APPLYING GIS AND RS TO ASSESS THE URBANIZATION PROCESS IN DA NANG CITY FROM 1989 TO 2014

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ABSTRACT

Da Nang City is an important economic-social center of Central Vietnam. In recent years, along with the economic development, the urbanization process in Da Nang City occurs with a rapid rate. The urbanization process brings benefits and challenges to the managers of Da Nang City. The determination of characteristics of the urbanization process has important implications in building the appropriate urban management strategies for Da Nang City, helps the managers of this city promoting the benefits and overcome the challenges. This research uses GIS and RS techniques to assess the urbanization process in Da Nang City in the period from 1989 to 2014. To address the research goal, the author combines the multispectral classification, NDVI calculation and principal component analysis (PCA) methods to interpret six Landsat images (1989, 1996, 2003, 2007, 2010, 2014), then uses the GIS tools to build the urban land distribution maps and bases on them to determine the characteristics of the urbanization process in this city over the years. This research has shown the main features of the urbanization process in Da Nang City from 1989 to 2014, helps the managers gain a more comprehensive view of the urbanization process in this city.
Keywords: Urbanization process; Da Nang City; GIS; RS; Landsat Image.

1. INTRODUCTION

Urbanization is the process that cities and towns are formed and they become larger over time as more and more people begin living and working in these areas (Merriam-Webster, 2014). This process began during the industrial revolution, when people moved towards cities for getting jobs in industries. Urbanization is an inevitable process that is going on very strong in the world, especially in Asian developing countries like Vietnam.

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This research uses GIS and RS techniques to assess the urbanization process in the study area in the period from 1989 to 2014. To address the research goal, the author combines the multispectral classification, NDVI calculation and PCA methods to interpret the Landsat images of the study area, then uses the GIS tools to build the urban land distribution maps and bases on them to determine the characteristics of the urbanization process in the study area over the years. The study area in this research is the entire of Da Nang City with six districts and two counties.

2. METHODS AND DATA

2.1 Methods

The whole research process is divided into four phases: (1) collecting and correcting Landsat images, (2) enhancing image quality and transforming Landsat images, (3) classifying Landsat images and assessing the accuracy of classification process, (4) building distribution maps, estimating urban land area and evaluating results. The detailed research process diagram is shown in the Figure 1.

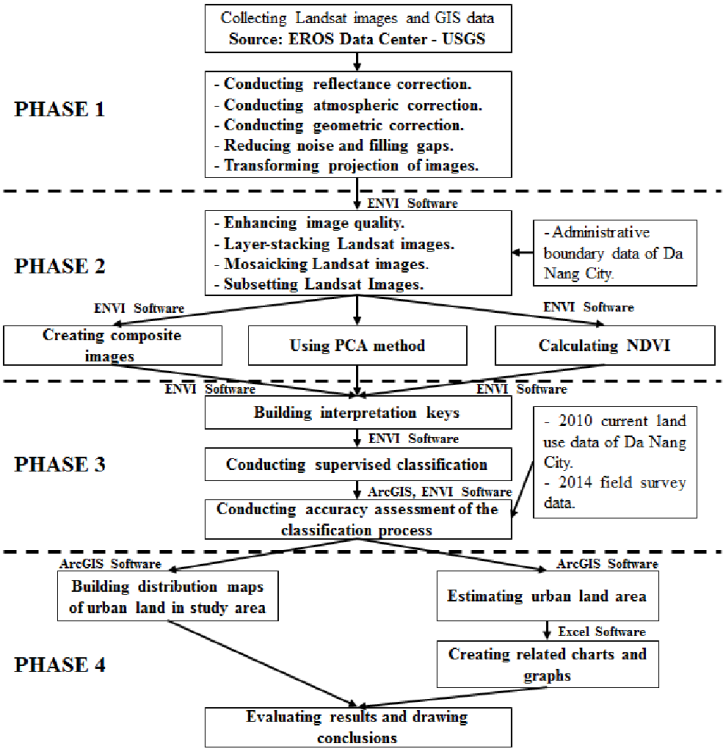


Figure 1. Detailed research process diagram.

