Application of High-Resolution Satellite Image to Vegetation Environment Evaluation in the Urban Area

Satoshi Shibata
Graduate School of Science and Technology, Nagasaki University
1-14, Bunkyo-machi, Nagasaki 852-8521, Japan
shibata@stu.civil.nagasaki-u.ac.jp

Kaoru Tachiiri
Department of Civil Eng., Faculty of Eng., Nagasaki University
1-14, Bunkyo-machi, Nagasaki 852-8521, Japan
tachiiri@net.nagasaki-u.ac.jp

Keinosuke Gotoh
Graduate School of Science and Technology, Nagasaki University
1-14, Bunkyo-machi, Nagasaki 852-8521, Japan
gotoh@civil.nagasaki-u.ac.jp

Abstract: The main objective of this study is to examine the effectiveness of newly available high spatial resolution satellite images, in evaluating vegetation environment of the urban areas. In doing so, we have used satellite images from QuickBird and selected some areas of Fukuoka City, Kyushu Japan, as study area. The results of the study revealed that, high resolution images are more effective in close monitoring of the vegetation status and green plants should be planted in open spaces and roofs of urban areas to increase vegetation, which will in turn act as a remedy to reduce heat island phenomenon.
Keywords: Remote Sensing, High-resolution Satellite Image, Vegetation Index

1. Introduction

Recently, heat island phenomenons resulting from high land surface temperature in the urban areas are occurring in many cities and developed into a major problem in Japan. As a method to reduce the heat island phenomenon, green vegetation is very effective, which also fixes the carbon dioxide of the greenhouse gases by photosynthesis. In addition to this, green vegetation also provides to urban residents a place for recreation and an opportunity to come in close contact with nature.

However, this green-covered area usually decreases as urban development progresses. Therefore, it is indispensable to consider green conservation into urban plan and very important to develop the useful method to monitor their changes in different parts of the city. In this respect, satellite remote sensing is very effective to monitor the growth and changes of green vegetation. But with the conventional satellite images having 20-30m spatial resolutions, close viewing and monitoring of the vegetation is quite difficult task. As a solution to this problem, lately, high spatial resolution, i.e. equivalent to or under 1m, satellite images became available due to launching of commercial satellites which contain the high spatial resolution sensors.

In the backdrop of the situation described above, this study aims to monitor the green vegetation in urban cities by using newly available high spatial resolution images.

2. Methodology

In this study, to analyze and investigate the vegetation environment in the urban areas, Hakata and Chuo Ward of Fukuoka City, Kyushu, Japan, were selected as study area. Satellite images from QuickBird and IKONOS data were used. From the QuickBird images of the study area, Normalized Difference Vegetation Index (NDVI) is calculated to map the spatial vegetation distribution and also estimated the vegetation coverage rate, in order to investigate the vegetation environment. NDVI is calculated by using the following equations:

$$NDVI = \frac{BAND4 - BAND3}{BAND4 + BAND3} \quad (1)$$

BAND3：Red-infrared wavelength

BAND4：Near-infrared wavelength

$$\rho_3 = 0.000446 \times DN + 0.012580 \quad (2)$$

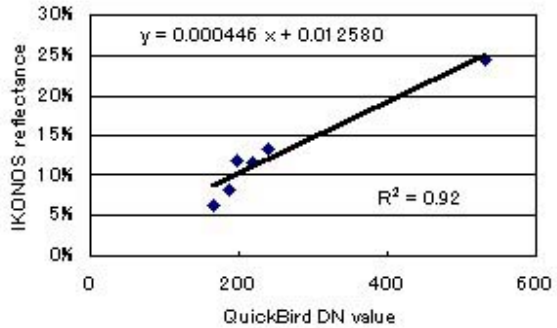
$$\rho_4 = 0.000446 \times DN - 0.003826 \quad (3)$$

ρ_3：The reflectance of BAND3

ρ_4：The reflectance of BAND4

Satellite data used were multi-spectrum and panchromatic data of QuickBird. They have spatial resolution of 2.44m and 0.6m,respectively. The study areas were Hakata and Chuo Ward of Fukuoka City. Observation date was 5 October 2002.

