STUDY ON URBAN GROWTH OF HANOI USING MULTITEMPORAL AND MULTISENSOR REMOTE SENSING DATA

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ABSTRACT

Hanoi is the capital of Vietnam with population of about 2.5 millions. Recent development in economy has obvious impact on growth of Hanoi City. This change can be monitored using multitemporal remote sensing images. In this study, the authors use multitemporal remote sensing images from 1975 to 2001 to monitor the growth of Hanoi city areas. The remote sensing data set is composed of LANDSAT MSS, TM, SPOT and TERRA ASTER images. These images have been geo-referenced and resample to 15 m resolution. Both visual interpretation and Maximum Likelihood classification methods have been applied. Finally, a map of urban growth of Hanoi was established. By combination of socio-economic and other local geographical information with results derived from remote sensing data analysis some discussions on urban growth of Hanoi from 1975 to 2001 was presented. The study also aims to demonstrate usefulness of mutitemporal remote sensing data usage to monitor dynamic phenomena such as urban growth.

1. Introduction

Since 1975 Vietnam has experienced several economic development phases with different stamps of success. One of the most important milestone in development that influenced in great scale on growth of Hanoi City is transition from a centrally planned to market-oriented economy. The *doi moi (reform)* economic liberalization policies embarked in the mid-1980s have spurred unprecedented rates of economic growth and industrial development. One of the most evident effects of economic growth is the urbanization of agricultural land and the rural to urban migration of laborers. The rate of urban expansion is expected to escalate as reforms continue and populations flood the cities in search of new economic opportunities. Together with Haiphong and Quang Ninh, Hanoi is at the center of the Red River Delta, one of the most important development triangles in Vietnam. The region sits on a large floodplain and patchwork of rice paddies, transected by numerous irrigation canals. Continued urban expansion will have significant impacts on agriculture, drainage patterns, the occurrence of urban flooding, and sustainable land use. In this study, we use data from four sensors MSS, TM, SPOT HRV and ASTER, to examine urban growth dynamics in the Hanoi area between 1975 and 2001

2. Methods

The satellite data is composed of 6 images (table 1). The images were registered to the 2001 ASTER scenes with spatial resolution resampled to15 m. On figure 1 is shown Hanoi City from 1975 to 2001. Due to different spatial resolution the 1975 image appears as the coarsest. The 1975 year is time just after American War. Most constructions have been destroyed. There is not seen clear typical pattern for city on this image. It is easy to understand. Most urban area (built up area) were under tree coverage. One can find out hardly some infrastructures such as roads, old city and big constructions like railway station, factories etc. Since then the city has been rapidly developed. In 1984 the city could be very well interpreted by both colour shades and urban structure. From 1986 to 2001, the city has been continuously expanded. The change could be qualitatively recognized by visual

interpretation, however, for quantitative evaluation we have selected only images of the last three dates 10/21/1992, 12/20/1999 and 11/16/2001.

Table 1. Characteristics of imagery used in the study

Scene	Acquisition Date	Bands Used (μm)	Resolution (m)
MSS	12/29/75 05/08/84	0.5 - 0.6 0.6 - 0.7 0.7 - 0.8	80
SPOT HRV	10/21/86	0.5 - 0.6 0.6 – 0.7 0.8 – 0.9	20
TM	10/21//92 12/20/99	0.52 - 0.60 0.63 - 0.69 0.76 - 0.90	30
ASTER	11/16/01	0.52 - 0.60 0.63 - 0.69 0.76 - 0.86	15

