Ability of Combining Remote Sensing Data and Land Use Rights Registration Records in Land Use Data Acquisition

Tran Nhu Trung[1], Nguyen Thi Hong Nhung[2] and Le Qui Thuc[3]

[1] TECOS, Ministry of Natural Resources and Environment, 62 Nguyen Chi Thanh, Hanoi, Vietnam
E-mail: trunggeomatics@pmail.vnn.vn

[2] Faculty of Geography, Hanoi University of Science, VNU, 334 Nguyen Trai, Hanoi, Vietnam
E-mail: nhn121@yahoo.com

[3] Vietnam Association of Geodesy, Cartography and Remote Sensing
E-mail: Lequythuc@hn.vnn.vn

Abstract

Land use data (LU) is one of the core data for land administration. Land use data in Vietnam is captured, processed and distributed via 4 levels of land administration system (LA), from commune to national level through district and province. However, this trail of land use data acquisition and processing exposes inconsistencies in data reliability, especially once reaching the national level.

Remote sensing technology (RS), with its increasingly improved spatial, temporal, spectral resolution, becomes a potential tool to overcome the above-mentioned drawback. It happens however that the initially captured results from RS data stand usually not in accordance with LU, officially supplied by LA offices.

This paper presents a framework of combining RS data with land registration records to generate more reliable LU data.

1. Introduction

Since land was considered popularly as the most significant resource in civil life, land use must be acknowledged and managed adequately. LU in Vietnam is officially captured, processed and distributed via 4 levels of land administration system, from commune to national level through district and province. Starting from commune, land use data is compiled and reported from level to level upward the national level, whereby, at each level the LU undergoes a certain degree of generalization to meet the need of land use management of the respective land administration level.

This routine mode of LU acquisition and processing exposes inconsistencies in data reliability due to: 1) the uncontrollable data level-wise generalization process and 2) the out of date of the data provided, at the national level in particular. In the recent meeting of the working group on national land use inventory in 2005, the credibility of land use information generalized from commune to national level is assessed to be 50% - 70% (RSC-MONRE, 2003a)

Remote sensing technology (RS), with its increasingly improved spatial, temporal and spectral resolution, finds its application in many disciplines both in scientific researches and practical projects as well. In LU acquisition, remotely sensed data can be used to overcome the above-mentioned drawback. It has to be kept in mind however that RS data does not always stand in compliance with LU supplied officially through the LA system. A RS application research in Ca Mau province (Southern of Vietnam) has shown in some cases the discrepancies between data supplied by RS and those by LA office. For example, the aquaculture area is estimated as 47,000 ha and 25,000 ha, respectively with land registration records from land use statistic and measurement from RS data (RSC-MONRE, 2003b).

Several researches attempted to compensate these discrepancies, among them emerge the matter of combination RS data with other available data sources such as land registration records (LR) and land use statistic (LS) through the land use classification process (Thomas, 2001). Land parcel was used likewise as the narrower boundary to verify and compensate the classified land use classes (Arikan, 2004). With this method, an increase of 10% in classification accuracy can be expected compared with traditional methods.

This paper tries to use as many as possible land use data from land registration sources, combining them with RS data to perform the precise land use classification then. This procedure will be discussed in more detail in the following paragraphs.

2. LR-aided Classification Approach

An quantitative analysis of LR provided LU recently made by Trung (2004) showed that the geometrical accuracy of these data fully satisfy requirements in all application disciplines while their thematic resolution can only meet the level III of 4 levels land use classification system (LUCS) in Vietnam LA. That means, to fulfill all technical requirements in land use demand, additional works should be done to make further detailed thematic information at level IV.

Main objective of the LR-aided classification focuses therefore on how to use RS technology to upgrade the thematic resolution of the LR provided information, thus making them adaptable to the land use classification at level IV, the most detailed level in LUCS.