Regarding the NDVI image, we have used the reflectance equation derived from IKONOS data



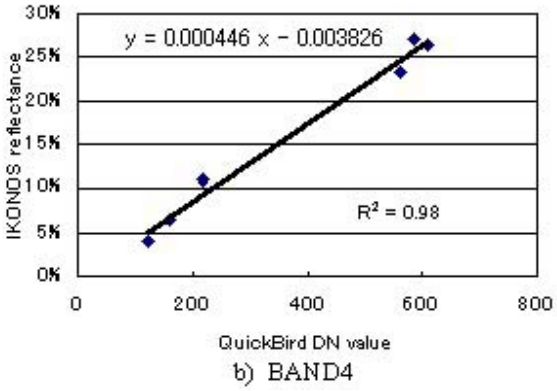


Fig.1. The correlation between IKONOS reflectance data and QuickBird DN Value

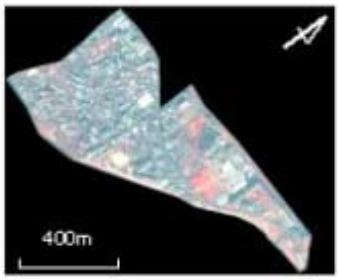


Fig.3. The false color image in Minoshima

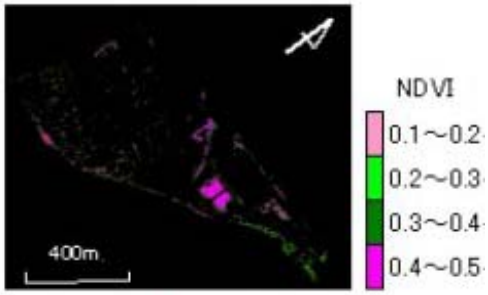


Fig.4. The NDVI image in Minoshima

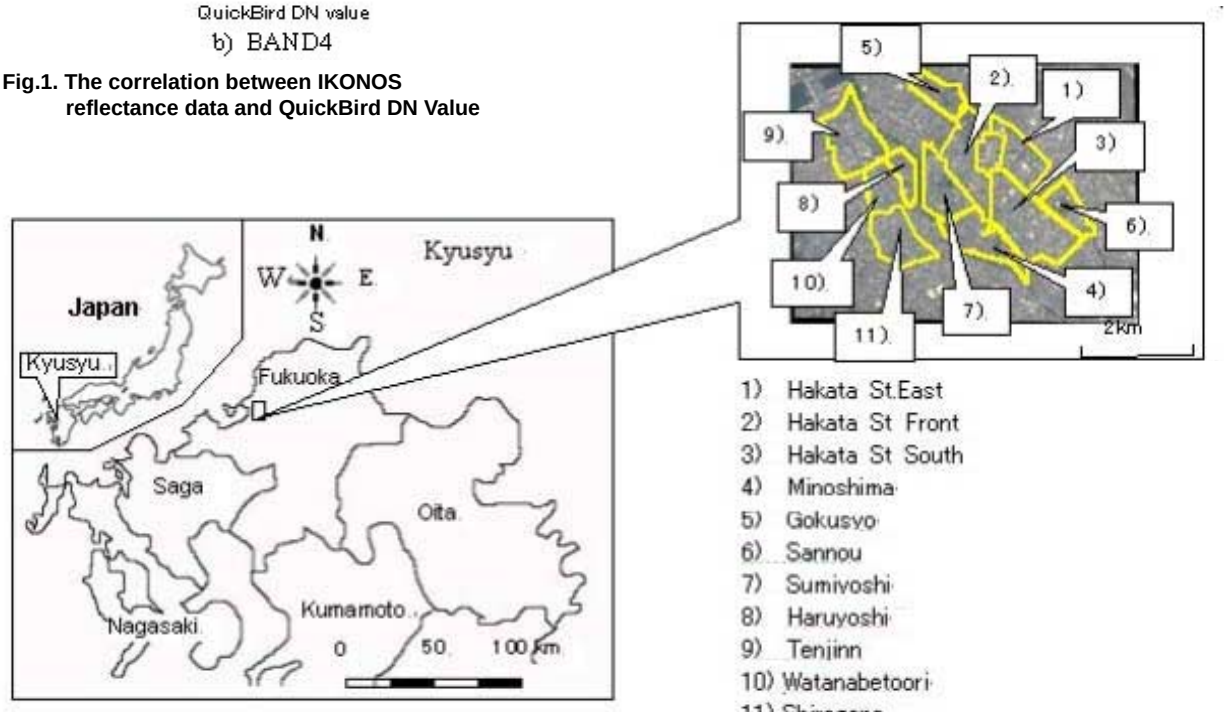


Fig.2. Location of the Study Areas

(observation date: 19 Mar 2001), as reflectance equation correlation between the DN (digital number) of QuickBird data and reflectance equation data of IKONOS, to obtain the reflectance equation for the QuickBird data. The correlation figures are shown in **Fig.1**. Equations 2 and 3 discussed before are used for calculating BAND3 and BAND4 data.

