Extraction of some preserved subtropical forest communities in Tokunoshima Island with satellite images for sustainable land-management of an island ecosystem

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Abstract

Growing habitats of endangered species have been fragmented and isolated by anthropogenic activities and many endangered species have been threatened with extinction in Japan. The Impacts are severe at a small island in particular. Discrimination of the quality and quantity of such habitats is basic and important information for preserved subtropical forest communities.

The study was carried out on Tokunoshima Island, south-western Japan, with many endangered species. In this region, several endangered species distribute in a mature subtropical evergreen forest covered by *Quercus* Miyagii trees with big buttress. Then this study is aimed to develop a simple method for identifying growing habitats of mature *Quercus* Miyagii trees using satellite images.

We preliminary tried to classify land use by maximum likelihood method using ground truth results on some Landsat TM images. As the spatial resolution of TM images and the limited ground truth of growing habitats of *Quercus* Miyagii, we could not identify their growing habitats effectively.

Keywords: sustainable land-management, island ecosystem, Landsat-5/TM, ALOS/AVNIR

1. INTRODUCTION

This study focused to clarify the effects of diversity of the Tokunosima Island, as a test case, affected by isolation of forested area according by anthropogenic activities. Discrimination of the quality and quantity of such habitats is basic and important information for preserved subtropical forest communities.

The changes of land use were analyzed by the land-classification maps during 12 years of satellite data, i.e., Landsat-5/TM and ALOS/AVNIR-2. The spectral reflectances of several tree crows were measured by a handheld spectral radiometer. And a method of identified *Quercus* Miyagii trees with big buttress were examined.

2. MATERIALS and METHODOLOGY

2.1 Materials

Land classification was performed by satellite images as follows

Landsat-5/TM (Path-Row: 113-41)

1988/04/15, 1995/06/06,
1997/05/26, 2000/11/26
ALOS/AVNIR-2 (N27.85, E129.1)
2006/10/10, 2006/11/25, 2007/08/28

Extraction of several types of trees was used with spectral images taken in ground truth.

2.2. Ground truth

The spectral reflectance energy from several kinds of tree crowns, *Q.* Miyagii, *C.* Sieboldii, *P.* Luchuensis, and so on, were measure by a handheld spectral radiometer (KE-1, ELM Ltd., Japan) with 400nm to 1,000nm of wave-region, 4 degrees of FOV, and 3nm of wave-intervals. These measurements were carried out by measuring the objects and a standard white board alternatively with an angle of depression 50 to 70 degrees. The white board, 40cm squares, was set on a distance from 1m forward to the meter, and was located vertically and normally to the ground and sun orientation, respectively. In this time, the area of observation was taken by the video camera.

Spectral images were taken by a video camera mounted with bandpass filter. Bandpass filter has a 20nm region.

2.3. Analyzing method

The spectral reflectances were calculated by the energy from object and the white board. These spectral curves were differentiated with wavelength, first and second orderly. Peaks and bottoms in these differentiated curves were discussed and were defined as special wavelength. The indices, used special wavelength, were designated for identifying the trees.

The land classification was performed by the maximum likelihood method with ERDAS Imagine ver. 8.7. The spectral images were processed that the brightness within the white board are constant for several spectral images.

3. RESULTS AND DISCUSSION

3.1. Land classification

Figure 1 shows the land classification processed by maximum likelihood method for Landsat-5/TM on 18th April 1988 and on 26th Nov. 2000. During 1988 to 2000, a coral leaf, indicated with red region, was decreased as a pollution of coastal sea and increasing of sea temperature. On the other hand, natural field is decreasing and farmland is increasing.

Figure 2 also shows the land classification of ALOS/AVNIR-2 on 28th Aug. 2007. As the scene area was limited on a northern part of the Tokunoshima Island and most parts were covered with cloud, the land classification was not done perfectly. However, comparing these figures, it was suggested that the differences of ground resolution Landsat-5/TM and ALOS/AVNIR-2 was effective to make a land classification.

Using preliminary experimental results, an accuracy of land classification has to be improved using ALOS/AVNIR-2 data. The identifying method for the endangered species, i.e., *Quercus* Miyagii, will be developing.

