CS－80

COMPARISON OF URBANIZATION AND ENVIRONMENTAL CONDITION IN ASIAN CITIES USING SATELLITE REMOTE SENSING DATA

Toyohashi University of Technology Member M.Kawamura
Toyohashi University of Technology Student Member○S.Jayamanna
Toyohashi University of Technology Member Y.Tsujiko
Toyohashi University of Technology Student Member A.Sugiyama

1.INTRODUCTION

The rapid economic growth in Asian nations is causing increased urbanization in major urban areas of these nations. This has given rise to many environmental problems not only within these urban agglomerations but also outside them, often leading to problems of a global nature. Satellite images provide the only effective means of monitoring the rapidly changing conditions in these urban areas. Therefore the objective of this study is to develop the method to quantitatively estimate and compare the urbanization and environmental condition of different cities using satellite remote sensing data.

Data of several Asian cities which have very different developing situations have been used in this study. Of these, Kuala Lumpur City in Malaysia, Colombo City in Sri Lanka and Nagoya City in Japan are selected as typically representing three different types of development situations. Colombo City is typical of the many old colonial port cities, which are today the primate cities of these developing nations whose urban systems lack a well balanced hierarchy of cities and are dominated by one or two very large agglomerations. These cities are growing rapidly, but their infrastructure and public services are at a very low level and often in serious deterioration. The area within the municipal council limits of Colombo City is 3370 hectares with a population of 650000. Kuala Lumpur represents a capital city of the economically dynamic South East Asian Region presently rapidly growing under a strong industrialization drive. The Federal Territory of Kuala Lumpur is approximately 24000 hectares with an estimated 1.4 million population. Nagoya city is part of the very large Osaka-Nagoya-Tokyo extended metropolis known as the Pacific Coastal Belt. As such, in comparison to Colombo and Kuala Lumpur, Nagoya is characterised by a relatively large proportion of paved transportation routes. Nagoya represents a city in a developed country with infrastructure and public services at a very high level. It has a land area of 33000 hectares and a population of approximately 2.2 million.

For the quantitative analysis of these urban areas using satellite remote sensing data the authors use a proposed index UI, computed using Landsat TM bands 7 and 4 and the Normalized Difference Vegetation Index (NDVI).

2. DATA AND INDICES USED IN THE STUDY

2.1 Conventional Data

1:50000 land use maps of Colombo (1981) and Kuala Lumpur (1984) was used to obtain land cover information in these urban areas. These maps were scanned and used in the analysis. In the case of Nagoya City TDT data of 1987 was used to obtain land cover information. Statistical data relating to the urban areas was used.

2.2 Remote Sensing Data.

Digital data from Landsat TM images of 500 pixels by 400 pixels was used . TM data of Colombo was of Dec 1987, Kuala Lumpur-June 1989, Nagoya and cities in Aichi Prefecture-July 1985, and Mokpo City in South Korea-Sept 1992. TM data used was from images aquired during the summer season.

2.3 The Urban Index UI and NDVI

UI was computed as shown below using Landsat TM band7 (B7) and band4 (B4). This index was found to have a strong relation with the density of development. Therefore UI is used as a measure of urbanization.

$$UI=\frac{(B7-B4)}{(B7+B4)} \quad \cdots (1)$$

NDVI is used as a measure of the vegetation condition which represents the natural environment in the urban area.

3. ANALYSIS AND RESULTS

Figs1,2 and 3 are UI images of 500 by 400 TM pixels of Colombo, Kuala Lumpur and Nagoya Cities and they show the areas which have UI values larger than 70. The spatial arrangement of the developed area can be seen by these figures. The UI and NDVI values were computed for 510m by 510m pixels. Fig.4 shows the UI-NDVI relation for Colombo,Kuala Lumpur and Nagoya cities. It shows the relation between urbanization and the natural environment in the three urban areas. The significance of the UI-NDVI relations were interpreted using land cover information of the urban areas. UI and NDVI images were registered with scanned land use maps and the 510m by 510m pixels assigned to a category if more than 60% of TM pixels within the 510m by 510m pixel belonged to that category. The pixels assigned to categories in this manner and