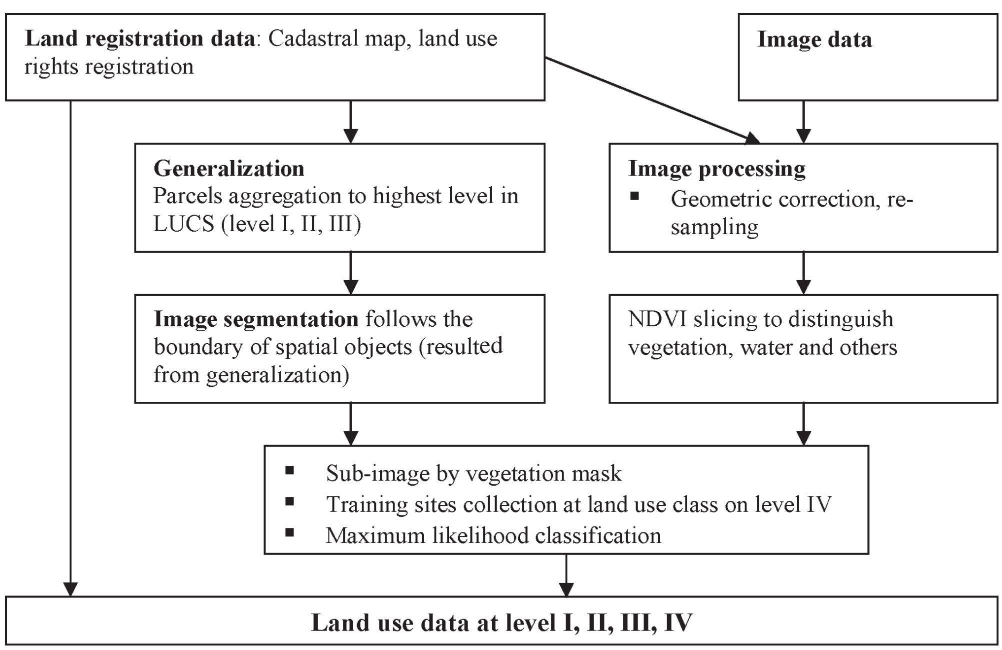


Figure 1: Working flow of LR-aid classification

The working flow of LR-aid classification approach is described in Figure 1.

Firstly, LU is extracted from LR to generate 30 land use classes (level III in LUCS correspondingly). As regard to the image processing, some preparatory works like geometric correction, adaptive image fusion (sigma filtering) are taken first in order to have improved resolution image without change in spectral characteristic (Steinnocher, 1999). Then vegetation, water surface and other land cover types inside farmland group are outlined. Using the farmland boundary derived from LR, fused image was segmented close to the objects of interest. This segmented image was interpreted into the 3 above cited land cover types using vegetation mask created from NDVI image. By doing so, cropland (already known in LR), water surface and other land cover types can be more interpretable in the satellite image thus making the classification easier.

Supervised classification with maximum likelihood algorithm was chosen using 3 bands (3,5,4) of sub-image that were calculated with the lowest correlation in correlation matrix. In order to discriminate differences in vegetation mask, data set of the 3 above Landsat 7ETM+ bands was tested to be the most appropriate channels. Rice crops may be detected by using multitemporal data, however, in the scope of this study we applied knowledge based method for single band to classify vegetation objects to as many as posible. With reference to the date of satellite data, it is clear that sown land has the lowest reflectance in vegetation groups and rice crops are predominant according to local cultivation calendar. Thus, cropland was classified into crops rice classes and sown land with more detail which could be known as multi-resolution segmentation procedure of hierarchical objects.

While the geometrical accuracy is confirmed and enhanced right in the beginning phase of land use detection, the image classification starting from level III ensures much certainty in result than those from level I of LUCS. Furthermore, the final results of image classification are more persuadable when it references on official land use sources (LR, land use statistics) since the beginning of the detection.