3.2. Spectral reflectance

Spectral characteristics of tree crown on four kinds of tree species are shown in Fig.3. The spectral reflectances in visible region were not varied for tree species. On the

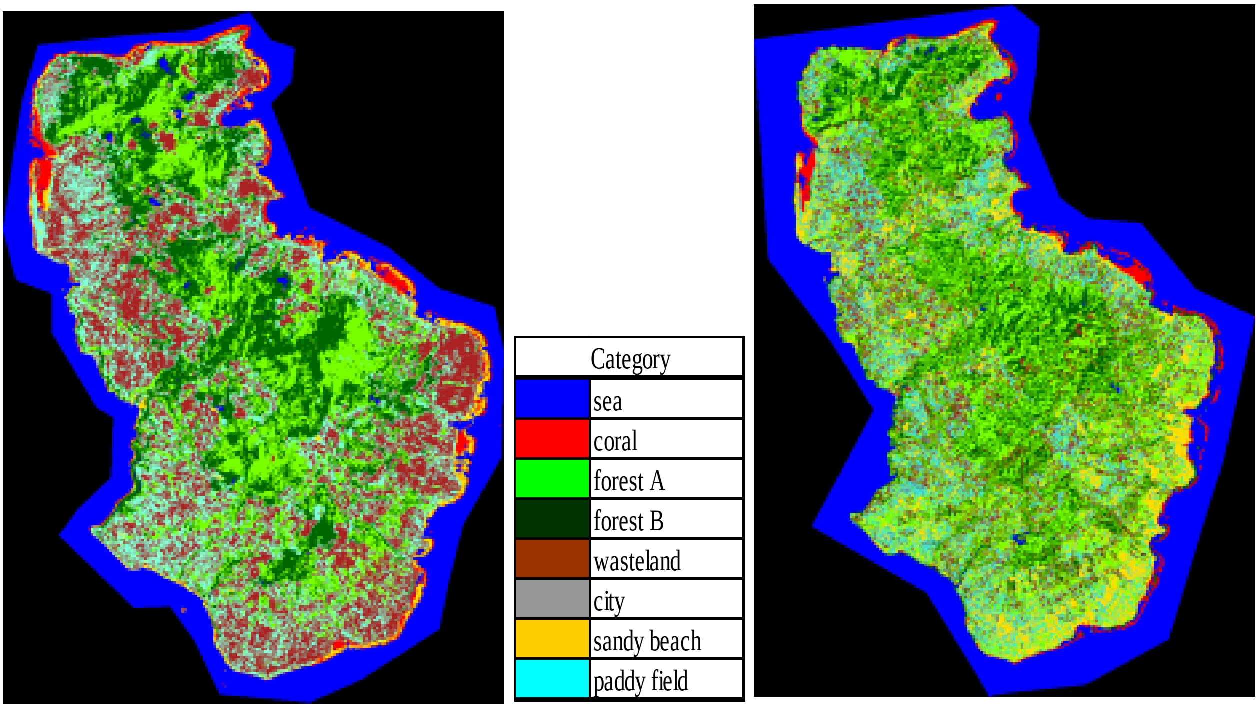

Figure 1. Land classification by Landsat-5/TM (Left:18th April, 1988 and Right:26th Nov., 2000).

other hand, the spectral reflectances in near infrared region were differed with tree species apparently. Moreover, it was certained that the leaf of *Quercus* Miyagii has unisotropic reflectance because of the reflectance was differed with measuring directions, i.e., forward and backward to sun light.

Figure 4 shows the spectral characteristics of tree leaves on several kinds of tree species. These tree leaves were placed on a black paper horizontally. Figure 5 shows the area measured by the spectral radiometer. The spectral reflectances in visible region were not varied for tree species and the spectral reflectances in near infrared region were not varied for tree species, too. However the reflectances of leaves are higher than that of tree crowns. According to the measured area shown in Fig.5, it was certained that this area is composed not only leaf but also space, as called as mixel state. Then the differences of these reflectance curves are originated by the different

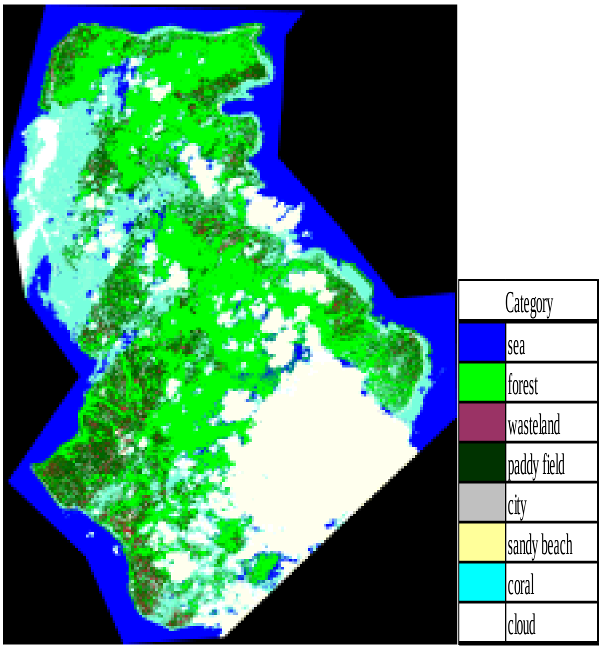

Figure 2. Land classification by ALOS/AVNIR-2 (28th Aug., 2007).