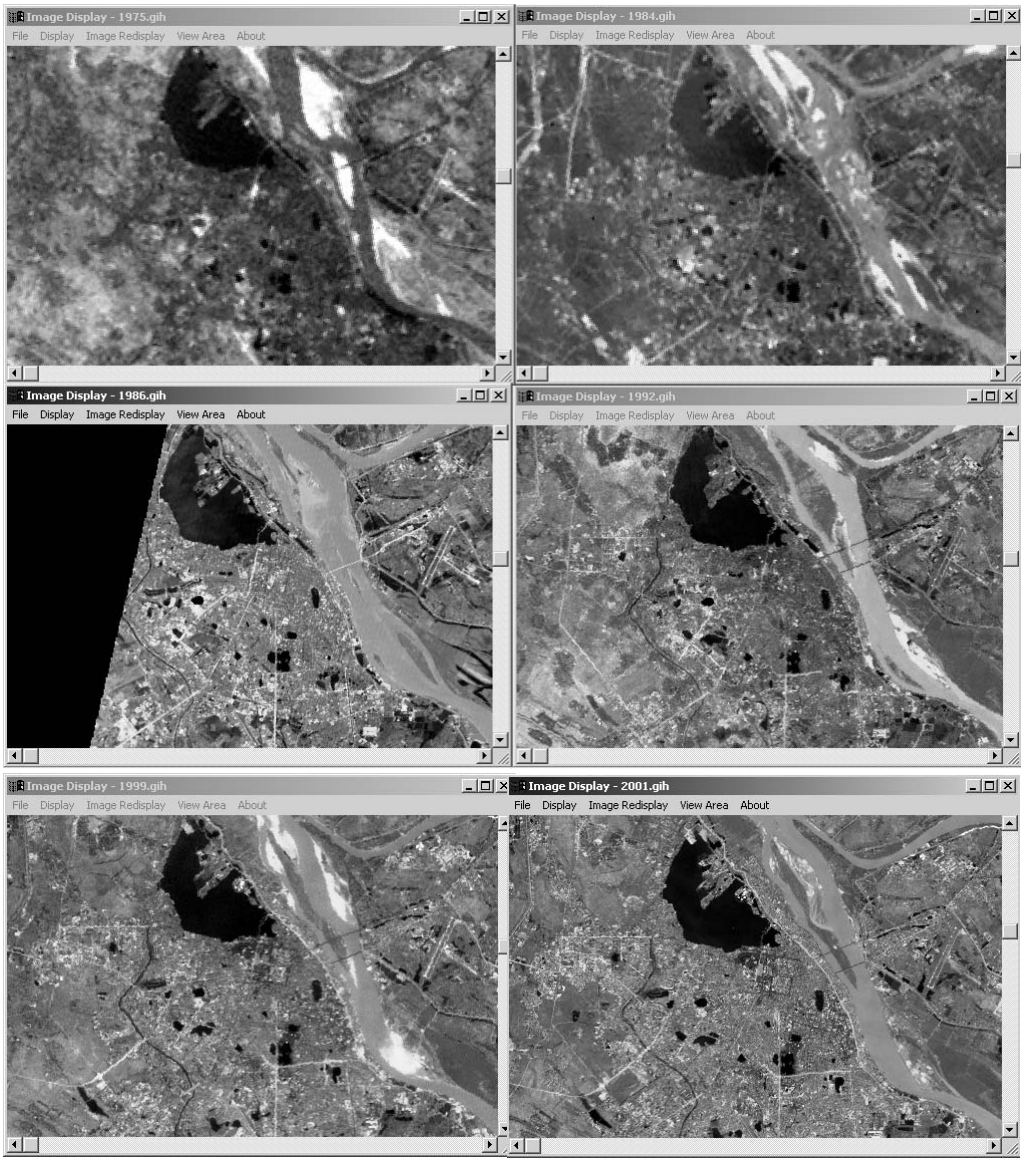


Figure 1. False colour composite of Hannoi city in 1975 (left top), 1984 (right top), 1986 (middle left), 1992 (middle right), 1999 (bottom left) and 2001 (bottom right)

These three images were acquired in almost same season so we can expect that seasonal change could be neglected. At first the ASTER image of 2001 was classified by Maximum likelihood method to define the largest extension of the city. The urban extension was used as mask image to limit the framework for change analysis. For simplification, we took study area only on the west site of the Red river delta.

