

Monitoring Urban Space Expansion Using Remote Sensing Data in Ha Long City, Quang Ninh Province in Vietnam

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Key words: VSW index, urban expansion, supervised classification.

SUMMARY

At the present, the innovation task has hastened the urbanization following the rate of economic development. Most of urban areas in Vietnam are improved, developed, expanded. Amongst them, Ha Long city is highly urbanized city in the center of economic triangle of Ha Noi – Hai Phong – Quang Ninh. The urbanization make a new face of the city and the urban space is more and more expanded. However, along with the enlargement, what the rule is and how the relationship with environmental elements around are? With the managers, knowing that information is an indispensable need.

Now, the strong development of remote sensing and GIS technology has helped us to study easily the urban space development. This research uses SPOT image to calculate VSW (Vegetation-Soil-Water) index images, what distinguishes clearly Vegetation, Soil and Water elements on the image. This ability of VSW index image is the base of detecting clearly urban area. The VSW index is calculated by the scatter plot of red band and near-infrared band, what is in almost of types of satellite image. Thus, applying VSW index method is an advantage in collecting image data. VSW index image is classified to 7 layers: Forest, shrub, mangrove, bare soil, coal exploitation area, water, urban. The comparison classified images over research periods to built change image, what shows the dimensions of expansion and the replated, replacing classes. The change images are later overlaid to traffic map and commune administrative map of HaLong city to obtain the map of expansion of each commune and the dimensions of expansion.

The research result shows that Ha Long city expands with differently rate over the study periods. The 1994 – 2004 period changes quickly but from 2004 to 2008 the rate of expansion is very slow. The figure of urban space expansion is along the Highway 18

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1. INTRODUCTION

Ha Long city is a famous sea tourist City in the Northeastern of Viet Nam for Ha Long bay, which is known to be recognized twice natural heritage of the world. The area of mainland of Ha Long is 22,250 ha, spreading on the coordinate of scale 20⁰55'N to 21⁰05'N and 106⁰50'E to 107⁰30'E.

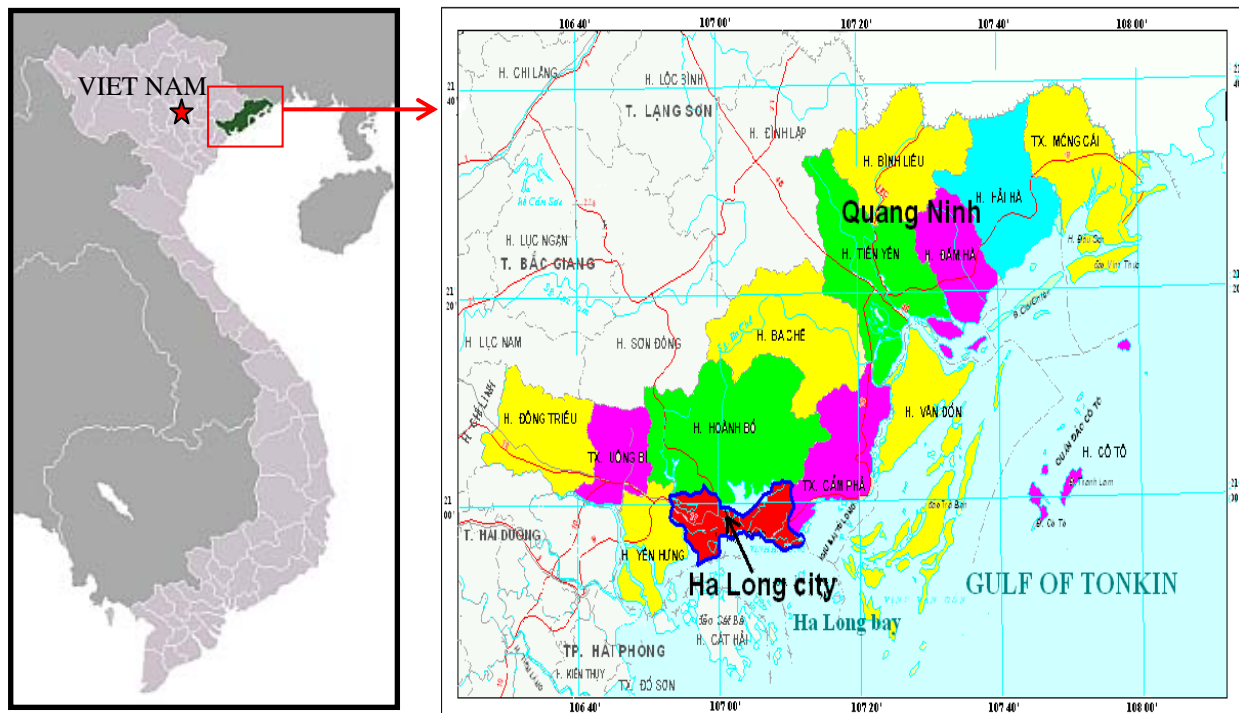


Figure 1: Study area of Ha Long city

Recent time, base on the advantages in tourism, traffic, shipbuilding and mining industry, the economy and sociality of Ha Long has developed rapidly, along with that is the incessant urban expansion. To monitor the direction of the urban space expansion of Ha Long, this paper used multi-temporal satellite images obtained during different periods of time from 1994 to 2008. For this study the supervised classification method using VWS index is applied to obtain the urban area. The classification result integrates with GIS to define urban expansion of Ha Long.