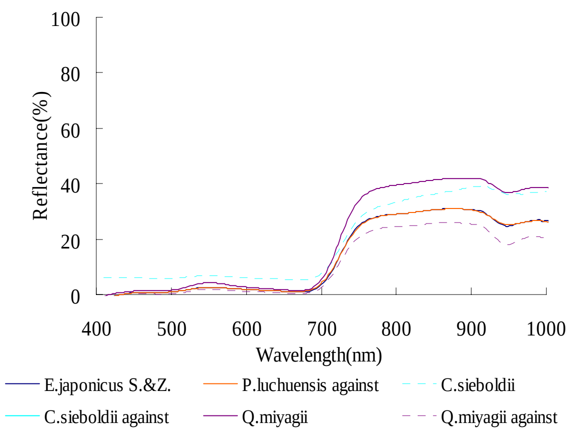

Figure 3. Spectral characteristics of several standing tree crowns in Tokunosima Island.

species and spaces.

3.3. Special wavelength

The spectral characteristic curves of *Q*. Miyagii, were differentiated by wavelength, first and second order. As shown in Fig.6, several peaks (or bottoms) are appeared. Wavelengths of these peaks (or bottoms) were 540nm, 570nm and 740nm in first differential curves. And 500nm and 700nm appeared in second differential curves. As these wavelengths of peaks (or bottoms), derived

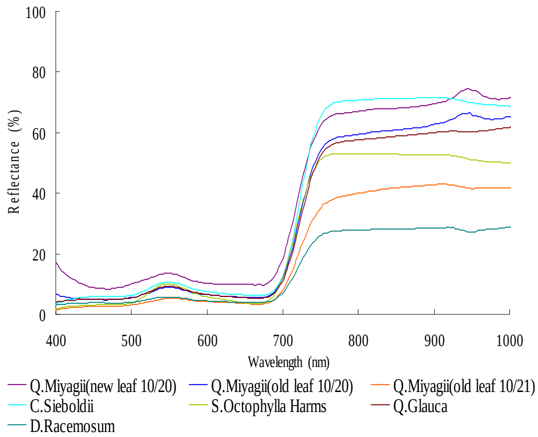

Figure 4. Spectral characteristics of leaves of several kinds of trees.

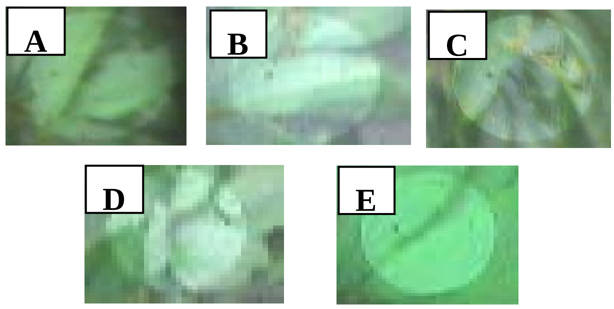

Figure 5. Field of view on handheld spectrometer A: D.*Racemosum, B:* C.*Sieboldii, C:* Q.*Miyagii, D:* S.*Octophyppa, E:* Q.*Glauca*

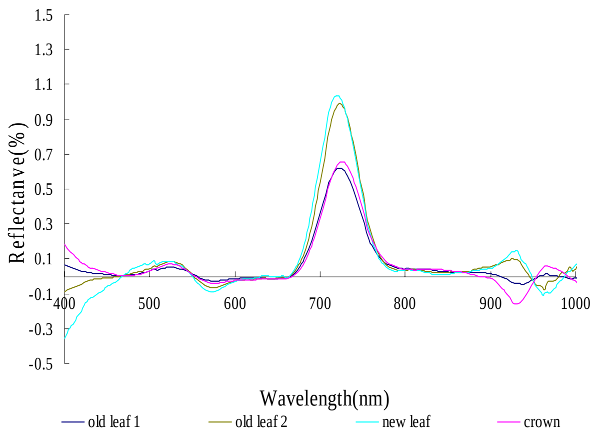

Figure 6. Differential curves of spectral characteristic curves of Q.Miyagii.

from tea canopy in same procedures, showed the closely correlation with a component of tea leaves and of paddy rice leaves[1)], it is conjectured that the wavelength identified from the differentiated curves have a possibility of the extraction of *Quercus* Miyagii effectively.