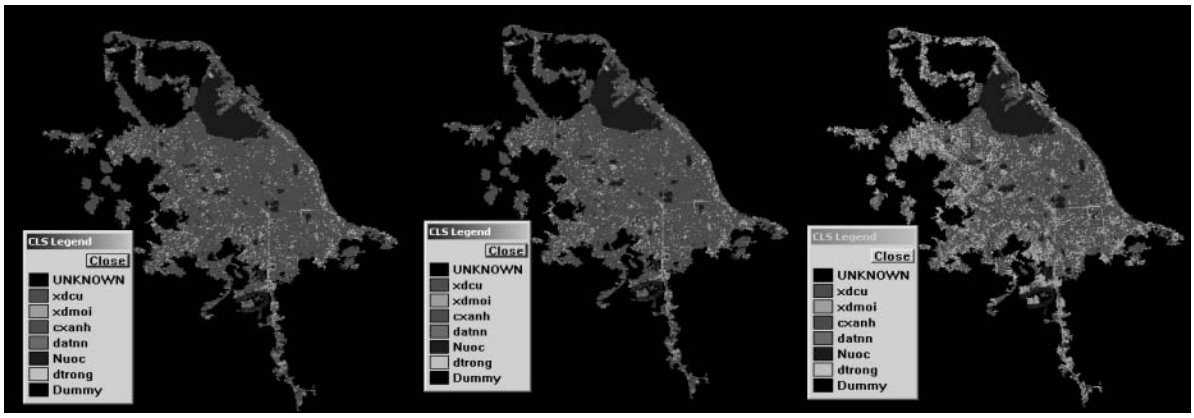


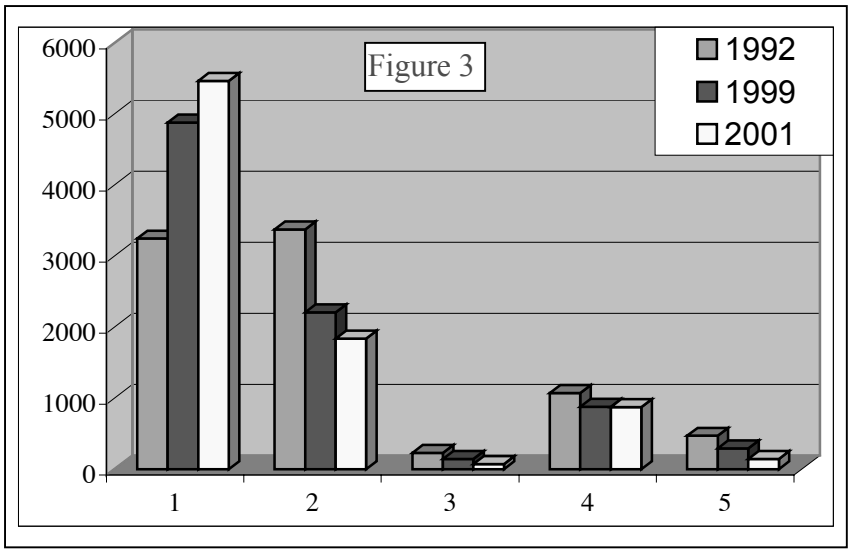
Figure 2. Urban area extraction by MLC. Hanoi in 1992 (left), 1999 (middle) and 2001 (right)