Key Words : Remote Sensing, Urban Index, NDVI, Urbanization, Environment, Asia
Hibarigaoka, Tempaku-Cho, Toyohashi-shi, Aichi, 441 TEL:0532-47-0111 FAX:0532-44-6831

their percentage numbers can be seen in Figs 5,6 and 7. The curves also show the differences in urbanization in the three urban areas. It is seen that similar land cover categories have a similar close range of UI and NDVI values in the three urban areas. This implies that the indices UI and NDVI could be used to compare urbanization and the environmental condition in the different urban areas. Fig.5 shows that the built-up area of Colombo is concentrated in one area (within the City) seen by the large percentage of pixels in this category and that the built-up area has a larger proportion of urban vegetation which is seen by the large range of NDVI values for this category. Fig.6 shows that Kuala Lumpur's buit-up area is more scattered. This can also be seen by comparing Figs 1 and 2. The large percentage of vegetation pixels seen in Kuala Lumpur indicate large vegetation areas. From Fig.7 it is seen that in comparison, the built-up area of Nagoya is large and concentrated and its vegetation areas are small. Fig.8 shows the relation between UI and the percentage of developed area in the cities. The developed area includes commercial, industrial, residential, public and paved areas. It shows that UI is high where this percentage is high. Therefore the UI-NDVI relation shown by Fig.9 can be used to compare the urban development in the different cities.

4. CONCLUSION

From this study it can be seen that satellite remote sensing data can be used to compare urbanization and the environmental condition of urban areas from different regions and having very different development conditions. It is also seen that the indices UI and NDVI reflect the differences in urbanization in the 3 cities.

Fig.1 Colombo City

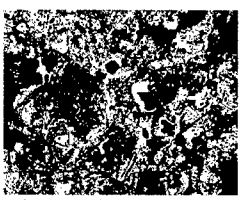

Fig.2 Kuala Lumpur City

Fig.3 Nagoya City

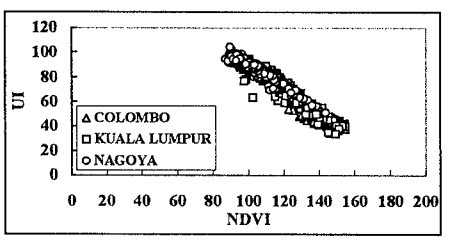

Fig.4 UI-NDVI Relation for 3 cities

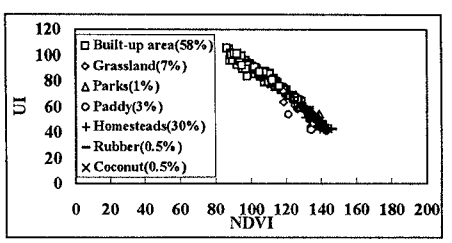

Fig.5 UI-NDVI Relation for Colombo City

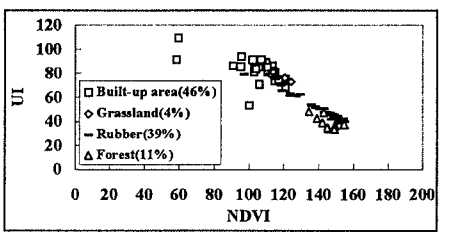

Fig.6 UI-NDVI Relation for Kuala Lumpur City (500×400 pixels)

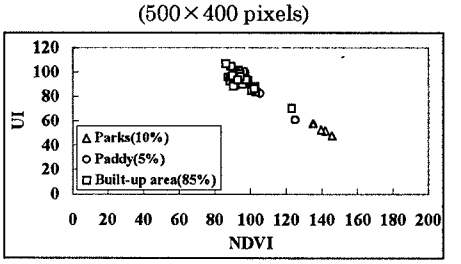

Fig.7 UI-NDVI Relation for Nagoya City

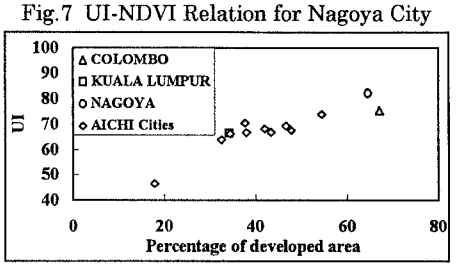

Fig.8 Relation between UI and the developed area

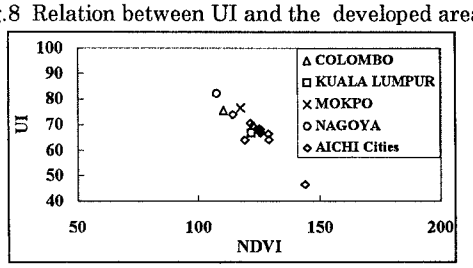

Fig.9 UI-NDVI Relation for cities(admin: units)