3. Farm Land Case Study

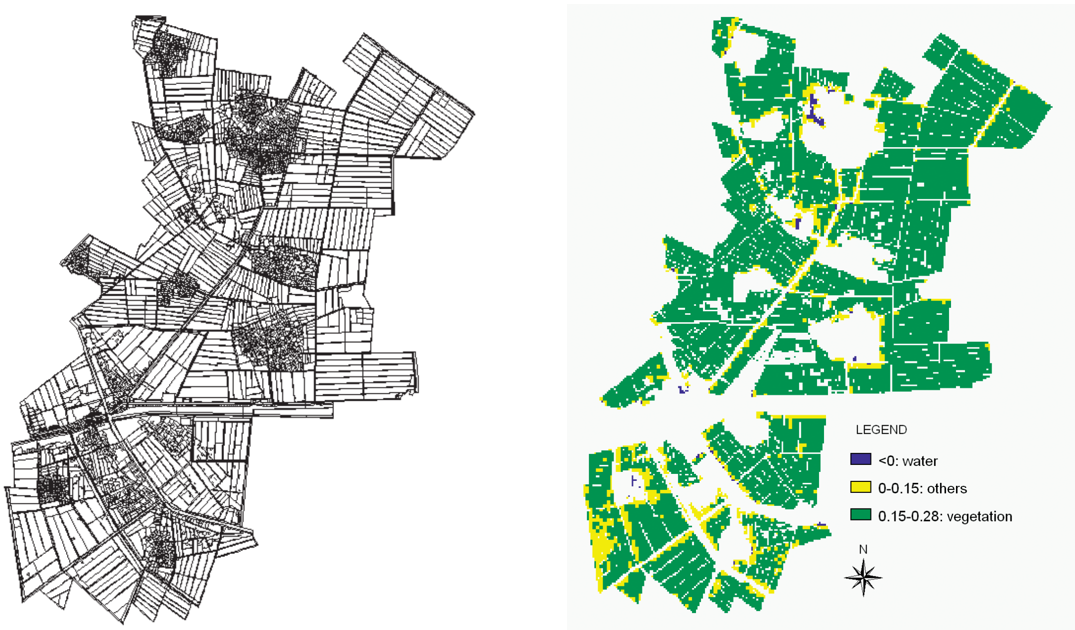
3.1 Case Study Introduction

In order to experience with the above approach, a case study was carried out at Bac Ly commune of Ha Nam province in the Red river delta. Data used is Landsat 7 ETM+ acquired in September 2000, land registration records, cadastral map and land use statistics supplied by Ha Nam land administration department in the same year.

LR data is presented on map in Figure 2(a). Image segmentation is illustrated in Figure 2(b). Normalized different vegetation index (NDVI) image was created using band 3, 4 of Landsat 7ETM+. In order to create vegetation mask, NDVI image was sliced in 3 types: vegetation, water and others by threshold of NDVI value. Two separate sample sets of equal size were selected from these surveys, one for the NDVI signature sets for classification, and the other for the evaluation of classes.

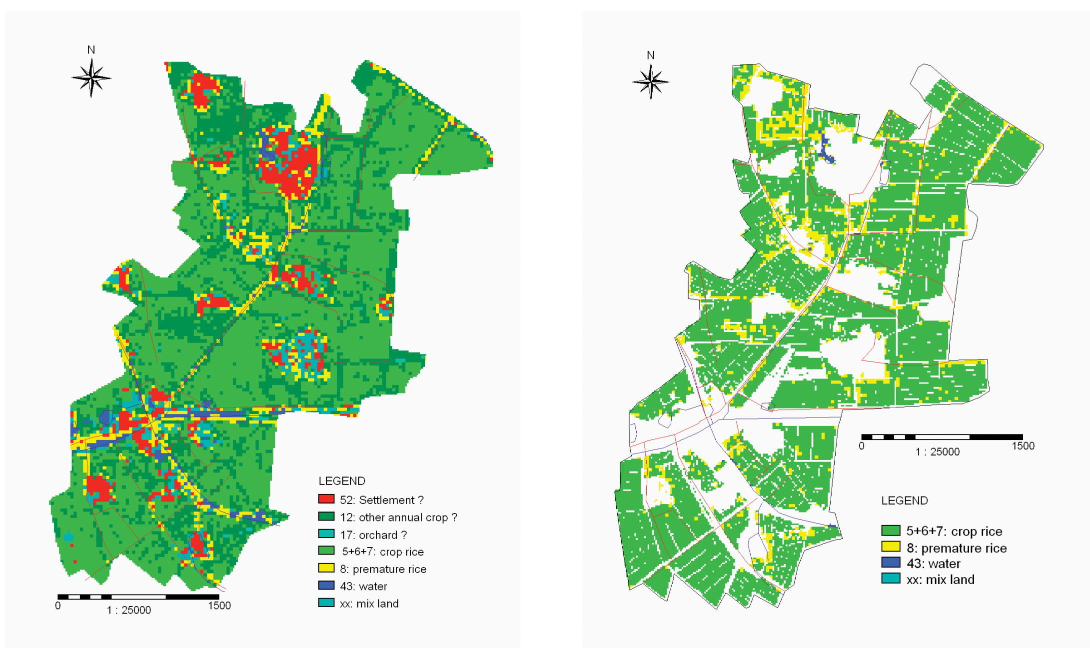
The segmented-image created by using farmland parcel boundary and vegetation mask derived from NDVI image must cover enough number of pixels for applying the supervised classification method. Vegetation mask was divided into crop rice and sown land according to the difference in spectral response of crop rice and sown land at the time of image acquisition. The detailed land use classes were given in the Figure 3(a). Meanwhile, a classification of the same area without LR data was performed in order to make comparison (Figure 3(a)).

