APPLICATION OF REMOTE SENSING IN LAND USE CHANGE PATTERN IN DA NANG CITY, VIETNAM

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ABSTRACT

After 1997 when Da Nang became one of five central cities of Vietnam, the urbanization makes land use in the city change rapidly. Observation the land use change spatial and its pattern is necessary for urban planning of the city. Remote sensing data is used for recognition the land use changes and patterns in whole city. Several image processing methods had been applied: image change detection; pixel-based classification, object-based classification for the series of satellite image from 1990 to 2007. The image interpretation and field data had been used for verification. Result of the study shows that the object-based classification can be applied successfully for land use change pattern of the city, even with the mid-resolution Landsat ETM images. Based on the land use change pattern observed, the study brings recommendation for sustainable development of the city.

1. INTRODUCTION

Danang City is one of the strong urbanization city in Vietnam in recent years. The urban expansion driven by economic factors - social and geographical factors as population growth, economic development - political (Xiao et al, 2005). As the city expanded under nature of the development pressure, the boundaries between urban change as well. Expanding urban in the way out of control and changing land use pattern brings issues (Brook and Davila 2000), including both positive and negative impact for the natural environment as well as society and economy. This study aims to estimation the change of urban of Danang in the recent years, from 1990 to 2007 by using satellite images.

The use of satellite imagery which has a medium resolution such as Landsat TM to assess the changes in Danang city has many difficulties. The challengers come from the nature of structure of urban land from – formed from smaller than 30 meters constructions (the streets, the individual houses etc ...). Accordingly, the visual interpretation methods as well as image classification have met with some difficult challenges to overcome. Selected method object - based classification can be considered as possible solution. This method applied in Danang has shown considerable potential applications, especially when it is supplemented by the visual interpretation.

2. METHODOLOGY

2.1 Satellite image used

Satellite image data used in this study are Landsat TM and ETM images taken in 1990, 2001 and 2007. In addition, a high resolution Spot Image (2.5 m) was used to create training classes (sample) and test the results.

2.2 Image segmentation

Assessing changes in satellite images can be made by many different methods, including the most often used: post classification assessment. With the post classification assessment method, the process of information extraction (i.e. classification methods) is very important. Both visual interpretation and digital image classification methods have advantages and certain disadvantages. From recent years, object-based classification method is used widely and brings remarkable results. However, it is remarked that most satellite image data used in the object-based classification studies is very high resolution (such as Ikonos, QuickBird, etc.) or high resolution (such as SPOT 5, AVENIR, etc.). There is no many studies applied object-based classification for medium resolution image such as Landsat TM.