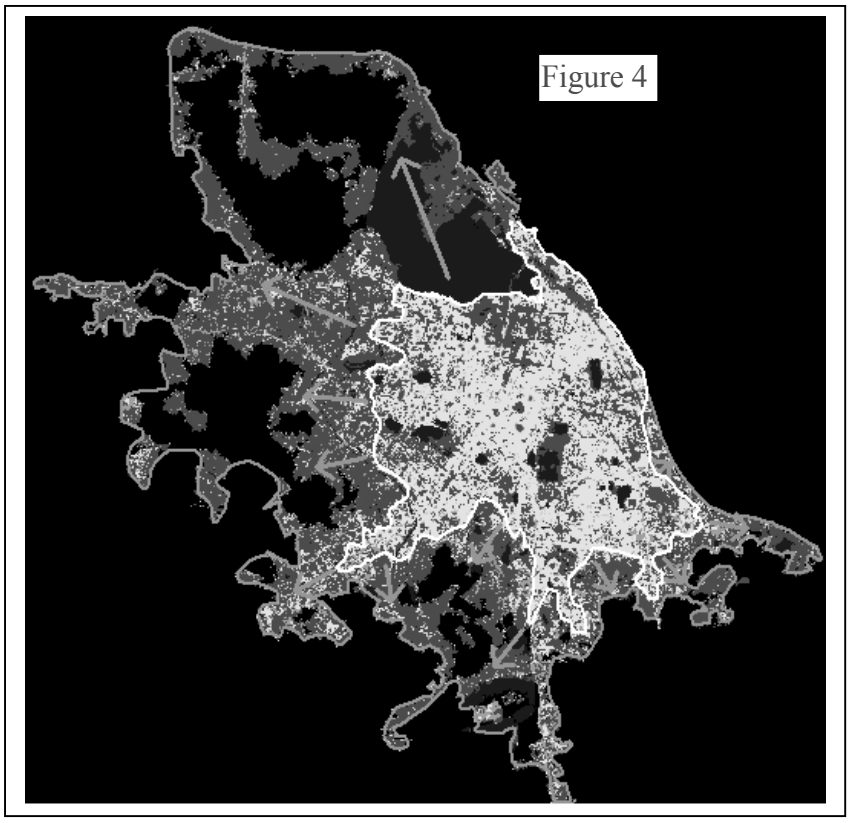
The classified images has 5 classes: old housing area, new construction, bare land, vegetation and water body. These classes were defined using GPS photo database and field work.

Figure 2. Training sample selection using GPS photo database

On figure 3 is shown graph of change analysis of Hanoi from 1992. For this purpose we merged the old to new construction class so that number of classes are only four. The urban development has result on increase of built up area and decrease of vegetation cover, agriculture land, bare land and water body. The built up area has been expanded from 3248 ha (1992) to 4882 ha (1999) and 5467 ha (2001). It is about 50% of city has been enlarged in period from 1992 to 1999 and 68% from 1992 to 2001. This development has led to loss of other resources such as agriculture land, vegetation cover and water bodies. Of cause, the loss of these resources is inevitable in urbanization, however, keeping rational proportion of them is key factor to ensure sustainability of the urban environment.

On figure 4 is shown spatial comparison of Hanoi in 1992 and 2001. The inner polygon is Hanoi City in 1992 and the outer boundary is Hanoi City in 2001. The boundaries have been visually interpreted by TM image in respective years. The arrows mark informatively direction of city growth. After almost ten years of development the city has been expanded to west and south sites. The east site is blocked by the Red river therefore the expansion could not take place much there. The development of Hanoi is tightly linked with development of Vietnam. The growth of GDP of Vietnam from 1991 to 1995 is 12.52% and from 1996 to 2000 is 10.38%. GDP growth of Hanoi for the period 1991-2000 is 2-3% higher than the country GDP growth. The change of proportion in land use detected by remote sensing data is reflected in some economic values. For instance, increase in built up area is influenced by housing development on one hand and also industrial infrastructure development. The GDP growth for industry sector is estimated for 15% /year for the past 5 years in Hanoi while agriculture GDP has gone down from 5.13% in 1996 to 3.8% in 2000. The urbanization process seems to follow transportation network development. Along new roads there have been established spontaneously light commerce centres which played leading role in formulation of new urban area. The foreign investment has played also positive role in pushing development of Hanoi.





3. Conclusion

Preliminary results indicate that multi-sensor and multitemporal data are useful for assessing urban growth dynamics. Thus far, we have only applied a simple classification algorithm to a limited set of spectral bands. Our next step is to evaluate the utility of

additional bands and other change detection approaches for our study area. The inclusion of SAR data could improve quality of classification by bringing more information on urban structure that the conventional optical data cannot provide. The Hanoi area is of historical, agricultural, and cultural importance. As such, monitoring urban growth in the region is important for understanding the direct and indirect effects of policy reforms on sustainable land use.

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