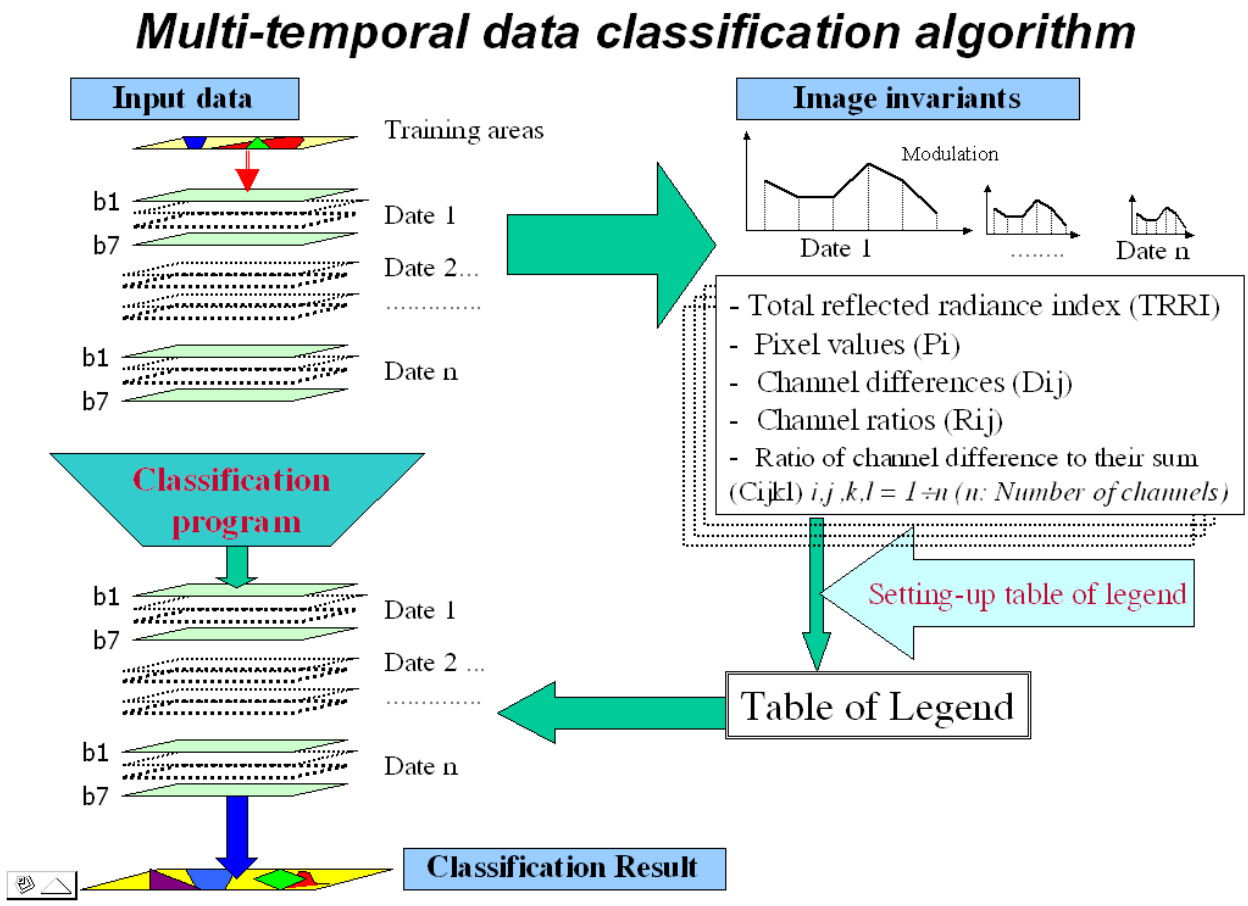


Fig. 4: Outline of Algorithm

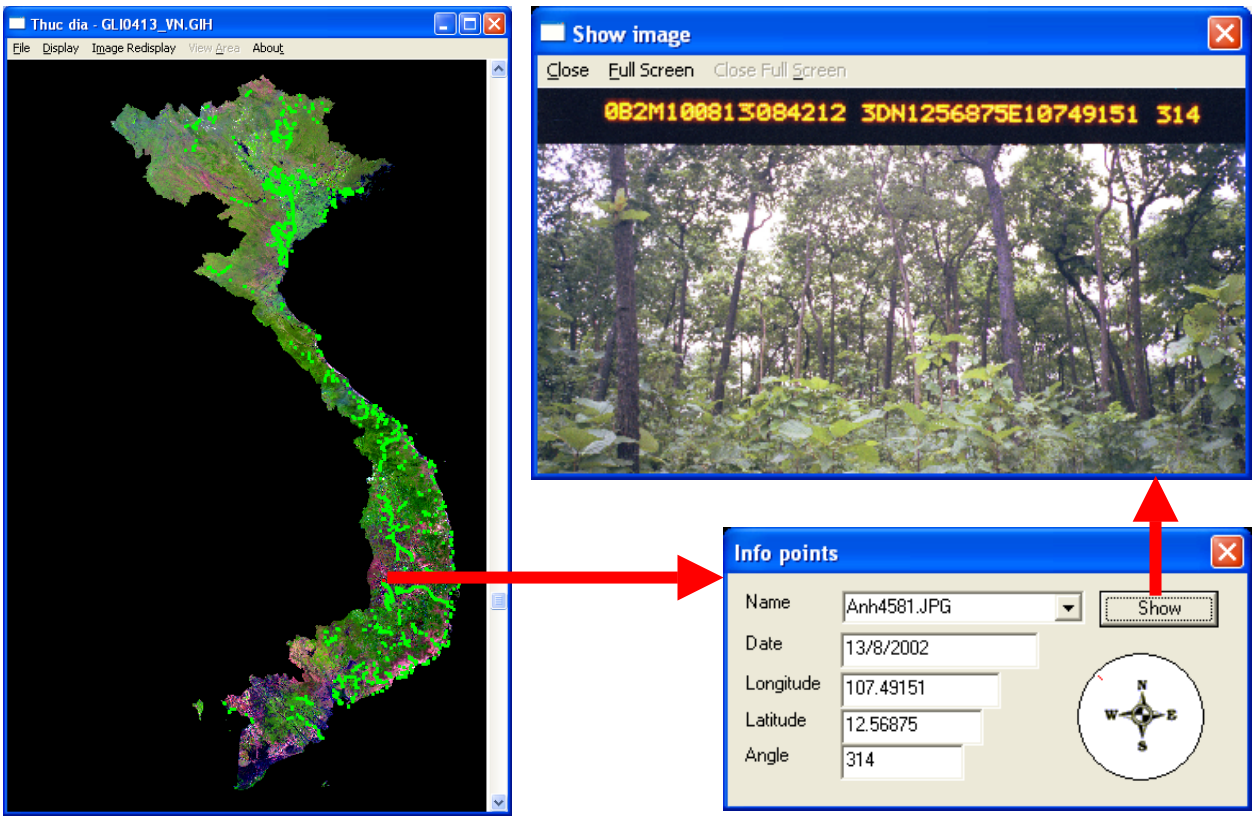