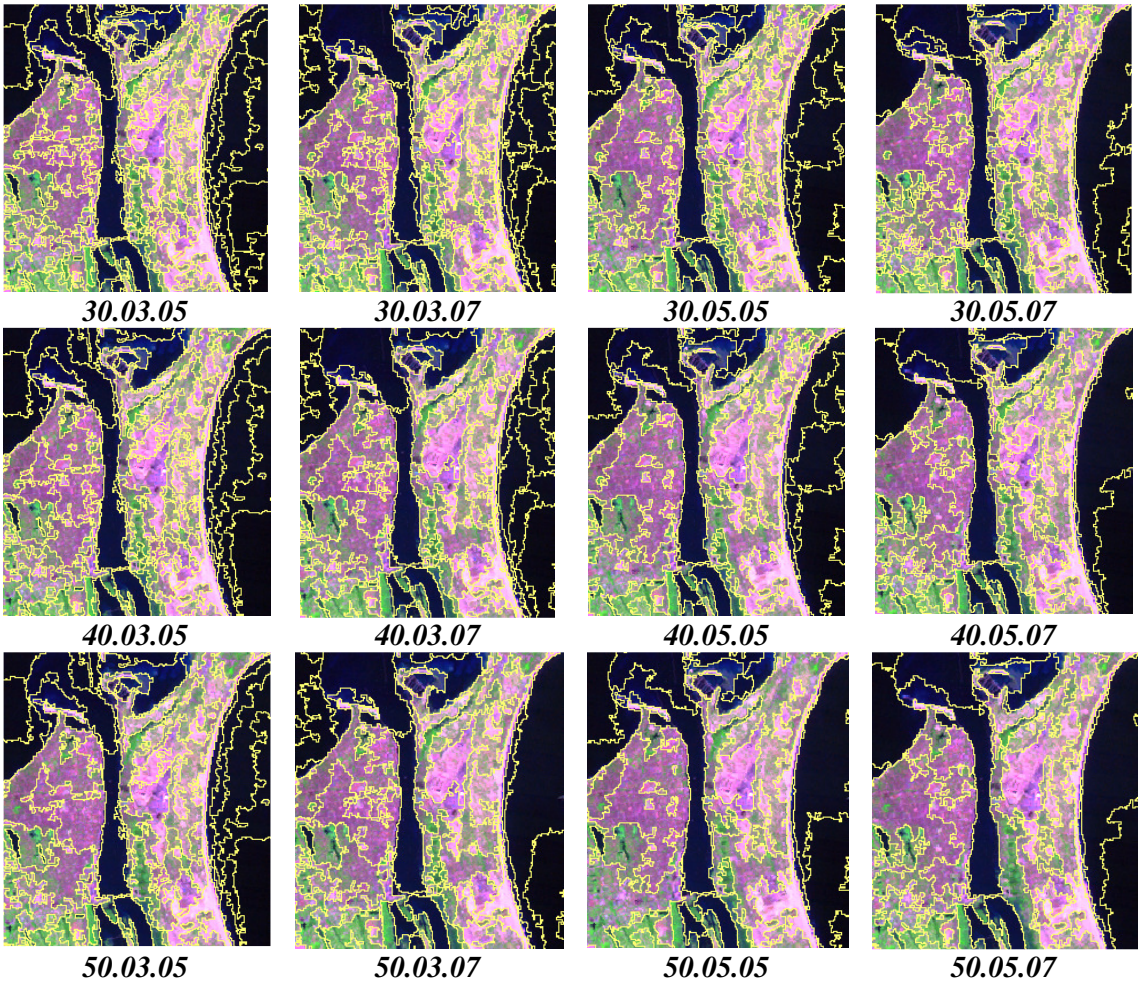
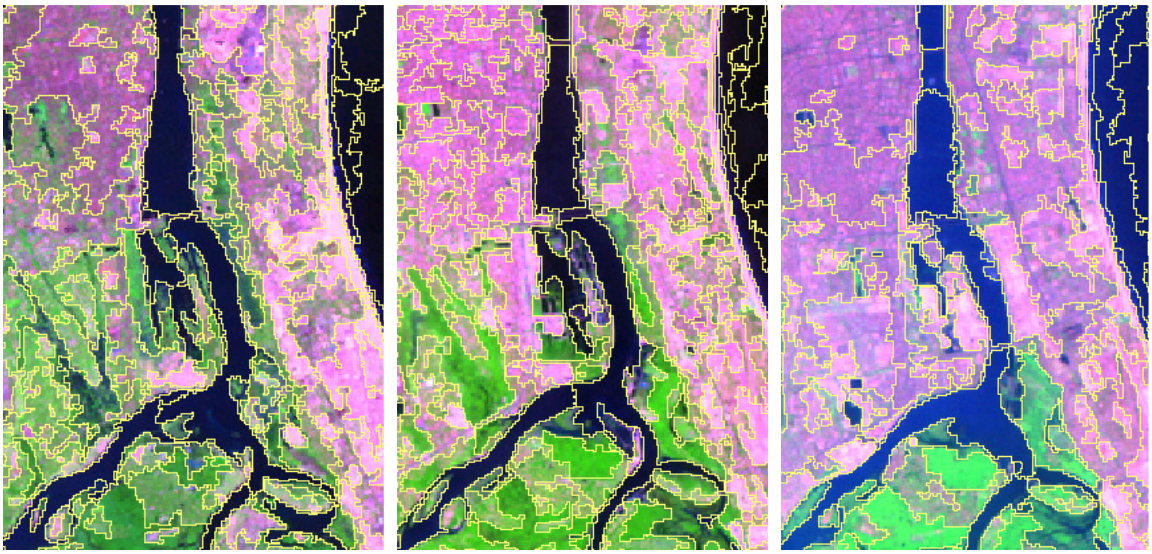


Figure 1. Parameters effect to segmentation. ***Threshold. Shape. Compactness***

One of the important issues of object based classification method is segmentation process. This process requires scrutiny in order to achieve the acceptable accurate classification result. In this study, we have used different parameters to examine the effectiveness of the segmentation process (see Figure 1).

It is clear that the choice of segmentation parameters is depended on the **scale** of the study. In this study, with the intended scale 1:50.000 and based on statistical parameters classification the parameters are chosen as threshold 40; shape 0.5, compactness 0.5. Utilization of the different segmentation software also significantly affects the results (Tuan, 2010). In this study, we used the software from University of Berkeley. All three image segmentation results are shown in Figure 2.