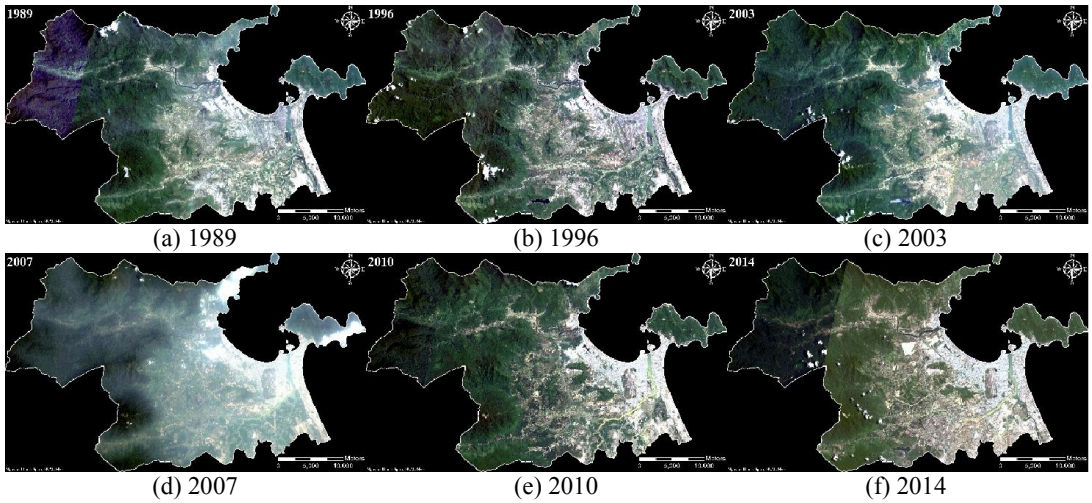
2.2 Data

To conduct this research, the author uses three types of data: (1) remote sensing data, (2) GIS data, (3) field survey data. The remote sensing data used in this research is the Landsat images of six years 1989, 1996, 2003, 2007, 2010 and 2014 of the study area. The second type of data used in this research is the GIS data of the study area. The GIS data includes administrative boundaries, land use, main roads, rivers and streams of the study area. The third type of data used in this research is the field survey data of the study area. The field survey data is collected in 2014 with two Garmin GPSMAP 60CSx handheld GPS navigators.

3. RESULTS AND DISCUSSION

3.1 Results of creating composite images, using PCA method and calculating NDVI

The Landsat images are corrected, enhanced image quality and subsetted based on the administrative boundary data of the study area. After subsetting images, the author creates the natural-color composite images from the subsetted images. In the natural-color composite images, each land cover type has a specific color. This helps the interpreter easy to distinguish between the different land cover types in the study area. The natural-color composite images of the study area are shown in the Figure 2.

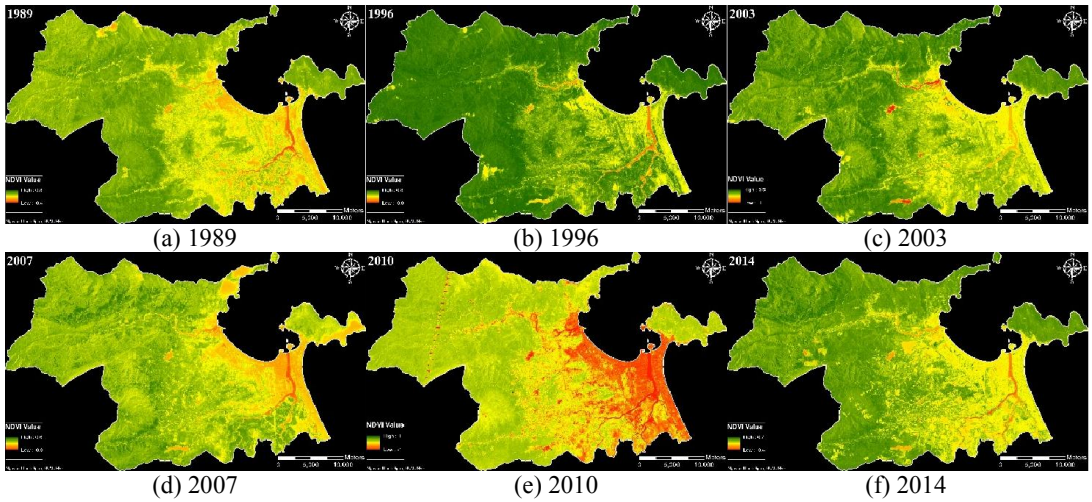


(a) 1989 (b) 1996 (c) 2003

(d) 2007 (e) 2010 (f) 2014

Figure 2. Natural-color composite images of the study area.