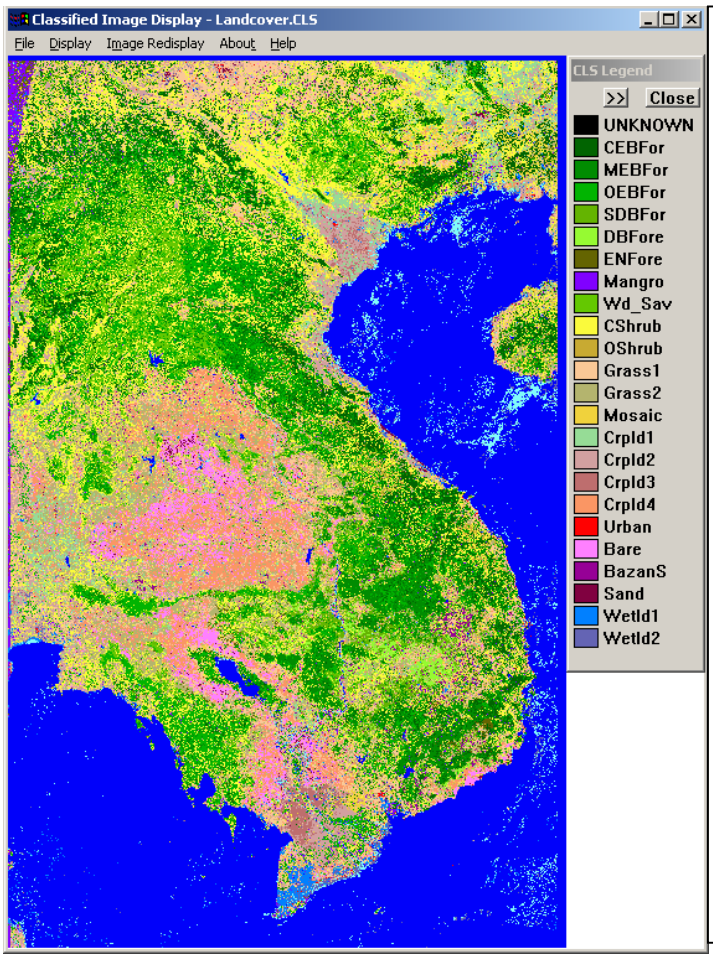
Fig. 5: Ground truth GPS photos of Vietnam. (Green points are position of photos)