3.4. Image analysis

The spectral characteristics of the trees grown on the side of Mt. Amagi are shown in Fig.8. The color image and the spectral images on the same region are shown in Fig.9. The legends, Q. Miyagii, P. Luchuensis, and C. Sieboldii, X and Y, in Fig.8 are the circle where these trees are grown and not determined in Fig.9. These characteristics were measured with an angle of elevation of 30 degrees. The brightnesses in spectral images, i.e., 540nm and 640nm, are not obviously but these are corresponded with spectral reflectance in Fig.8.

Using these results, an algorithm for identifying of *Quercus* Miyagii will have to be developed.

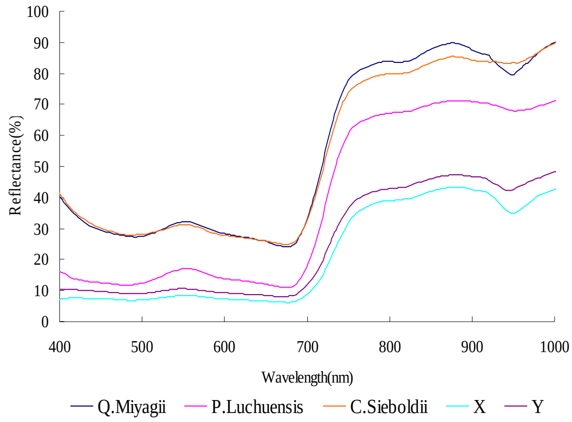

Figure 7. Spectral characteristics on the side of Mt. Amagi.

4. CONCLUSIONS

For investigation of Extraction of some preserved subtropical forest communities in Tokunoshima Island with satellite images for sustainable land-management of an island ecosystem, the spectral reflectance curves were analyzed and the spectral images were taken. The following questions are become evidently.

1) The spectral reflectance curves show the mixed state frequently.
2) Developing the index used characteristic wavelengths, for extraction of the endangered species, the mixed state has to be kept in mind.
3) The differences of ground resolution for Landsat-5/TM and ALOS/AVNIR-2 has to be taken account for the accuracy of land classification.

Acknowledgement

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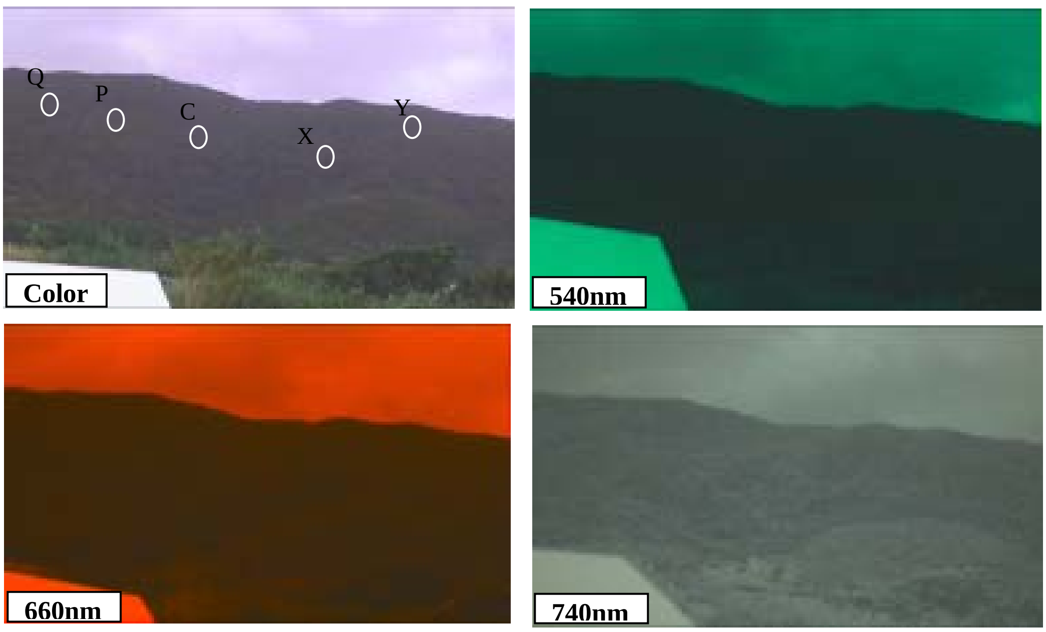

Figure 8. Spectral images on the side of Mt. Amagi.