Ground Based Observation of Vegetation Coverage, LAI and APAR to Develop New Vegetation Indices Algorithm for ASTER

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Abstract

To develop new vegetation indices algorithm, some vegetation parameters which are Vegetation Coverage(VC), Leaf Area Index(LAI) and Absorbed Photosynthetically Active Radiation(APAR) were obtained by ground based observation with spectral reflectance for cypress, willow, konara oak and grasses.

VC data was obtained through interpretation of photograph which had taken from cherry picker sited above the vegetation canopy. LAI was directly measured through the number of leaves and their area. APAR data was acquired by using Line quantum sensor. Wide spectral range data was used to relate these vegetation parameters to spectrum.

As a result of statistical analysis using these data, significant correlation was found between spectral data and these vegetation parameters. It suggests the possibility of new vegetation indices algorithm.

1. Introduction

In recent years attention has been focused on environmental problem such as global deforestation and desertification that causes soil erosion, climatic change and so on [ex) Univ. Tokyo,1993 ; Zorpette. G,1993]. Vegetation monitoring from space helps us to solve these environmental problems.

NDVI has been used for vegetation monitoring in various environmental study. But it is difficult to get biological information of vegetation by using NDVI, because the index is affected by a lot of different vegetation factors such as species, biomass, photosynthetic activity and coverage.

EOS-AM which will be launched in 1998 has five optical sensors. ASTER is one of the characteristic sensor which has many spectral bands in short wave infrared region. Most important role of these bands is the application for geological studies. In addition it is also expected to be applicable for ecological survey.

The objective of this study is to develop new vegetation indices algorithm for ASTER data. The indices are expected to be evidently correspondent with biological parameters of vegetation not but vegetation species.

LAI, APAR and VC were observed for grass, deciduous tree and coniferous tree. Each parameter corresponds to vegetation volume, quality and distribution respectively. Spectral data was acquired together with these vegetation parameters observation. Statistical analysis was applied for the investigation of the relationship between these vegetation parameters and spectral data. Then we discussed the optimum vegetation indices for ASTER.

We mainly described observation methodologies of vegetation parameters and field spectrum measurement in this paper.

2. Observation Methodologies

2.1 Observation site

Observation was carried out at Tsukuba which locates southern part of Ibaragi pref. (Figure 1). Because a lot of agricultural laboratories with various vegetation field exist in this region, it is easy to get data for many kinds of vegetation under various conditions.

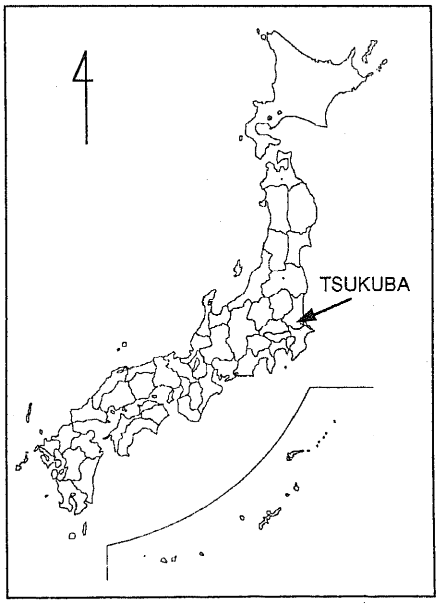

Figure 1. Observation site in this study

2.2 Observation targets

Observation targets were cypress, willow, konara oak and grasses. Their colony can be seen everywhere in Japan. Because each field has more than about 10m x 10m area, it is possible to regard them horizontally uniform for radiation.

2.3 Observation platform

As our concern is oriented toward satellite based indices, VC, APAR and spectrum must be perpendicularly observed by instruments just above the vegetation canopy. Because each target is more than about 5m tall, cherry picker was used as a observation platform (Figure 2). Figure 3 shows the workable area of basket loaded on the cherry picker which was used in this study. It is possible to observe perpendicularly around the center of a colony far enough from the top of vegetation canopy.

Figure 2. The cherry picker (the right side)

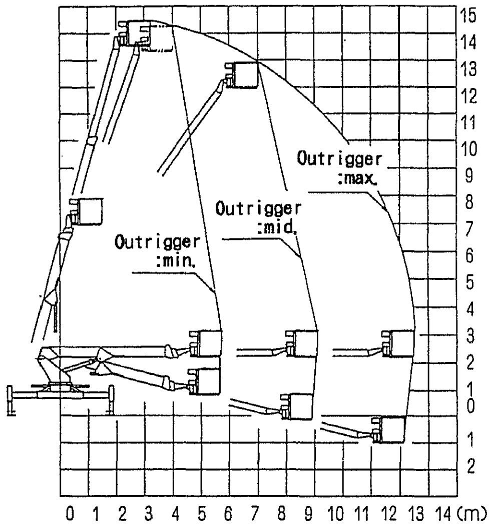

Figure 3. Workable Area of the cherry picker

2.4 Spectrum observation

MSR-7000 spectrometer loaded on the cherry picker basket was used for the vegetation spectrum observation. Main specifications of MSR-7000 is given in table 1.