Legend for classification was chosen following IGBP standard. Standard legend of IGBP for global land cover has 17 classes. In this study, we broke down some classes of IGBP to more detail ones. Total number classes are 25. Result and legend will be show in the below section.

4. Result and discussion

GLI image has 4 spectral channels more than MODIS in 250m resolution including Blue band, Green band, and 2 bands in short ware infrared. So that GLI image will able to determine land cover objects as types of soil, moisture of objects, cover percentage of vegetation better than MODIS.

Combination of MODIS and GLI can get a completely temporal dataset. Using temporal dataset can determine objects that have change following season like deciduous forest and evergreen forest, differently cultivated lands based on cultivated schedule, soil moisture and so on. Combining advantage of temporal dataset and priorities about spectral of GLI can make a detail and accurate result.



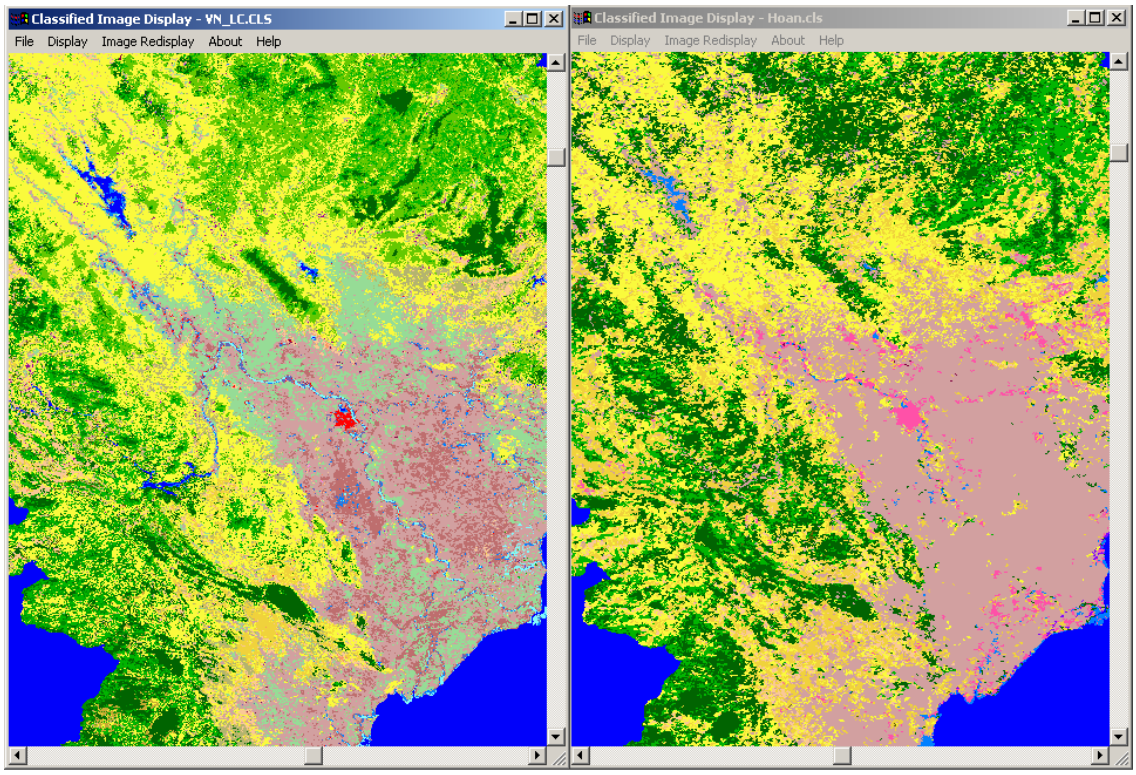
Legend

1. CEBFor: Closed Evergreen Broadleaf Forest
2. MEBFor: Medium Evergreen Broadleaf Forest
3. OEBFor: Open Evergreen Broadleaf Forest
4. SDBFor: Semi Deciduous Broadleaf Forest
5. DBFore: Deciduous Broadleaf Forest
