SOME PRE-ANALYSIS TECHNIQUES OF REMOTE SENSING IMAGES FOR LAND-USE IN MEKONG DELTA

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ABSTRACT

In recent year, socio-economic development has changed land-use status strongly in Mekong Delta. This will affect making decision of regional and local developing plans. Therefore, studying on fact identifying methods of landuse status will be helpful for managers to make developing plans. The techniques of remote sensing analysis can make them. However, analysis results are influenced natural conditions during getting images time, such as clouds covered and low resolution. Techniques of merging the SPOT images with RADARSAT images and other preprocessing techniques can enhance the images and overcome these obstacles and difficulties. Further, analyzing techniques of remote sensing images also premise to recognize landuse status such as shrimp ponds, mangrove forest and etc automatically.

INTRODUCTION

The Mekong area was one of the largest deltas in the world. The mangrove forest used to coverage about 250.000 ha in 1943 (Maurand 1943 cited in Hong and San, 1993). Because of the war, the fuel wood logging and impacts of hydrodynamic processes in river/waters and economic restructure, mangrove forests have been destroyed. They were about 191,800 ha in 1983 and 156,000 ha in 1988. During the war, they were seriously reduced, about 36% area of southern Vietnam were destroyed by herbicides. (NAS, 1974)

In recent years, due to the rapidly developing of shrimp culture movement, a large part of the mangrove forests is still being converting to shrimp ponds. They have caused the negative effects not only in the structure of vegetation and soils in Mekong Delta but also in the socioeconomy and living conditions of local people. Therefore, the study on status and changes of landuse in Mekong play in an important role in suitable economic development.

Many results have indicated the remote sensing technique can be applied for identifying landuse but the results depend on pre-enhancement/analysis techniques as well as algorithms for interpretation of remote sensing images. This paper shows some pre-analysis techniques of remote sensing images in land-use.

STUDY MATERIALS

Studied sites: Tra Vinh and Ca Mau provinces (Fig. 1)

Images

- One SPOT4 image scene covered whole Camau region in April 10th 2001 corresponding with dry season with 4 channels: channel 1: 0.50 - 0.59 µm (green), 2 : 0.60 - 0.68 µm (red), 3: 0.79 - 0.89 µm (near infra-red); 4: 1.50 - 1.75 µm (short wave infra - red), ground resolution: 10m; processing level: 1A (UTM)

- One SPOT4 image scene cover whole Travinh region in January 22nd 2001 corresponding with dry season with 4 channels and the same as Camau

- One radar image high resolution (6.25m and further on) covered a part of Camau

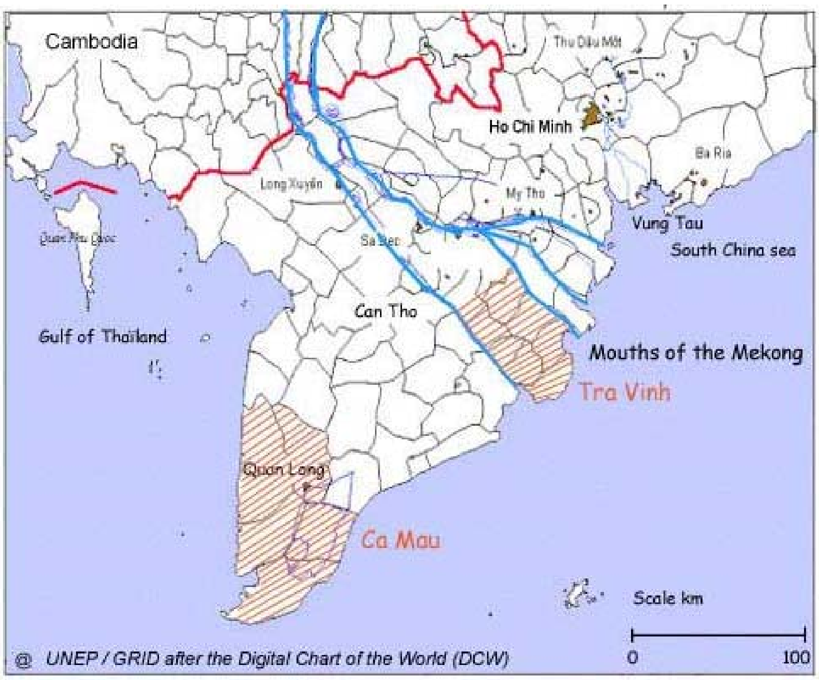


Figure 1: Studied sites

Mapping material:

- A series of topographic map in 1965-1966 (US Army) in Camau (4 pieces) and Travinh (2 pieces) on scale 1/50.000 were collected. These maps allow showing the evolution level of forest ecology system in the past ant present time.