1990 2001 2007

Figure 2. Image segmentation

2.2 Object based classification

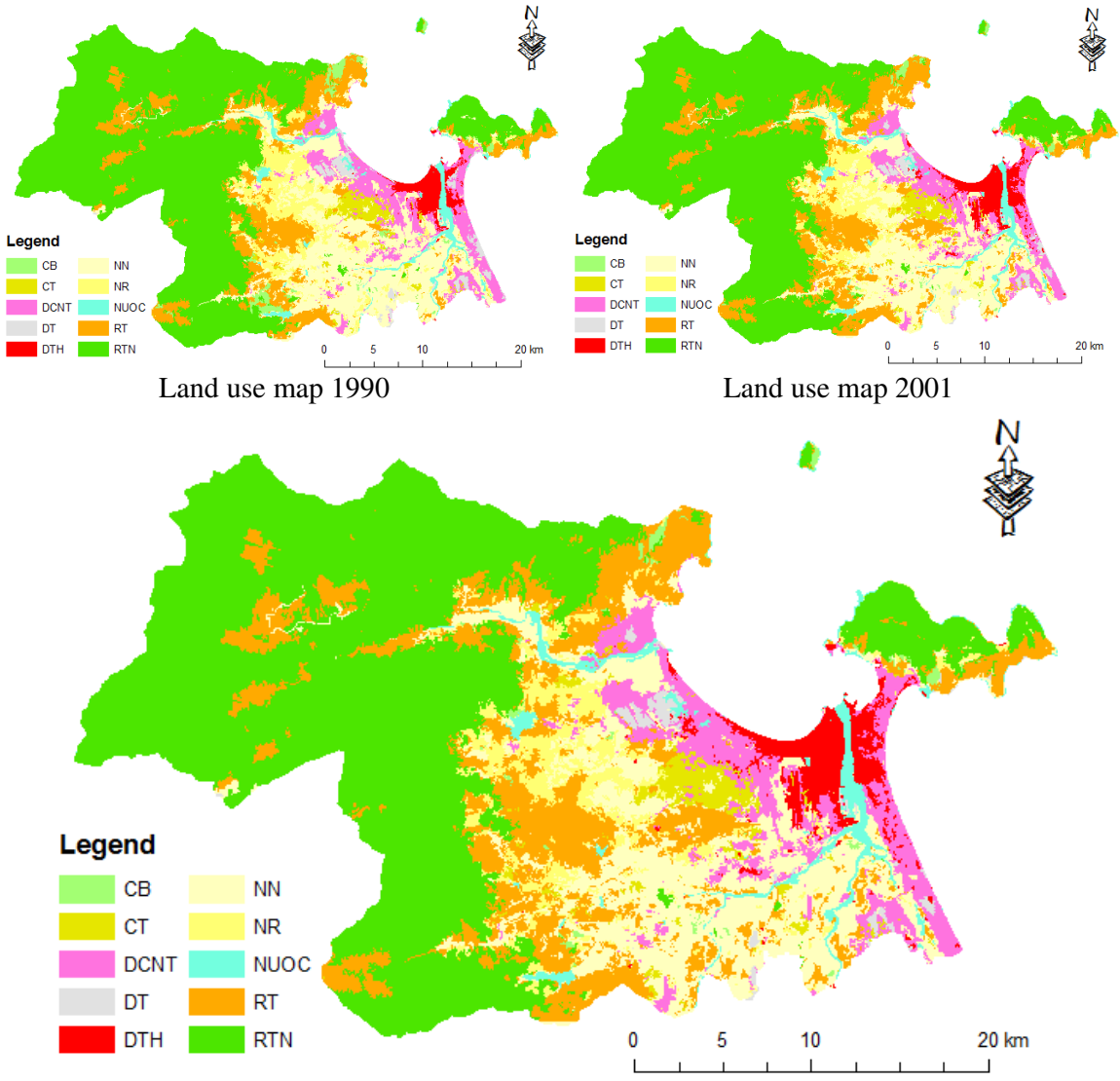
The following step of segmentation is classification - or to assign write attribute values for the polygon. In order to classify the segmented image, image statistical parameters for each polygon was calculated, including the value of mean, standard deviation of each band.

In this study, open source software named "Weka" (stand for "Waikato Environment for Knowledge Analysis") is used for image supervised classification. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization. It is also well-suited for developing new machine learning schemes.

First of all, statistical parameters were calculated for each polygon: mean; STD. In fact, it can be calculate for unlimited number of image channel. Then, the sampling process has been carried out. In reality, this is a process of image interpretation based on segmentation results. The numbers of polygons which would be entered attribute (i.e. interpretation) is about from 5% to 10% of the total number of polygons (Tuan,2010). Naturally, the accuracy of results strongly depends on the accuracy of the sampling process. The attribute table with "train class" column then is imported into Weka for classification.

Classification algorithm was chosen as "Random Forest" (Breiman L., 2001).

Classified results are stored as a new column named "predictclass" in the attribute table. There are also several tools for classification results assessment on Weka. The train layer for classification is sampled by image interpretation of SPOT 2.5 m. The statistical parameters of polygon of train layer also be calculated according Landsat images instead of SPOT image. This statistical data were used as reference information in the classification process. The classification results are shown in figure 3 bellows.