6. ENFore: Evergreen Needleleaf Forest
7. Mangro: Mangrove Forest
8. Wd_Sav: Woody Savannas
9. CShrub: Closed Shrub
10. OShrub: Open Shrub
11. Grass1: Grass and Shrub
12. Grass2: Grass and Bare Soil
13. FrTree: Fruit Trees
14. Mosaic: Including mixture of: cultivated land, natural land, garden, …..
15. Crpld1: Combination of rice land and other crop lands
16. Crpld2: Rice in all of year
17. Crpld3: Rice land has one flood season
18. Crpld4: Dry crop land
19. Urban: Building Area
20. Barren: Dry Barren
21. BazanS: Grass and Shrub in Bazan Soil
22. Sand: Sand, Rock
23. WetLd1: Swamp, Pond (Aquaculture land)
24. WetLd2: Warp, Wet Sand
25. Water: Water

Fig. 6: Land cover classification result and legend

This result was validated by using ground truth GPS photos of Vietnam. We selected randomly 30 points and compared with classification result. Accuracy was estimated about 90 percent.

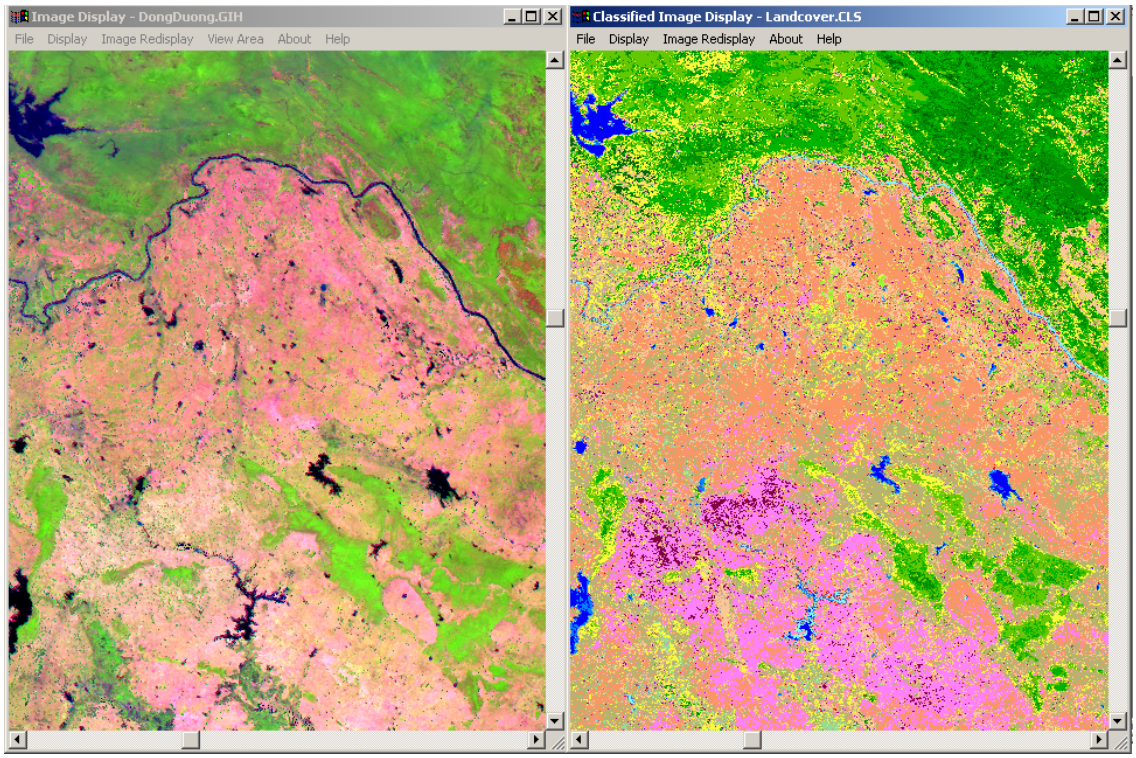
In figure 7 below, comparison of results from GLI+MODIS and from only MODIS shows that forest in result of GLI+MODIS is more detail than that of MODIS. The different types of cultivated land can be determined clearly and detailly. Specially, other objects like water, urban in GLI+MODIS result are clearer than in MODIS very much.