Table 1. Specifications of MSR-7000

Spectral range	80 - 2500 nm
Spectral interval	1nm
Focal length	350 mm
IFOV	22°
Scan time	about 3 min.

MSR-7000 with wide spectral range is very easy to set on a small basket of the cherry picker, because light-gathering instrument is made by fine optical fiber. On the other hand it is difficult to grasp precise position of targets, because MSR-7000 has no view-finder. Therefore we attached optical fiber to CCD camera with two dimensional level and true up each optical axis as shown in Figure 4. Operator can easily decide position of the optical sensor by monitoring a video CRT.

Figure 5 shows a typical example of spectral radiance of vegetation. As S/N value is extremely low in short wave infrared region, it was necessary to use moving average with wide window. A discontinuity which is appeared near 1500 nm was corrected by manual interpolation.

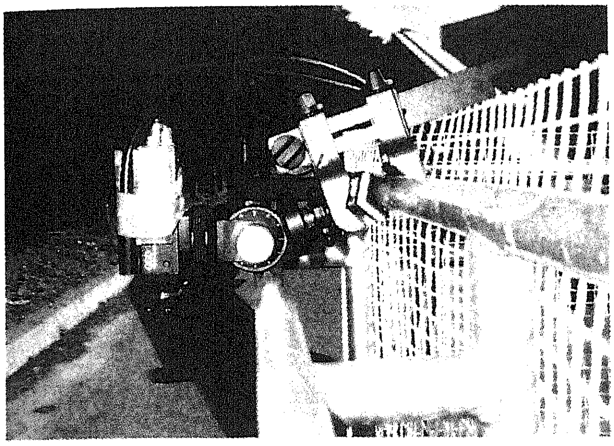

Figure 4. Optical fiber of MSR-7000 on CCD camera

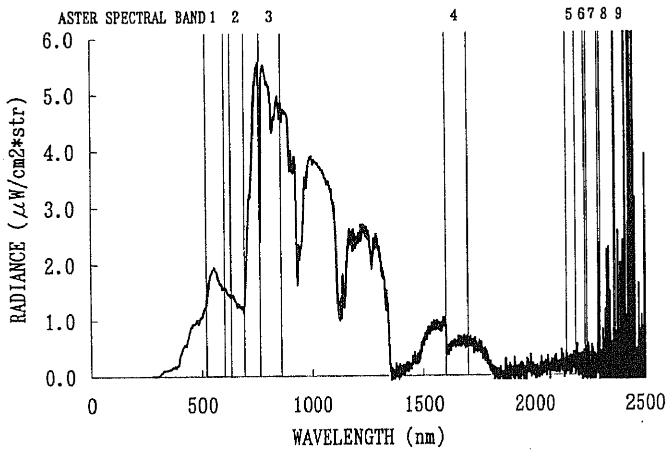

Figure 5. Radiance of vegetation acquired by MSR-7000

2.5 VC observation

At the same time of spectrum observation, several photographs of the same point were taken under different exposure so as to take all canopy layer.

Photographs were digitized by image scanner in 24-bit data with masking sheet which corresponds to IFOV of spectrometer. To extract canopy part on the image, [green] / [red] ratio was calculated, and binary image was made from the ratio image. Then VC can be got by summing up both canopy area and no-canopy area. Figure 6 gives photograph of grass and its binary image. In this case VC is 63%.

Figure 6-a. Original image

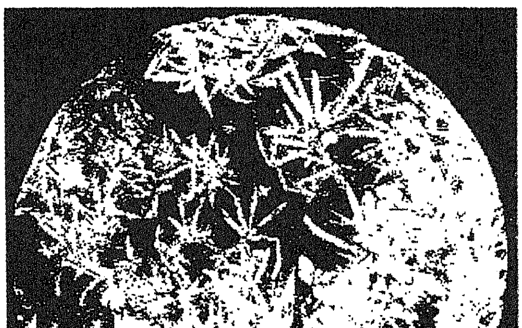

Figure 6-b. Binary image

2.6 LAI observation

LAI is a botanically important parameter. However LAI is difficult to measure accurately, because it is almost impossible to count directly leaf number per unit area.

In this study leaf area was measured by planimeter for some sample leaves. We count leaf number directly both from ground and cherry picker using frame of 50cm x 50cm area as a reference.

2.7 APAR observation

LI-191S line quantum sensor was used to get APAR data. Table 2 gives specifications of LI-191S.

Table 2. Specifications of LI-191S

Spectral range	400 - 700 nm
Response time	10 μ sec
Cosine correction	Corrected up to 80° of incidence
Azimuth	1% error over 360° at 45° elevation

We quickly measured the following PAR elements by using two line quantum sensors.