Land use map 1990 Land use map 2001

Land use map 2007. Legend: CB- shrub; CT - plantation; DCNT – rural residential area; DT – unused land; DTH – urban; NN – paddy; NR – nonirrigated agriculture; NUOC – water; RT – plantation forest; RTN – natural forest

Figure 3. Land use map of Danang City, year 1990; 2001 and 2007

Table 1. Statistics area of land use types in Da Nang

Land use	Area 1990 (ha)	Area 2001 (ha)	Area 2007 (ha)
Shrub	1253.8	565.45	457.91

Plantation	1749.7	1798.04	1802.05
Rural residential area	6459.6	6318.09	6600.63
Unused land	1464.4	1098.19	773.52
Urban	1731.0	2594.10	2843.49
Paddy	17222.8	15928.52	14661.68
Non-irrigated agriculture	6110.2	5657.27	5020.57
Water	2187.2	2187.22	2187.22
Plantation forest	12626.0	14800.57	16911.70
Natural forest	46417.3	46274.68	45963.36

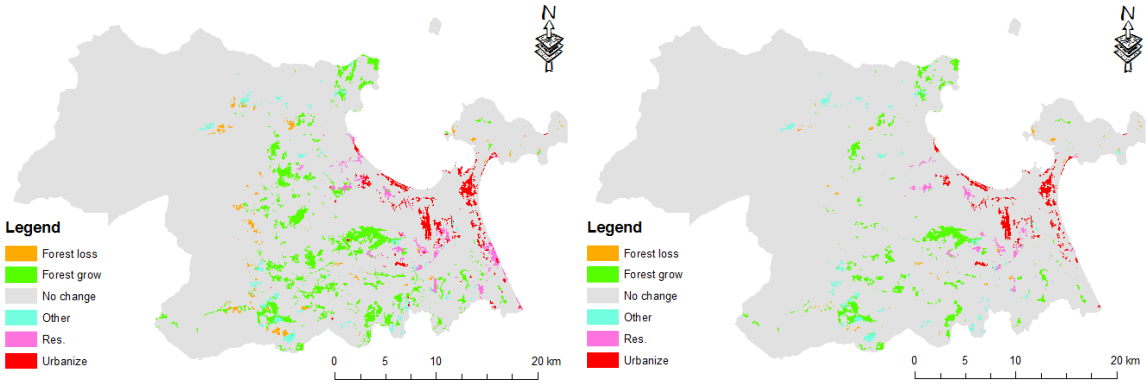
3. RESULT AND DISCUSSION

3.1 Land use change pattern in Danang City

To assess land use changes in Da Nang, the change of land use are grouped into the following groups (beside the "no change"):

- Forest loss: forest classes (natural and plantation forest) change to other non-forest classes
- Forest grow: Non-forest classes change to forest classes (natural and plantation forest)
- Res.: All classes change to "Rural residential area"
- Urbanize: All classes change to "Urban"
- Others: Change between other rest classes.

After overlay the land use maps of three dates, the land use change in Danang city is shown in figure 4 and table 2.



Change between 1990 and 2007 Change between 1990 and 2001

Figure 4. Land use change map of Danang City

Table 2. Change type and area of land use in Danang city

Change type	Change area (ha)		
	From 1990 to 2001	From 2001 to 2007	From 1990 to 2007
FL/Res.	2.5	0.0	2.5
FL/Urb	0.6	0.0	0.6
Forest grow	2171.2	2169.7	4340.0

Forest loss	136.1	369.8	505.1
No change	93056.7	93996.2	89837.1
Other	629.8	43.9	669.1
Res.	362.8	394.1	756.9
Urbanize	862.4	248.4	1110.9

3.2 Urban expansion of Danang city

Spatially, the urbanization in Danang held strongly into the south and east, at the districts Hai Chau, Thanh Khe and Ngu Hanh Son, at right bank of Han River and along My Khe beach.

Urbanization in Hai Chau is most powerful (in this district, dominant land-use changes is urbanization), urbanized area from 1990 to 2007 up to 300 hectares. The urbanization in Thanh Khe district is 108 hectares, smaller than Hai Chau district, because it is basically stable, the municipality was formed long time ago. The Ngu Hanh Son (156 ha) and Lien Chieu district (154.6 ha) also has relatively high speed of urbanization due to the expansion of new urban and industrial areas.

Most remarkable urbanization is in Son Tra district, where the urbanized area reached 313 hectares. The character of urbanization in this district is that the urbanization process is accompanied with forest loss. Clearly, the natural forest and plantations had to be disappeared for the other needs (rural residential area is also increased more than 10 hectares, with 25% of them moved from the forest area).

Timely, the urbanization in Da Nang happening faster at from 1990 to 2001 in comparison with from 2001 to 2007.

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