Result of GLI+MODIS 2003 Result of MODIS 2003

Fig. 7: Agricultural land and forest in Red river delta

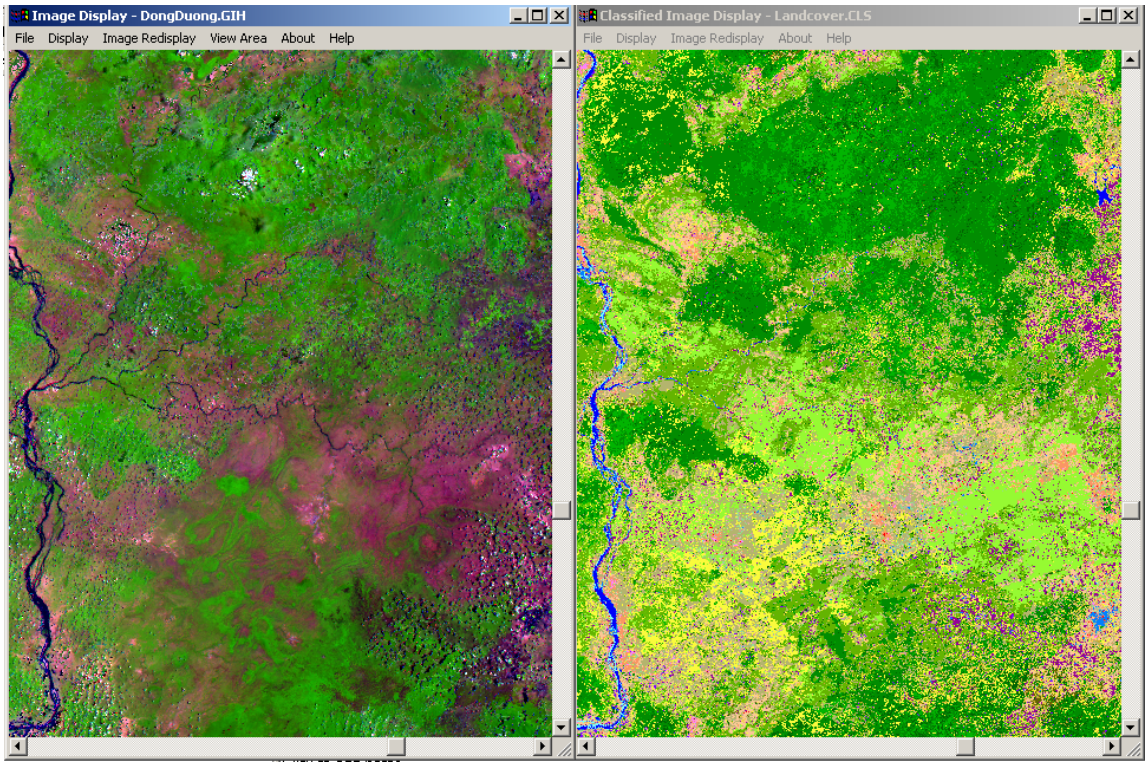
Figure 8 is comparison of color composite image and classification result in Thailand and Laos. Classifying can determine quite well difference of soil types in the same crop schedule of cultivated land. Classification result is quite similar to visual interpretation.



Color composite image Classification image

Fig. 8: Agricultural land and forest in Thailand and Laos

In figure 9 below, evergreen forest, semi deciduous forest and deciduous forest are determined quite clearly by using temporal dataset.



Color composite image Classification image

Fig. 9: Evergreen broadleaf forest and deciduous broadleaf forest in Cambodia and Vietnam

5. Conclusion

Combination of many types of images to classify land cover can get a better result. Each type of remote sensing image has some advantages and some disadvantages. Combining them together may restrain disadvantages and intensify advantages of them. Classification result is more detailed and more accurate, may be increasing application capability in the life.

GLI images have spectral advantages of Landsat-TM. Land cover classification result from combination of GLI and MODIS is estimated that details more than result from only MODIS data. With width swap, short repeat cycle, GLI data have precedence very much for monitoring and managing natural resource and environment. Moderate spatial resolution (250m) is suitable for studies in medium and small scales. From above result can affirm that GLI images are very good for land cover studies.

This study affirmed capable application of GASC algorithm ones more time. Currently, defining reflectance curve of land cover objects has still not enough. Focusing studies to develop a bank of training data for land cover classification is necessary. If reflectance curve types of land cover objects are defined fully by invariants, this method will become a semi automatic classification method. So that it can satisfy demands of processing a large number of images of current sensor versions, usefully for monitoring and managing natural resource and environment using remote sensing data.

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