The find analysis areas are located around the urban city centers, which are also considered by the city planning authority as important areas.

3. Results

Fig. 2 shows the location of the study areas. And **Fig. 3** and **4** show the image analysis result and NDVI image of the Minoshima study area. NDVI composition rates, in the Hakata and Chuo Ward, are shown by **Fig.5**, where the composition rate is classified into five categories with an interval of 0.1.

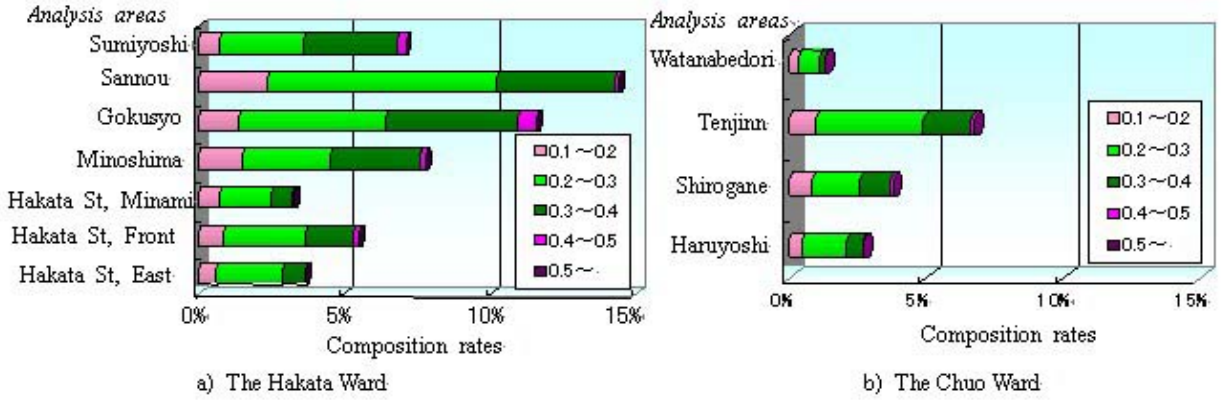


Fig.5. NDVI composition rates in each study area

4. Discussion

From **Fig. 5 a)**, we can see that the best vegetation composition rate is evident in the Sannou area. This is due to the contribution of the Sannou Park, supplying abundant green vegetation effect. Second best vegetation composition rate is observed in the Okusyo area, which contains many temples and the whole neighborhood nature is protected as conservation area. Next in the Minoshima area vegetation composition rate is moderate, which is thought to be due to planting of trees in the bank of the Nakagawa river flowing through the area. However, around the Hakata Station, located in the center of Fukuoka City, this rate is lower and urges the necessity to plant more trees.

From **Fig. 5 b)**, we can see that, although the Tenjin area has big parks, such as the Kego Park, Susaki Park and Across Fukuoka (contains roof planting), the quantity of vegetation is surprisingly less than that of the total Hakata Ward. This is due to the presence of high-rise buildings in the Tenjin area without few trees and green plants. Also in the Shirogane area the quantity of vegetation is lower and consists of housing areas. But this area has trees planted in both sides of the roads. In order to increase vegetation roof plating can be introduced in places where there are lack of open spaces due to the construction of high rise buildings.

Thus from the results of the study, it is evident that with the gradual urbanization of cities trees and green vegetations area decreases sharply. In the development process urbanization cannot be stooped, but to restore greenery and vegetation, roof plantation and tree planting in river banks or roadsides might be introduced. This will in turn act as one of the methods to reduce heat island phenomenon.

5. Conclusion

Evaluating and monitoring the growth and changes of the green vegetation environment of the urban cities is an important research topic for maintaining ecological balance, reducing heat island problem and also to ensure recreation facilities to the urban citizens. In this study, we tried to do this job by using newly available high resolution satellite images, which proved to be relatively more effective than conventional satellite images. However, this area leaves the opportunity for more detailed application and analysis.

Reference

[1] Fukuoka City Urban Maintenance Bureau, 1999. A Ground Plan of Fukuoka City, Department of Park Planning Section.