Besides creating composite images, the author also calculate NDVI for the subsetted images. The NDVI helps the interpreter determine the density of vegetation in the study area. The NDVI images of the study area are shown in the Figure 3.

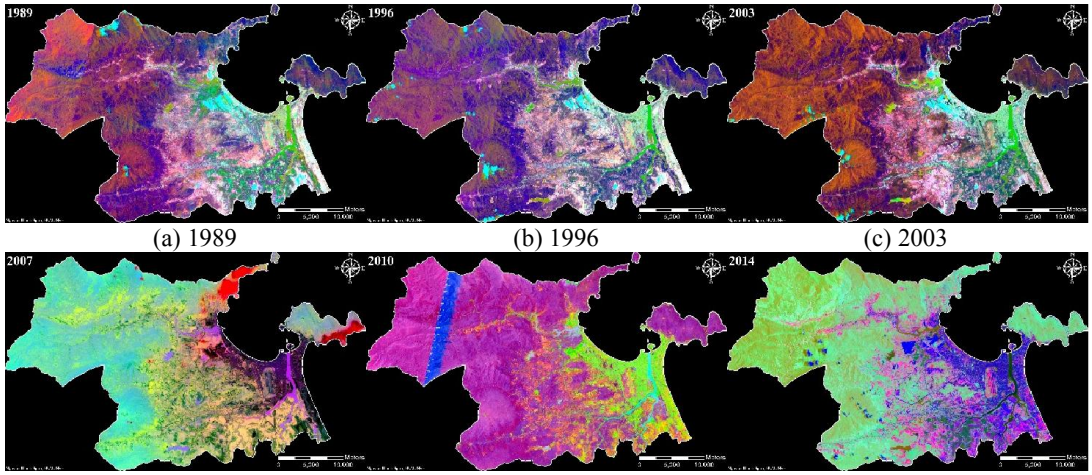


(a) 1989 (b) 1996 (c) 2003

(d) 2007 (e) 2010 (f) 2014

Figure 3. NDVI images of the study area.

In addition, the author also uses the PCA method on the subsetted images. The PCA method is used for eliminating the redundant information and highlighting the principal components in the subsetted images. This helps to increase the interpretability of the interpreter and improve the accuracy of the classification process. The Figure 4 shows the Principal components 3,2,1 composite images of the study area.



(a) 1989 (b) 1996 (c) 2003

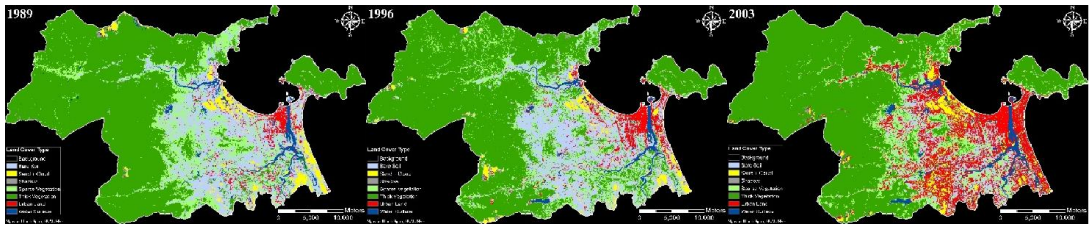
(d) 2007 (e) 2010 (f) 2014

Figure 4. Principal components 3,2,1 composite images of the study area.

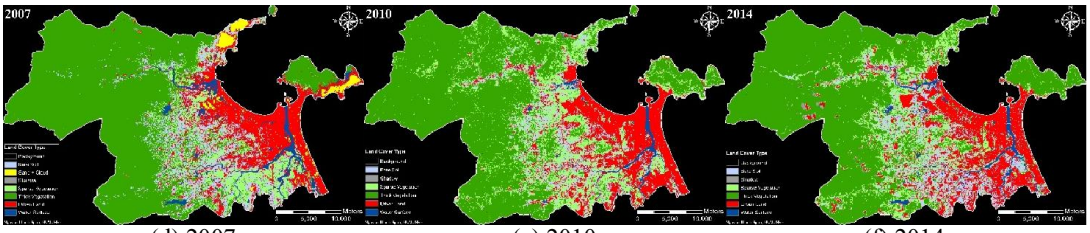
3.2 Results of classifying images and assessing the accuracy of classification process

After building the interpretation keys, the author conducts supervised classification on the subsetted images. The supervised classification algorithm that the author used in this research is Maximum Likelihood algorithm. This process separates the study area into six main land cover types: bare soil, sand, sparse vegetation, thick vegetation, urban land and water surface. The supervised classification results of the study area are shown in the Figure 5.