- A series of digitized map in forest status of Camau and Travinh provinces on scale 1/50.000. These maps were established by Forestry Inventory and Planning Institute (Hanoi) base on the field trip materials in 1997-1998.

Field trip: Field trip data of the ecology team performed in March 2001: based on false color composite image of both regions (from older images), in the field trip, we identified and draw boundaries of interesting areas that will be used for determining the training sites of the classified images in the laboratory.

METHODS AND RESULTS

Enhancement of image resolution using IHS/RGB transformation - image fusion

The method of improving image resolution with IHS/RGB transformation (Intensity, Hue and Saturation from /to Red, Green, and Blue) is based on the fact, that opposite to the RGB-color system the IHS channels are independent from each other.

The image resolution enhancement will be made use of this feature. The satellite images (in this situation is the SPOT4 images covering Camau region with 10 m resolution) are transformed to the IHS system. Then the intensity channel will be replaced with the high resolution channel (RADASAT image – 6.25 m resolution). After that these three images will be back-transformed to the RGB color system. The final procedure is RGB image fusion (Figure 2). Of course, in the process, some intermediate procedures as merge images by georeference, noise and speckle filter of RADARSAT image have be accomplished simultaneous.

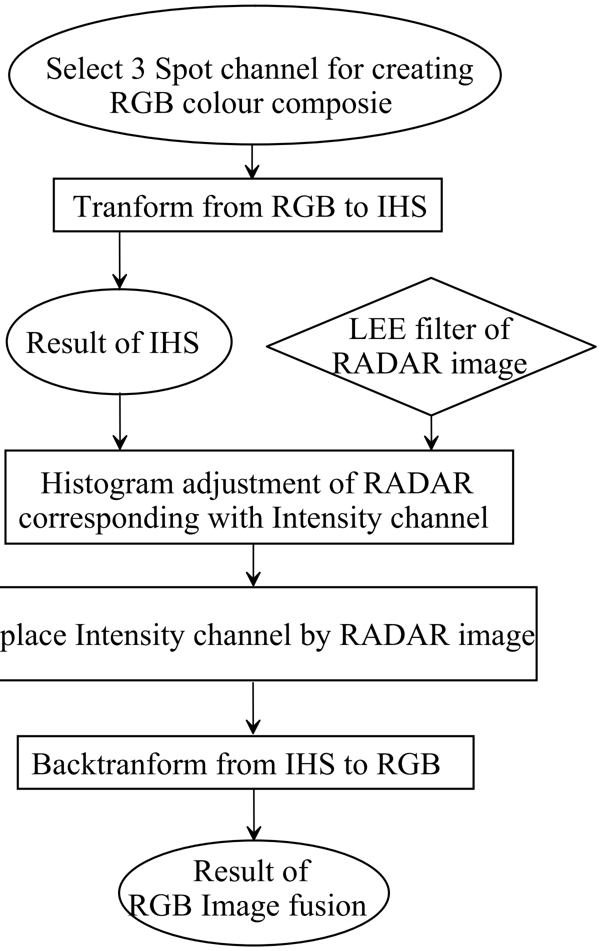


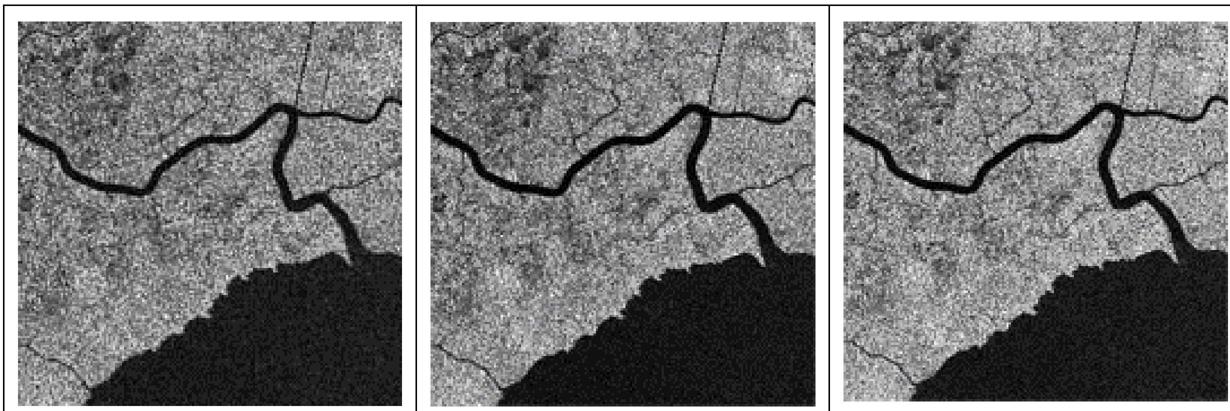
Figure 2: Flow scheme of performed steps in image fusion

Merge images by georeference (from difference image sources with difference resolutions) are accomplished base on georeference control points (GCPs). These points have absolute similarity between 2 image sources. In this study, the 78 GCPs are chosen.