At↓ : Downward PAR above the vegetation canopy
At↑ : Upward PAR above the vegetation canopy
Ab↓ : Downward PAR below the vegetation canopy
Ab↑ : Upward PAR below the vegetation canopy

APAR and FAPAR are defined as follows. Each parameter gives absorbed PAR amount and rate respectively.

$$APAR = (At\downarrow + Ab\uparrow) - (At\uparrow + Ab\downarrow) \quad (1)$$
$$FAPAR = APAR / At\downarrow \quad (2)$$

3. Results and Discussion

We used the data which was obtained by observation mentioned above for preliminary analysis. Figure 7 shows the relationship between ASTER spectral bands operation and VC with regression curve. Figure 8 shows LAI versus ASTER spectral bands operation with regression curve. Significant correlation can be seen in each figure.

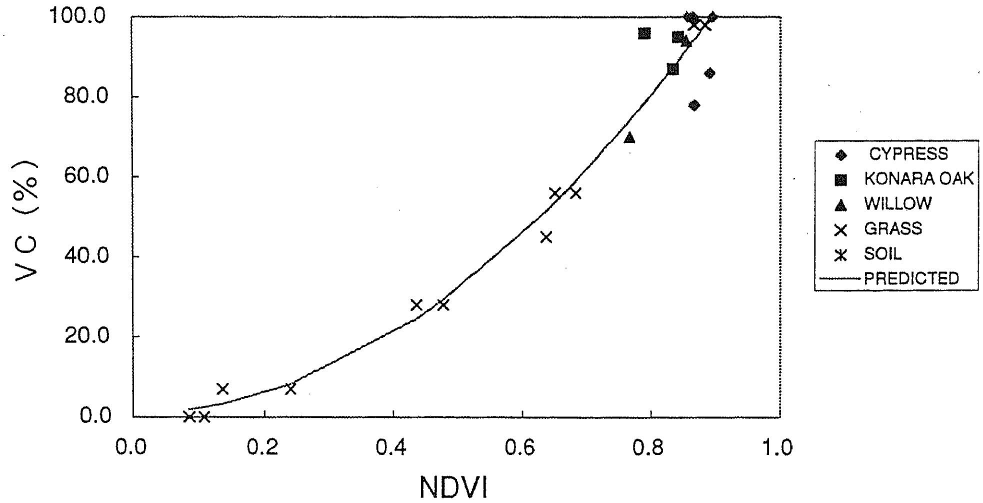

Figure 7. Relationship between ASTER spectral bands operation and VC

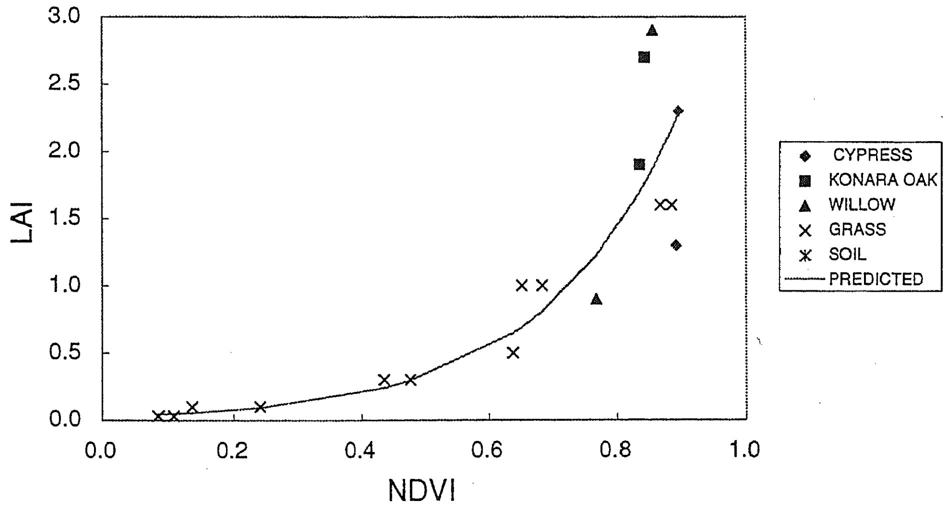

Figure 8. Relationship between ASTER spectral bands operation and LAI

There is remarkable noise in spectral data especially in short wave infrared region. Because the noise is not excludable using any type of digital filter, we cannot use band 8 and 9 which are the longest bands of ASTER VNIR. Although main target of these bands is geological use, they are expected to include much information of vegetation. Because leaf moisture affects the reflectance in these spectral range. If these spectral bands are available, higher correlation will be appeared between ASTER spectral bands operation and these two vegetation parameters. Consequently it is necessary to improve spectrometer for data acquisition in near future.

4. Conclusion

VC, LAI, APAR and spectrum was observed to develop algorithm of new vegetation indices for ASTER data. Methodologies of observation are very simple, practical and applicable to satellite data. As a result of this observation, accurate data was acquired for each vegetation parameter. Clear correspondence was found between ASTER spectral bands operation and each vegetation parameters. In near future improvement of spectrometer will make it possible to relate spectrum to vegetation parameters with higher correlation.

5. Acknowledgment

This study was implemented by financial support of ERSDAC "Research and Development of remote sensing technology for non-renewable resources - Development of technology for ASTER data application" project.

6. References

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