In order to assess the accuracy of the classification process, the author conducts to build the base error matrices from the classification results. These matrices help to calculate the Kappa coefficient and the overall accuracy of the classification process. Because of the lack of reference data, the author can only assess the accuracy for the classification results from 2010 and 2014 images. With the classification results from 2010 images, the Kappa coefficient value is 81.2262% and the overall accuracy value is 85.1373%. With the classification results from 2014 images, the Kappa coefficient value is 84.1138% and the overall accuracy value is 87.7264%. From the results obtained, both the classification results from 2010 and 2014 images have the high accuracy and achieve the image classification standard of USGS (the Kappa coefficient value should be greater than 80% and the overall accuracy value should be greater than 85%).



(a) 1989 (b) 1996 (c) 2003



(d) 2007 (e) 2010 (f) 2014

Figure 5. Supervised classification results of the study area.

From the classification results, the author estimates the percentage of land cover types in the study area over the years. The Figure 6 shows the chart of percentage of land cover types in the study area from 1989 to 2014.

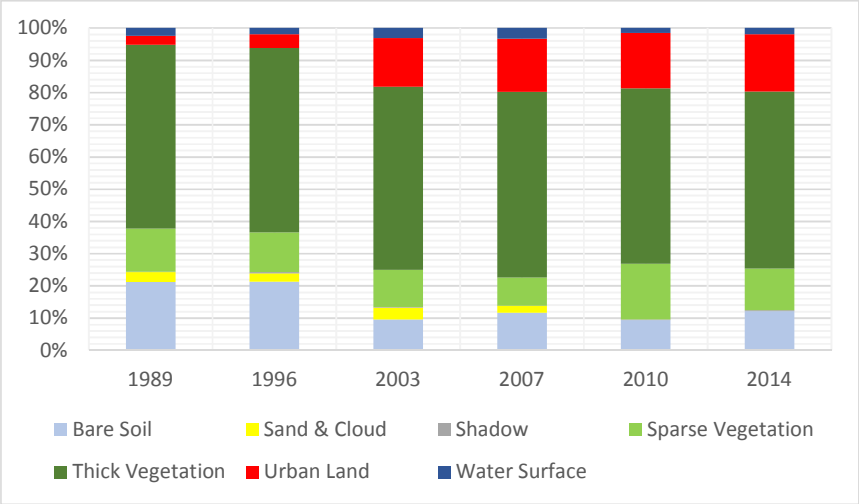
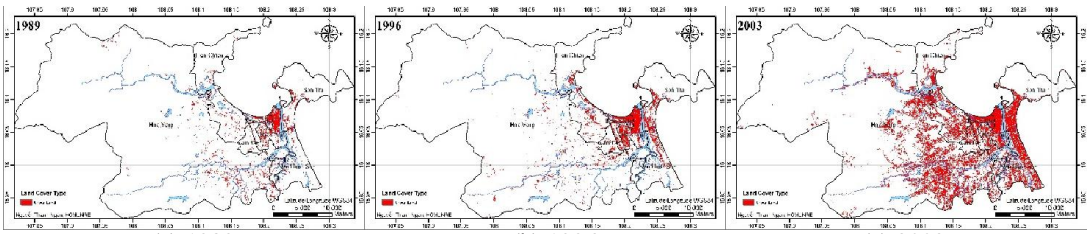


Figure 6. Chart of percentage of land cover types in the study area from 1989 to 2014.

3.3 Results of building distribution maps and estimating urban land area

After performing supervised classification, the author conducts to extract the urban land data from the classification results. The urban land data is combined with the other GIS data (administrative boundaries, rivers and streams) to build the urban land distribution maps of the study area. These maps are shown in the Figure 7.