Noise and speckle filter of RADARSAT image: since RADASAT used microwave energy, it is able to penetrate atmospheric barriers that often hinder optical imaging. So, RADASAT can “see” though cloud, rain, haze and dust and can operate in darkness, making data capture possible in any atmospheric conditions. In comparison with other satellite images, RADARs usually have higher resolution and many other advantages resulting. Today RADAR image have more and more practical applications in remote sensing field.

However, some problems come from RADAR imaging. RADAR images have a “speckled” or grainy appearance, resulted by a multiple scattering within a pixel. In RADAR terms, a large number of ground targets exhibit “diffuse” and “specular” reflectance patterns. Because the data are inherently “noisy”, they are required substantial preprocessing before they are used in a given analysis task. The RADASAT image covering the Camau region is not an exception. Some filtering methods applied in preprocess are LEE, MEDIAN and FROST. LEE filter (Laplacian Egde Enhancement filter) is useful in detecting edge and linear features in imagery. MEDIAN filter is useful to enhance some of the features in image scenes in order to select sites for detailed analysis. And FROST filter allows reducing speckle while preserving edges in radar image. This filter is intermediate between LEE filter and Median filter.

Results of a subset of Camau images after been different filters are presented in figures 3.



by LEE filter (3 *3)	by FROST filter (3 *3)	by MEDIAN filter (3 *3)

Figure 3: Results of enhancement methods of RADARSAT in Camau region

The image fusion procedure (figure 4), which was accomplished with following steps in figure 2, showed the resolution of the image after image fusion of SPOT4 and RADARSAT image is fairly enhanced. Some objects such as shrimp pond, culture land are distinguished clearly with other objects. Therefore, this method can provide the application aspect of a potential publication. In this treatment processing, with the helping of LEE filter, the results of image fusion were the best.

