CHARACTERIZING THE URBAN GROWTH OF HANOI, NAGOYA, AND SHANGHAI CITY USING REMOTE SENSING AND SPATIAL METRICS

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1. INTRODUCTION

In order to find a suitable direction for Hanoi city's urban plan, this study explored an approach of combining remote sensing and spatial metrics to characterize land use change in Hanoi (Vietnam), Nagoya (Japan), and Shanghai (China). The urbanization patterns of Hanoi in from 1975 to 2003 was analyzed and compared to them of Nagoya and Shanghai for same periods.

2. STUDY AREA AND DATA SOURCE

This study areas cover center parts of 3 cities Hanoi, Nagoya and Shanghai. Multi-spectral and multi-temporal satellite data were obtained, ASTER images from the Earth Remote Sensing Data Analysis Center (ERDAS) and Landsat images as from the Tropical Rain Forest Information Center, Michigan State University, U.S.A. Cloud cover was less than 10% in these images. The visible and NIR bands were used for data processing.

3. METHODOLOGY

3.1. Urban area mapping

All the satellite images were rectified to a 15 m spatial resolution and the Transverse Mercator coordination system. We applied the maximum-likelihood classification method to generate surface cover maps of urban areas. The land surface was classified into the 3 main classes such as water, non-urban and urban. In order to reduce the effects of mixel to the results, this study applied an approach that developed by Hai and Yamaguchi (2006) by integrating classification result, VSW index and NIR band. Fig.1 shows an example of Hanoi urban areas over times:

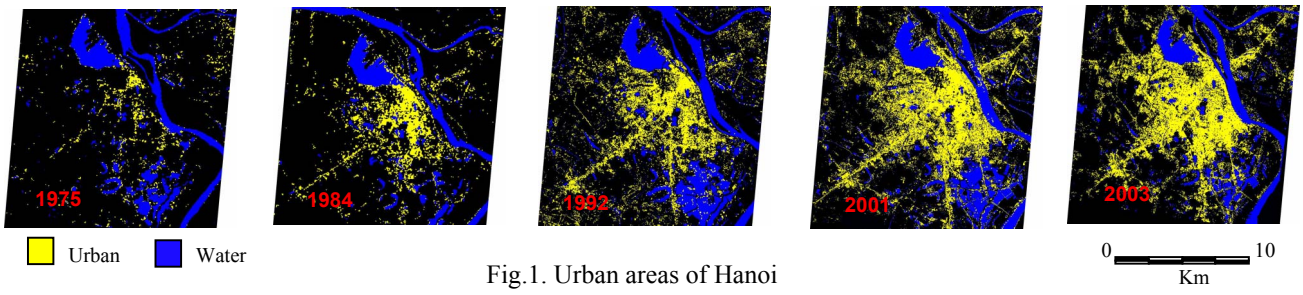

Fig.1. Urban areas of Hanoi

3.2. Spatial metrics

Recently, there has been an interest in applying spatial metrics to characterize the urban growth. The urbanization of the study areas show high trend of fragmented development. To manage change of urban growth this study primarily recommended a spatial metric of The Percentage of Like Adjacency (PLADJ). The percentage of like adjacency (PLADJ)(fig.2) was computed based on pixel-based index developed by Gardner and O'Neill (1988):

$$PLADJ = \frac{\sum_{i=1}^{m} g_{ii}}{\sum_{i=1}^{m}\sum_{k=1}^{m} g_{ik}} * 100$$

g_{ii}: number of like adjacencies between pixels of patch type i
g_{ik}: number of adjacencies between pixels of patch types: i and k

Fig.2.PLADJ

Results of PLADJ provided statistic data (fig.3) and a series of map with thermatic information about urban fragmentation for each city. Then, this study applied a regulation of landscape transformation (Forman, 1995) to make urban growth pattern maps based on results of PLADJ. We used 3 urban growth patterns such as: infill growth, expansion growth and outlying growth. Outlying growth was subsequently classified to 3 sub-patterns such as isolated branch, linear branch and clustered branch. A transformation based on several assumptions summarized was detailed as follows: isolated growth requires a small area of change, which one non developed area some distance from an existing developed area being developed. Linear branch growth is defined an urban growth such as a new road, corridor, or a new linear development that is generally surround by non developed land and some distance from existing developed land. Clustered branch shows a new urban growth that is neither linear nor isolated, but instead, a clustered or a group (Wilson,2003).

Next, the public domain statistical package FRAGSTATS (McGarigal et al., 2002) was applied to characterize urbanization of these cities. This program provides various variety of metrics to describe the landscape heterogeneity such as: NP quantifies the number of individual urban areas, ED is the length of urban boundary divided by the total landscape, LPI represents the separation small individual patches versus a dominant urban core, MNN describes a measure of distance, or open space between individual urban areas, AWMPFD describes fractal dimensions of urban patches, CONTAG describes the heterogeneity of a landscape.

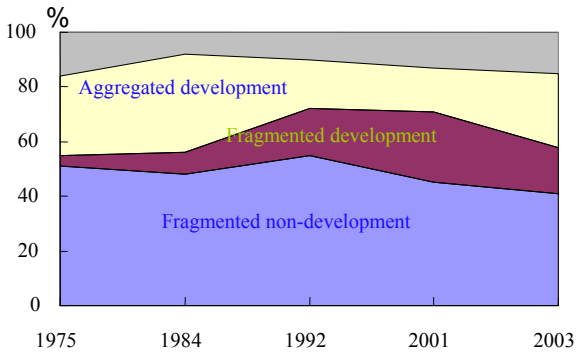

Fig.3. Configuration of Hanoi 1975-2003

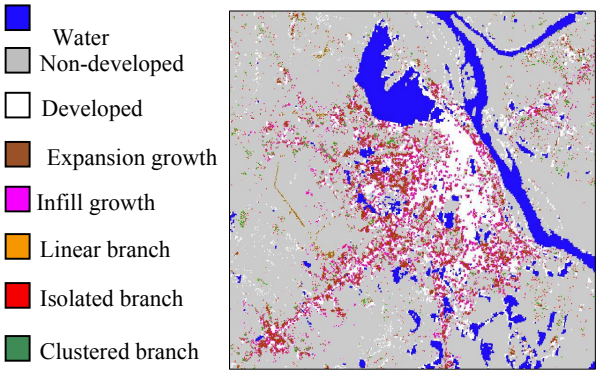

Fig.4. Results of urban growth patterns 1984-1992

4. DISCUSSION AND CONCLUSION

The final results showed that Nagoya and Shanghai city developed very fast in the 70s, early 80s and then slowdown, where as urbanization of Hanoi city dramatically increased after 90s until now. For Hanoi city, NP, ED, LPI, and MNN showed that expansion of Hanoi city more and more aggregate. It is predicted that, Hanoi city is continuing to expand and the expansion areas will be linked with the existing developed areas to create the configuration of the city more and more aggregately. This study is a good example to exhibit decision-makers to understand urban growth dynamics and help them make a sustainable future land use plan for Hanoi city.

5. REFERENCES

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