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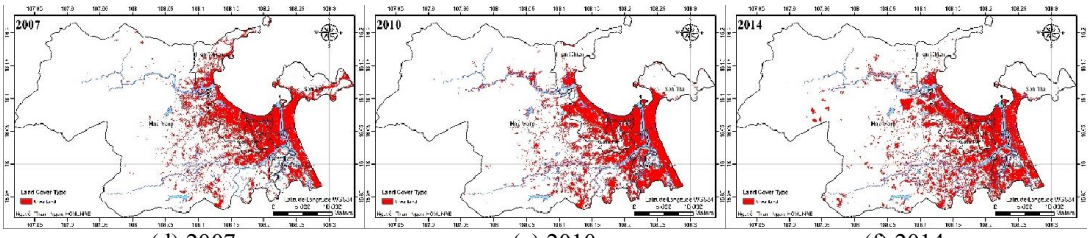

(d) 2007 (e) 2010 (f) 2014

Figure 7. Urban land distribution maps of the study area.

Besides building the urban land distribution maps, the author also uses the urban land data to estimate the urban land area and the percentage of urban land in the study area. The results of this process are shown in the Table 1. After estimating the urban land area, the author uses these results to create the graph of the urban land area in the study area from 1989 to 2014. This graph is shown in the Figure 8.

Table 1. Area value and percentage of urban land in the study area from 1989 to 2014.

Year	Urban land pixels	Urban land area (km^2)	Percent to total area (%)
1989	31,202	28.0818	2.1847
1996	47,206	42.4854	3.3052
2003	164,002	147.6018	11.4829
2007	178,376	160.5384	12.4894
2010	186,946	168.2514	13.0894
2014	193,407	174.0663	13.5418

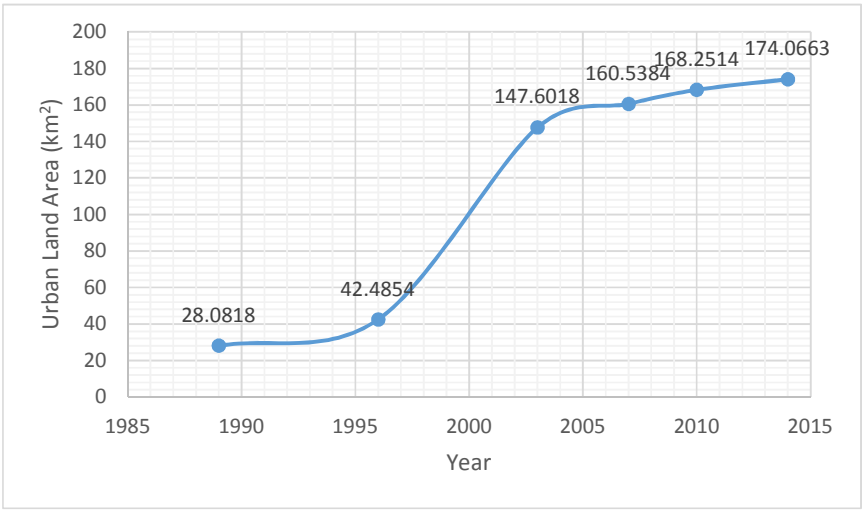

Figure 8. Graph of the urban land area in the study area from 1989 to 2014.

Based on the graph in the Figure 8, the author identifies the changing trend of the urban land area in the study area from 1989 to 2014. In five study periods, the urban land area in the study area tends to increase rapidly. The period in which the urban land area in the study grows fastest is from 1996 to 2003 (seven years), with the growth rate about 247.4177% (about

35.3454% each year). Besides, based on the maps in the Figure 7, the authors also identifies the regional distribution of urban land in the study area. In the period from 1989 to 1996, the urban land is mainly distributed in three districts: Hai Chau District, Son Tra District and Thanh Khe District. In the period from 2007 to 2014, the urban land is mainly distributed in six districts: Cam Le District, Lien Chieu District, Hai Chau District, Ngu Hanh Son District, Son Tra District and Thanh Khe District.

4. CONCLUDING REMARKS

From the results obtained, the author finds that this research has fully solved the research goal. This research has identified the area value, the changing trend, the percentage and the growth rate of urban land in the study area in the period from 1989 to 2014. Besides, this research has also determined the characteristics of the regional distribution of urban land in the study area. These are valuable data for support the managers of Da Nang City in building the appropriate urban management strategies. In addition, through this research, the author has built a process to interpret Landsat image, estimate the land cover area and create land cover map from Landsat image. This will be a useful reference for the similar studies in this field. For the similar studies, the author recommends using the satellite images which have higher spatial resolution to increase the accuracy and the reliability of the classification process.

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