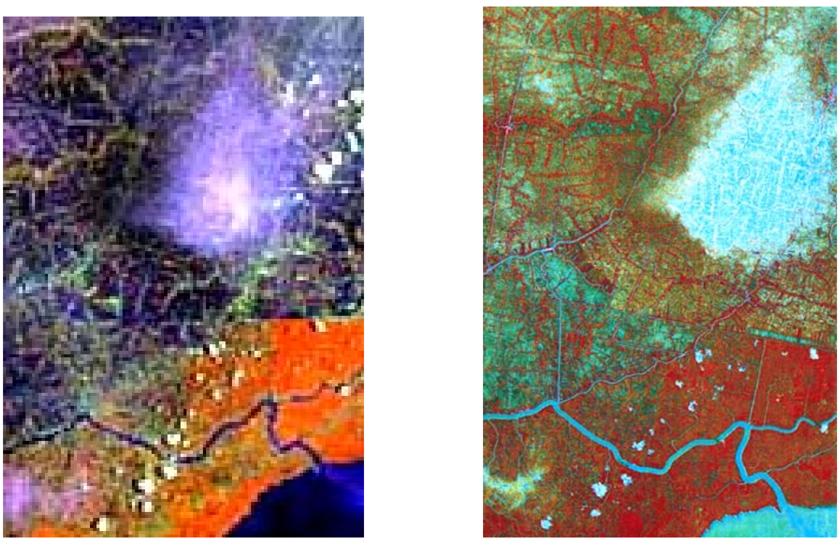


Figure 4: SPOT4 image (Left) and fusion image (Right) in Camau region (between SPOT4 and RADASAT images)

Detecting of shrimp ponds

This session show results of determination of shrimp pond in study areas based on Gond et al.'s method (Gond et al., 2001).

Because the shrimp culture in study areas is extensive model, a "shrimp pond" can be defined as a surface ranging in size between 1 hectare and few tens hectares of either free water or water with vegetation. The water content may range from water logged soil to water bodies several tens centimeter deep.

The best indicator with vegetation data: To assess water areas in a normalized way, the NDWI (Normalized Difference Water Index) may be used: NDWI = (NIR-SWIR)/(NIR+SWIR). This index increases with vegetation water content or from dry soil to free water. The NDVI (Normalized difference vegetation index), another very popular index in vegetation studies, is helpful if ponds are characterized by well-developed vegetation contrasting with surrounding dry land NDVI = (NIR-RED)/(NIR+RED). And, the difference of NDWI and NDVI also was taken into consideration because it reinforces the receptions of free water bodies.

Method to extract free water and shrimp pond: Three inputs are used here NDVI, NDWI and the original SWIR band. The process is carried out the following steps:

- assess NDVI and NDWI
- identify difference of NDVI and NDWI: (NDVI - NDWI)
- pixel values which are higher than -0.08 and less than 0.08 are kept as whole "water bodies".

In parallel, the same procedure is applied to the alone SWIR channel. In this case the threshold was set from - 0.05 to 0.05.

Both outputs are merged together by an "AND" function, hence a pixel to be kept as shrimp pond must satisfy both above conditions. The studied results are presented in figures 5.

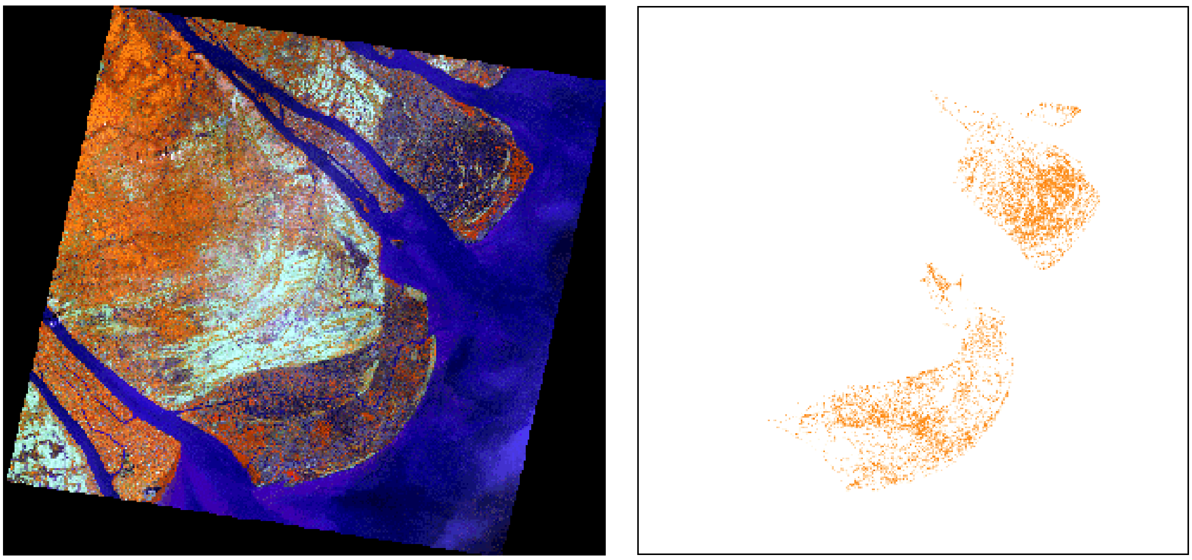


Figure 5: The SOPT image (Left) and shrimp ponds detected by automatic method (Right)

