GENERATION OF FOREST FRACTION MAP WITH MODIS IMAGES USING ENDMEMBER EXTRACTED FROM HIGH RESOLUTION IMAGE

Tae-Geun, Kim*
Kyu-Sung, Lee**

* National Park Research Institute, tgkim@knps.or.kr
16-1 Hogyeong-ri Jucheon-myeon, Namwon-si Jeollabukdo, Korea
Tel: 82-63-625-7654~6, Fax: 82-63-625-7657
**GeoInformatic Engineering of Inha University, ksung@inha.ac.kr
253 Yonghyun-dong, Nam-gu Incheon, Korea
Tel: 82-32-860-7601, Fax: 82-32-863-1506

ABSTRACT ... This paper is to present an approach for generating coarse resolution (MODIS data) fraction images of forested region in Korea peninsula using forest type area fraction derived from high resolution data (ASTER data) in regional forest area. A 15-m spatial resolution multi-spectral ASTER image was acquired under clear sky conditions on September 22, 2003 over the forested area near Seoul, Korea and was used to select each end-member that represent a pure reflectance of component of forest such as different forest, bare soil and water. The area fraction of selected each end-member and a 500-m spatial resolution MODIS reflectance product covering study area was applied to a linear mixture inversion model for calculating the fraction image of forest component across the South Korea. We found that the area fraction values of each end-member observed from high resolution image data could be used to separate forest cover in low resolution image data.

KEY WORDS: Fraction images, a linear mixture inversion model.

1. INTRODUCITION

With increasing availability of different spectral, spatial, and temporal resolution imagery from satellite platforms, these image data provide opportunity for up-scaling information in regional and global studies (Anita, et al 2004). Additionally, fraction image along with end-member available with the high spatial resolution imagery can better identify mixed pixel problem in low spatial resolution imagery.

To effectively solve mixed pixel problem for the case of low spatial resolution image data, a few studies have adopted linear mixture analysis method with end-member from high resolution image data. In cases of high spatial resolution image data, end-member reflectance can be obtained directly from the multi-spectral image data by sampling pixels to include a single ground feature. However, it is difficult to select end-member with low resolution image data. The appropriate end-member derived from high resolution image data improved the accuracy of fraction image from low resolution image data (Christine, et al., 1995 and Oleson, et al., 1995).

The objective of this study is to present an approach for generating coarse resolution (MODIS data) fraction images using end-members spectral reflectance extracted from high resolution (ASTER data) image.

2. METHODS

2.1 Study site and data used

The study area is located near Seoul city in middle part of the Korean peninsula. Dominant forest types are mixed deciduous and coniferous, plantation pine and larch, and natural deciduous stands (Figure 1).