2 METHODOLOGY

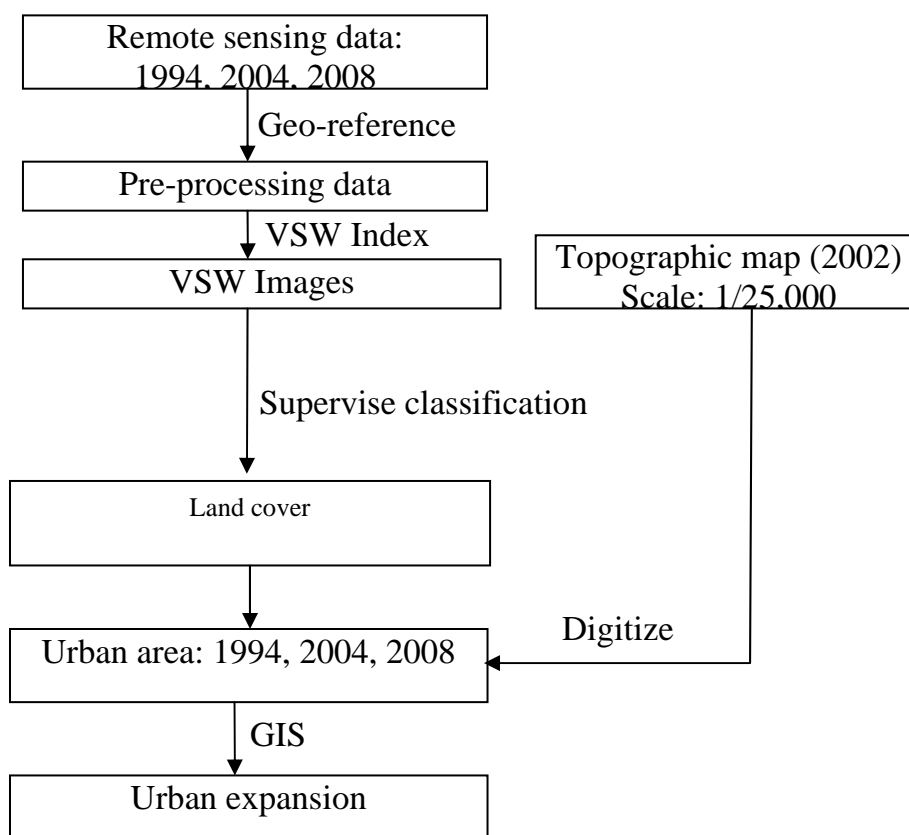


Figure 2: The study process for monitoring urban expansion

2.1 Data source

Data using in the research include: the multi-temporal dataset and topographic map are described in Table 1.

Order number	Data	Date	Resolution
1	Topographic map (1 :25.000)	2002	
2	SPOT	05/08/1994	10m
3	SPOT	04/07/2004	10m
4	AVNIR_2	01/03/2008	10m

Table 1: Data table

On the whole, the satellite images is clear, no cloud. Vegetation, bare soil and water element can define clearly on the images.

2.2 Geo-reference

Before using for analysis, the images are corrected geometric. At the geometric correction, control points are detected on the topographic map and the image 2008 with the RMS errors are estimated below 0.5pixel (5m). After that, the images at 1994 and 2004 are registered following the image 2008 base on UTM projection, datum WGS84, zone 48 Northern Hemisphere.

2.3 VSW index

The VSW index is defined as a natural extension of PVI index for monitoring not only vegetation conditions but also soil and water conditions as well (Yamagata, 1999). The VSW index is shown in Figure 3 which describes the relationship between VSW index and the end member triangle on a NIR-RED scatter plot. Distance of spectrum point P to each edge of the triangle is taken as representation of water, vegetation and soil. This study utilized the method to detect urban areas for finding the space urban expansion using time series data.

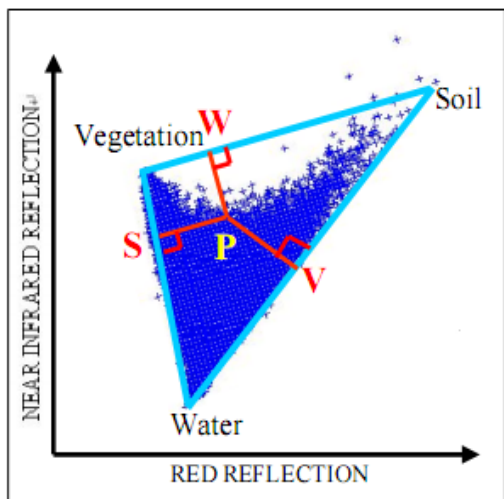


Figure 3. Relationship between VSW indices and the end member triangle of a NIR-Red scatter plot.