Figure 5 shows a majority of water surface of shrimp ponds was detected very well. However, parts of regions adjoining between shore and sea were wrongly detected. This matter will be made good by filter techniques and corrected by results of fieldtrips. Therefore, this method is quite effective for automatic drawing boundary of shrimp ponds as well as water surface mixing with vegetation. The applied potential of mentioned method is very large. This method can be applied to identify shrimp culture areas in mixing aquaculture-mangrove areas and then calculate area proportion between shrimp ponds and forestland. However, it is difficult to separate the shrimp pond and river/canals in the complex river network as in Camau.

Recognizing landuse in Mekong Delta

With many kinds of landuse distributing in the same regions, their management will be complex when status of landuse changes very strongly. The fast identification of landuse areas will be helpful in making plans of management and exploitation of land. This issue may be carried out by remote sensing analysis. The processes of recognizing landuse were done in figure 6.

In this process, 20 training areas and 25 sites were chosen for the multi-temporal classification of the Travinh and Camau image, respectively. List of training areas in Tra Vinh and Ca Mau were indicated in table 1. Due to different characteristics of of landuse in Travinh and Camau, the chosen items for classification are different

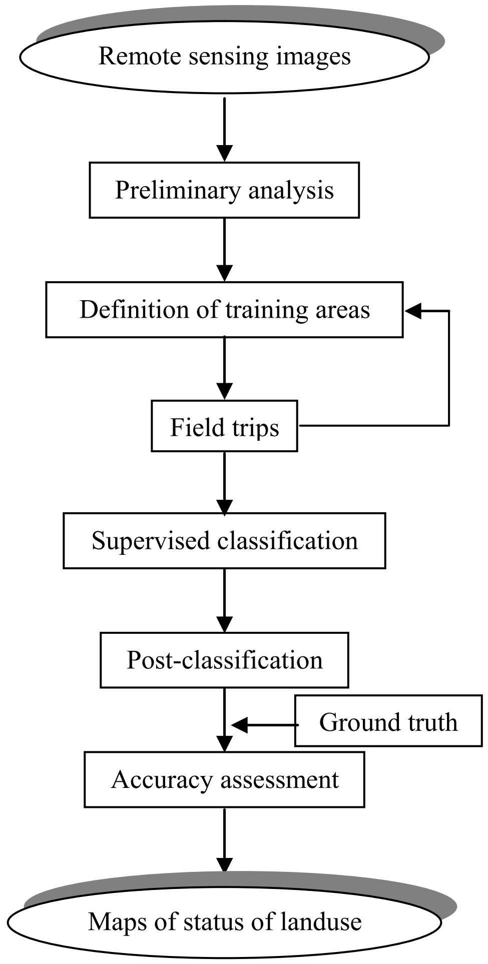


Figure 6: Diagram of the steps to identify landuse status from remote sensing images

Table 1. List of training areas for superior classification of remote sensing images

Tra Vinh	Ca Mau
- Aquaculture land - Natural forest (mixing of many species) - Plantation forest (only Rhizophora) - Mixed region of aquaculture and forest - Rice field after harvest - Rice field - Nipa - River, sea - Tidal flat and sediment - Rural inhabitance - Un-classified	- Aquaculture land - Mixed region of aquaculture and forest (aquaculture area more than forest one) - Mixed region of aquaculture and forest (aquaculture area relative equal forest one) - Mixed region of aquaculture and forest (aquaculture area less than forest one) - Mangrove forest level 1 (thick forest with older Rhizophora) - Mangrove forest level 2 (thin forest with younger Rhizophora) - Mangrove forest level 3 (forest with dominated by Avicennia) - Mangrove forest level 4 (Bare land and shrub) - Agriculture land - Marsh - Shallow sea and sediment - River, sea - Un-classified

The results of remote sensing analysis, flowing figure 6 with supervisor classification by maximum likelihood methods, are show in figures 7, 8 and 9. The classified result gives relative good result map of land-used status in Tra Vinh (1/2001) but it is rather bad in Ca Mau region (4/2001). There are some errors in the results. For example, a large area of Dam