The accuracy of LR-aided classification method was calculated using confusion matrix to reach nearly 92%, while the accuracy of non LR-aided classification is around 81 % (table 1). When overlaying parcel boundary on the result of non LR-aided classification, it is found that land use features scatter even in one



(a) (b)

Figure 2: Cadastral map & Segmented NDVI image by threshold



(a) (b)

Figure 3: Result of LR-aided classification (a), and non LR-aided classification (b)

parcel boundary while they are quite homogeneous in LR-aided classification's result. These results and verifications reveal that LR-aided classification is a feasible method to extract reliable land use data.

3.2 Results Analysis

The case study show that, even in official sources for land use data, one still see the differences between LR and land use statistics (Table 1). Even though the differences in this case are not much that means that the approach of generalization and aggregation of land use data from LR is a potential approach for LU acquisition.

The LR-aided approach gives more reliable data when we compare the figure for land use at farmland and cropland class in Table 1. The figure of 672 ha is closer and more persuadable to land use statistic and LR than the result of the traditional approach without LR-aided classification - 923 ha.

Technically, LR-aided classification method could separate spectral reflectance of other land use classes that is similar to spectral reflectance of farm land group, for instance, orchards and 2 crops rice, other annual cultivation land and crop land...Furthermore, LR-aided approach allows end user to see the differences of land use data at land parcel level. This ability will support the verification work for land use data, which can be supplied at any decision-making levels.

4. Conclusions and Recommendation

The study reveals that: (1) LR is important geographic information for RS analyst; (2) LR-aided classification could give reliable and detailed land use information.

Although land use information is assessed to be quite precise, the accuracy of this study is limited in resolution of RS data, number of needed multi-temporal data and in-depth studies on rice spectral response. Without a proper understanding of each land use classes and their behavior relating to RS detectors, confuse and miss classification may occurs. For 60 classes of LUCS, it needs to develop modern technology enabling a complete and rapid land use detection. Among these, RS with the LR-aided classification method is a typical application of modern technology. Although this study was conducted at commune, the ability of extending further study in this direction is available in conditions of Vietnam Land Administration.

However, to make this idea becoming an implementation procedure in practice, more work for experience at all levels of LUCS, all kind of land use classes should be tested. Furthermore, this study has to be extended for provincial level instead of communal level. Therefore, the combination or using LA data for RS land use detection still an opening question for further researches.

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Table 1: The differences of LU from differences sources & approaches

Unit: Ha

Code	Class	Land Rights Registration	Land use statistic	RS with LR-aid	RS without LR-aid
I.1.a	Farm land	688	685	672	923
I.1.a.1-3	Crop rice	No data	615	596	717
I.1.a.4	Sown land	No data	70	76	206
	Other				16

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