Figure 4. Composite image RGB: VWS 1994



Figure 5 Composite image RGB: VWS 2004



Figure 6. Composite image RGB: VWS2008

2.4 Image classification

Image classification is a conventional change detection method. The advantage of image classification is the ability to create a series of land cover maps. We applied the supervised classification method for time series VSW index to obtain the categories of land cover include forest, urban, water, bare soil, shrubs and coal exploitation area. Urban areas in 1994, 2004 and 2008 are extracted. By using GIS technique (convert vector, overlay and calculate), the urban expansion information (areas, the replacement of land covers to urban area) would obtain over the study periods.

3 RESULTS

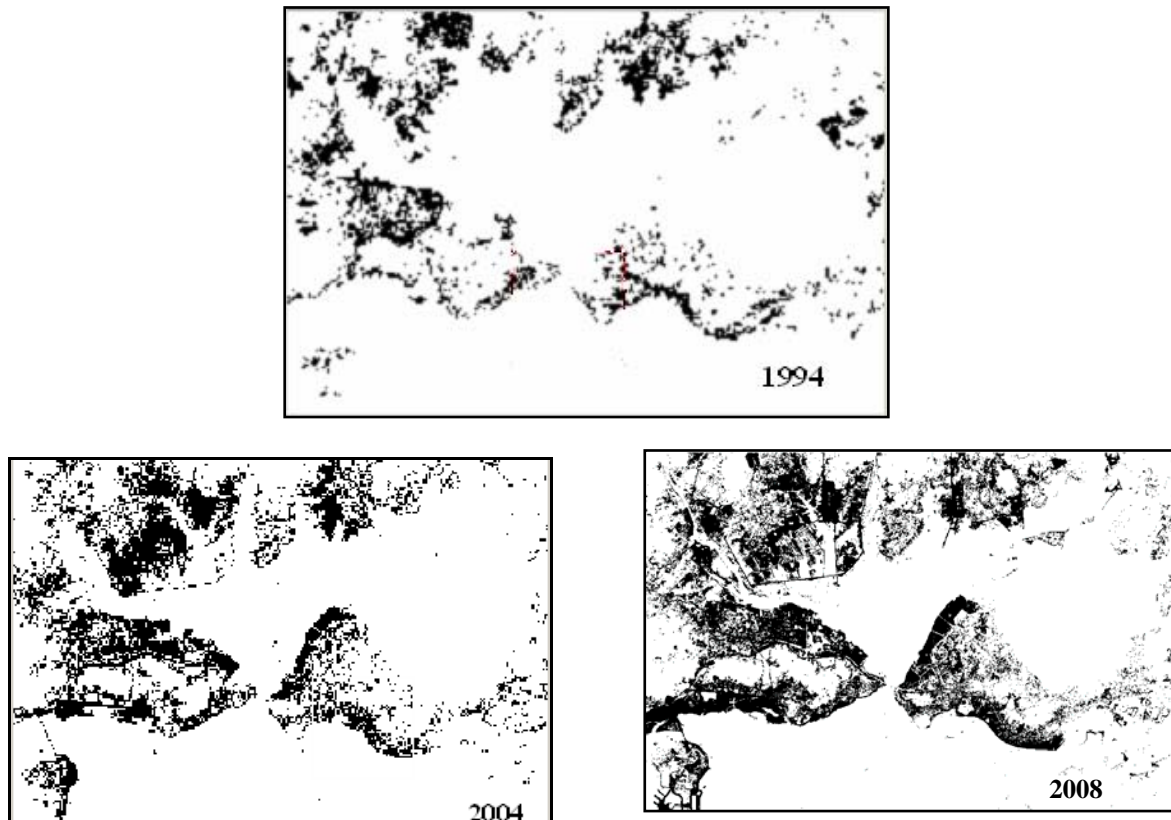


Figure 7: The urban area is extracted from VSW index image.

From Figure 7 we can visually see the expansion of urban area in Ha Long City from 1994 – 2008. According to the result from 1994–2004, the urban change was at high level, urban areas increase from 2723.9ha (1994) to 4872.3ha (2004). This period is first step for urbanization and industrialization, when Hon Gai was incorporated into Ha Long City. At the period from 2004 – 2008, the urban expansion Ha Long was not more variable because of the stable of the city architectural.

4 CONCLUSION

Through this research, the urban expansion of the study area over different periods using multi-temporal satellite images (SPOT, AVNIR_2) can be detected. The VSW Index was able to delineate soil, water, vegetation clearly.

The main direction of urban expansion in Ha Long is extension and increasing in construction density next to the coast, especially near the Cai Lan port and Bai Chay bridge, which connects Bai Chay to Hon Gai.

The highway No18 is the main road along the length of Ha Long city that is too the center of the urban space expansion to both of beside the road.

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