Doi district, classified as an "aquaculture land", is not true. Really, it is paddy field. These are caused the following reasons:

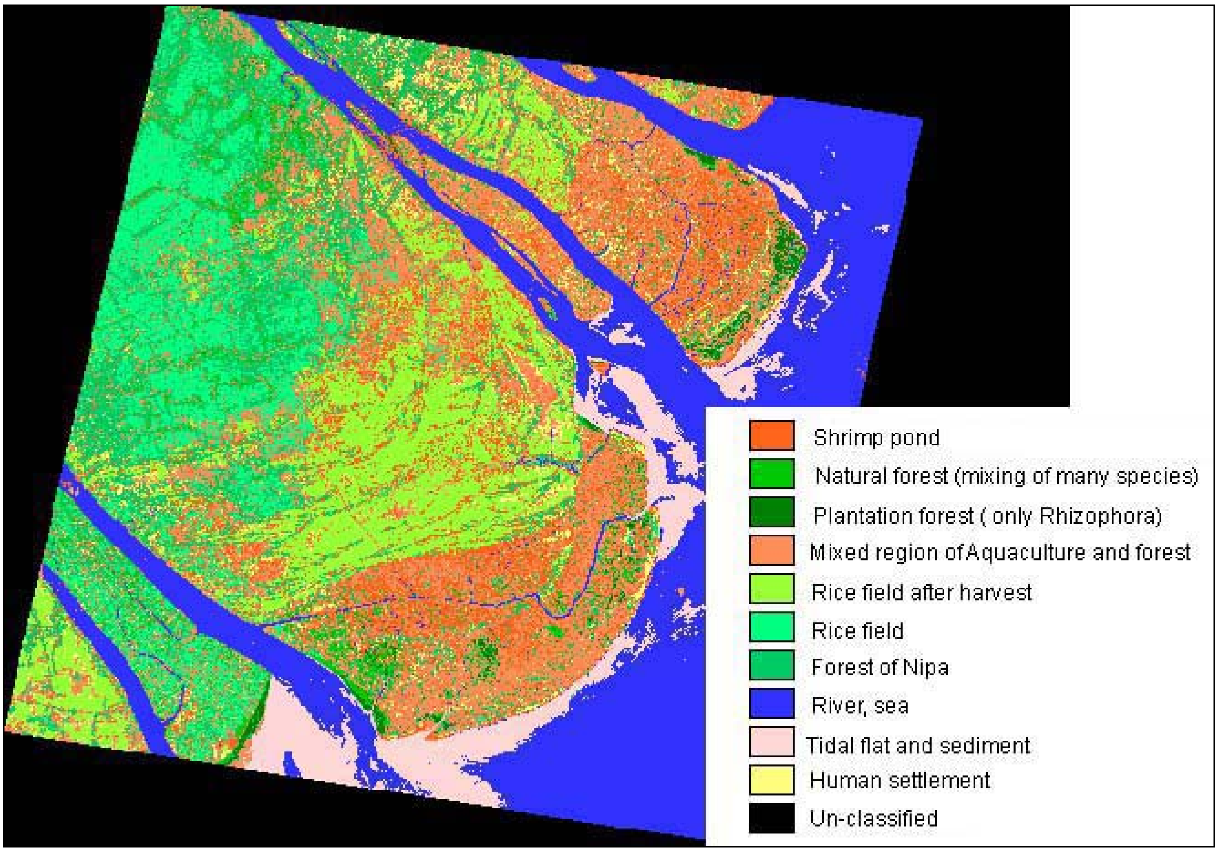


Figure 7: Land-use map in Tra vinh (1/2001)

- Effecting of clouds and their shadows: the image was acquired in partly cloudy and hazy. Although they were corrected with atmosphere by masking clouds and their shadows, the obtained results are limited. This matter will be improved in future by a suitable method of atmosphere correction.

- Due to reflective property of water: because rainy water located in paddy field, it is difficult to separate paddy fields and shrimp ponds automatically.

- Lack of information of ground truth sites: due to limit time of field trips, some area have not yet been checked.

- For obtaining the best land-use map in Camau region, outside study regions were masked (this region have been covered by cloud) and shrimp ponds (only in Damdoi district) were replaced by paddy field one. The final result is presented in figure 9.

In addition, the distinction between vegetation such classes (as different mangrove species, mangrove specie and fruit-trees, long-life trees) are very difficult. The usage and choose of suitable vegetation index (NDVI) is very important (especially in establishing forestry map in Mekong Delta).

In the land-use map in Camau region, 3 classes of "mixed region of aquaculture and forest" were separated according to difference participated percent base on visual consider in color structure. This problem has a big practical value in considering to relationship between mangrove forest and aquaculture.

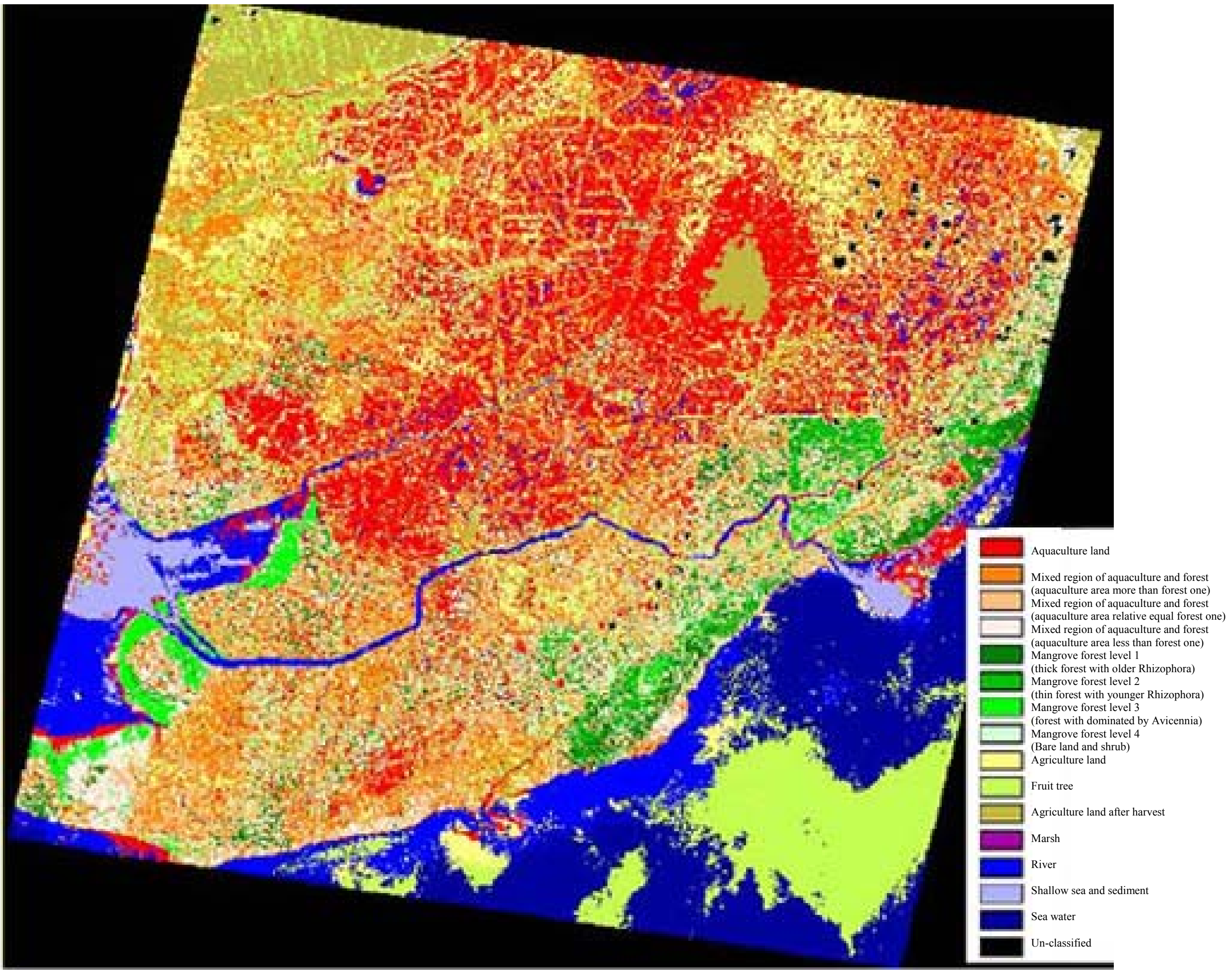


Figure 8: Land-used map in Ca mau (4/2001) with regions covered by cloud

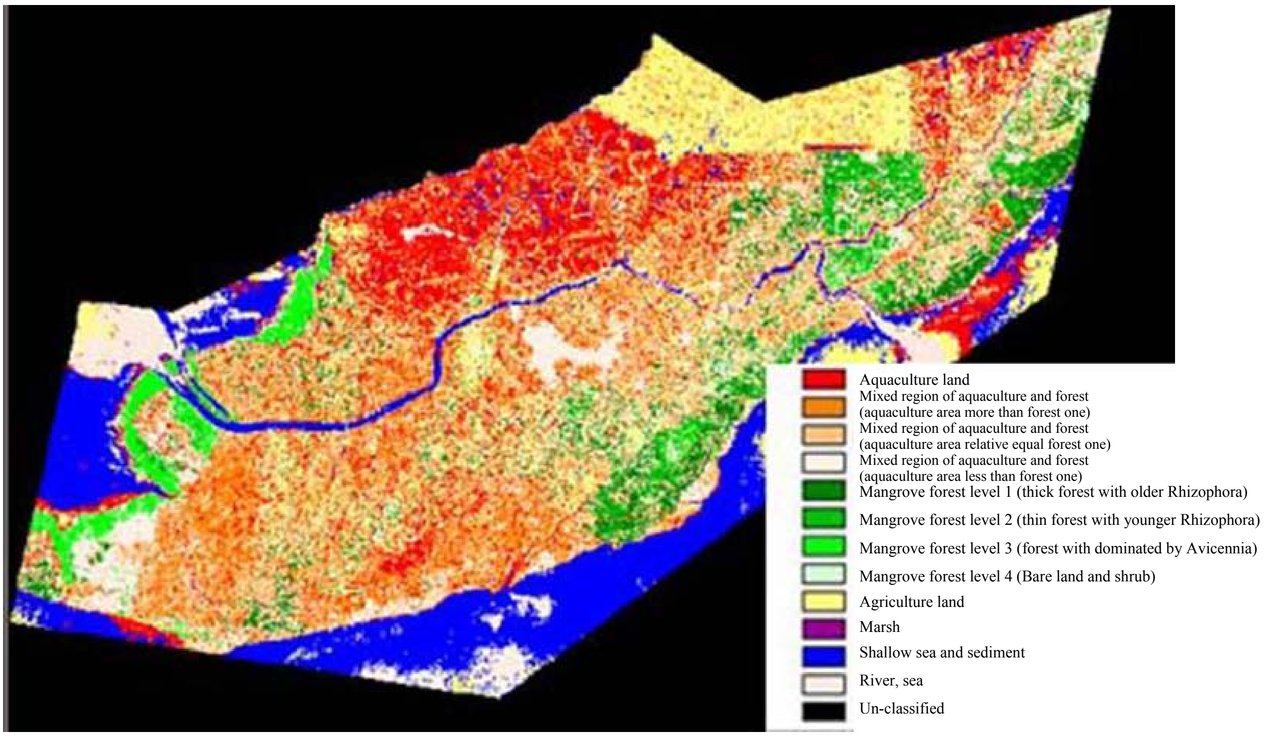


Figure 9: Land-used map in Ca mau (4/2001) after analysis

Conclusions

Some regions in the Mekong delta (such as Tra vinh and Camau) is the ideal positions of the remote sensing application (in SPOT image) for land use mapping and also mangrove forest mapping. The preliminary results of remote sensing application for land use mapping were mentioned in this study. SPOT images image can be used for landuse mapping in Mekong delta. The pre-analysis techniques of remote sensing images and the image fusion (between SPOT and RADARSAT images) allows to enhance images. In addition, some methods have been applied for detecting of the shrimp pond and landuse status.

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