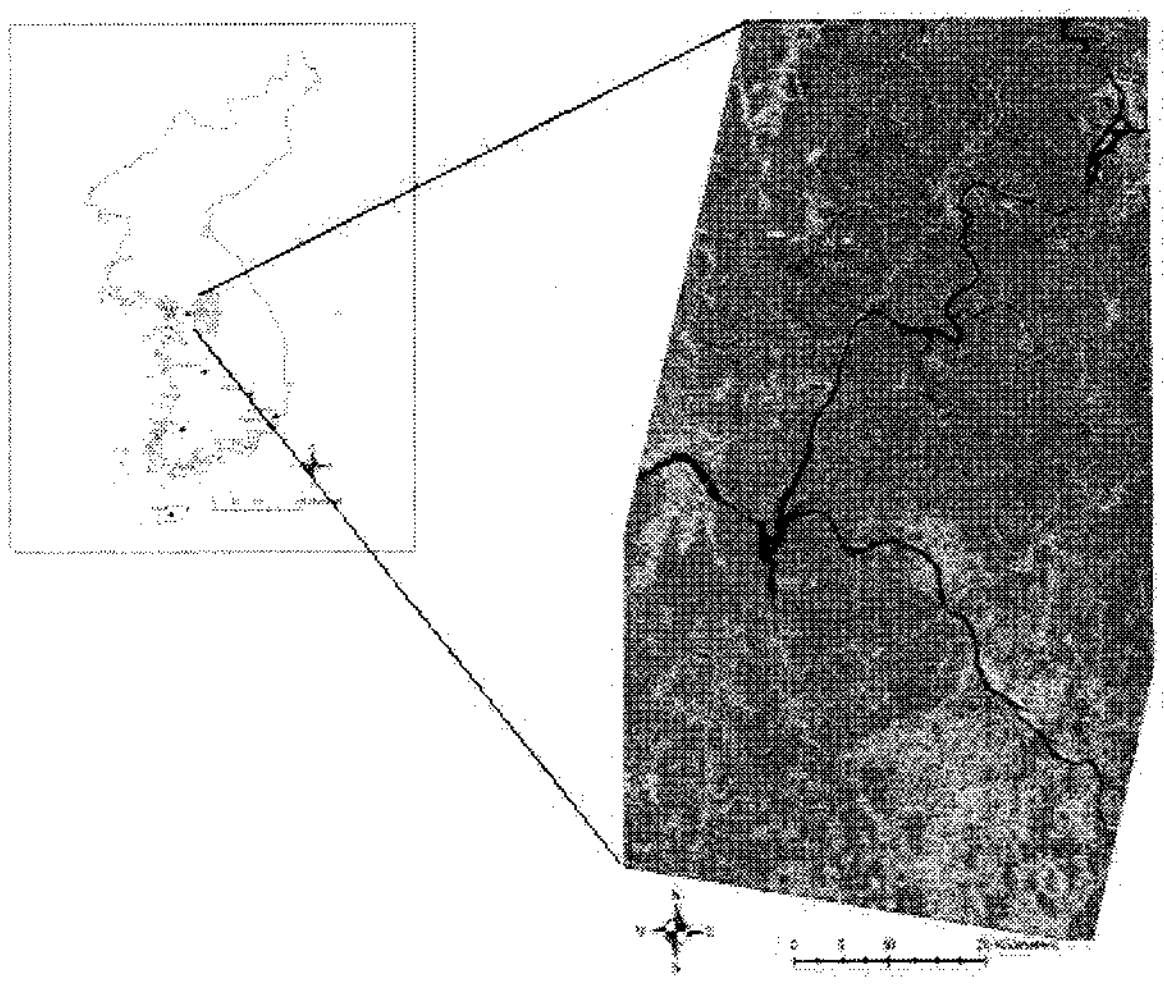

Fig 1. Color composite imagery over the study area

The multi-spectral ASTER imagery was acquired on September 22, 2003. The MODIS image data acquired on the same day as the ASTER data is used. The ASTER data was corrected for effects of the atmosphere and the reflectance values were derived using MODTRAN algorithm. The MODIS data was already available in the surface reflectance (MOD09 product). The two image data are then spatially registered.

2.2 Generation of forest fraction image with MODIS Image

To generate forest fraction image with MODIS, end-member and land cover map extracted from high resolution image such as ASTER data is used. The land cover map was made using a supervised classification method and is used to calculate forest type area fractions in MODIS data. As the two image data have been spatially registered, forest type area fractions in the MODIS image data can be easily estimated from ASTER image data by identifying the overlapping pixels. In this study, End-member of high resolution image (ASTER data) was taken as the mean reflectance value of pixels covered by a single land cover within 1km by 1km area corresponding to MODIS pixel size. To estimate the end-members' spectral reflectance for the MODIS image data covering study area, linear mixture inversion model is applied.. The equation is as follows.

$$\epsilon_{i,k} = R_{i,k} - \sum_{j=1}^{m} r_{j,k} f_{i,k}$$

(k=1,…,p and i=1,…,n)

where $R_{i,k}$ is the spectral reflectance in pixel i in spectral band k, in MODIS image data, fi,j is the fraction of pixel i covered by component j derived from ASTER image data, $r_{j,k}$ is the unknown spectral reflectance of component j in spectral band k in MODIS image data, $\varepsilon_{i,k}$ is the residual in pixel i land spectral band k, n is the number of pixels used, m is the number of components, and p is the number of spectral bands in image data

The fraction maps for mixed deciduous and coniferous, plantation pine and larch, soil and water over forested area in South Korea were made by applying end-member reflectance value extracted from MODIS data covering study area to the constrained linear mixture analysis (Shimabukuro et al., 1991).

3. RESULTS AND DISCUSSIONS

End-member reflectance extracted in ASTER image data were compared with MODIS end-member reflectance estimated by applying to a linear mixture inversion method. Figure 2 shows the relationship between end-member reflectance value from ASTER data and MODIS data.

The estimated end-member spectral reflectance from MODIS data is very close to observed end-member reflectance in ASTER image data. In overall, the correlation between the derived MODIS end-member and the observed ASTER end-member is strong with a R^2 correlation of 0.86, 0.79, 0.95, and 0.87 for the green, red, NIR, and SWIR band, respectively.

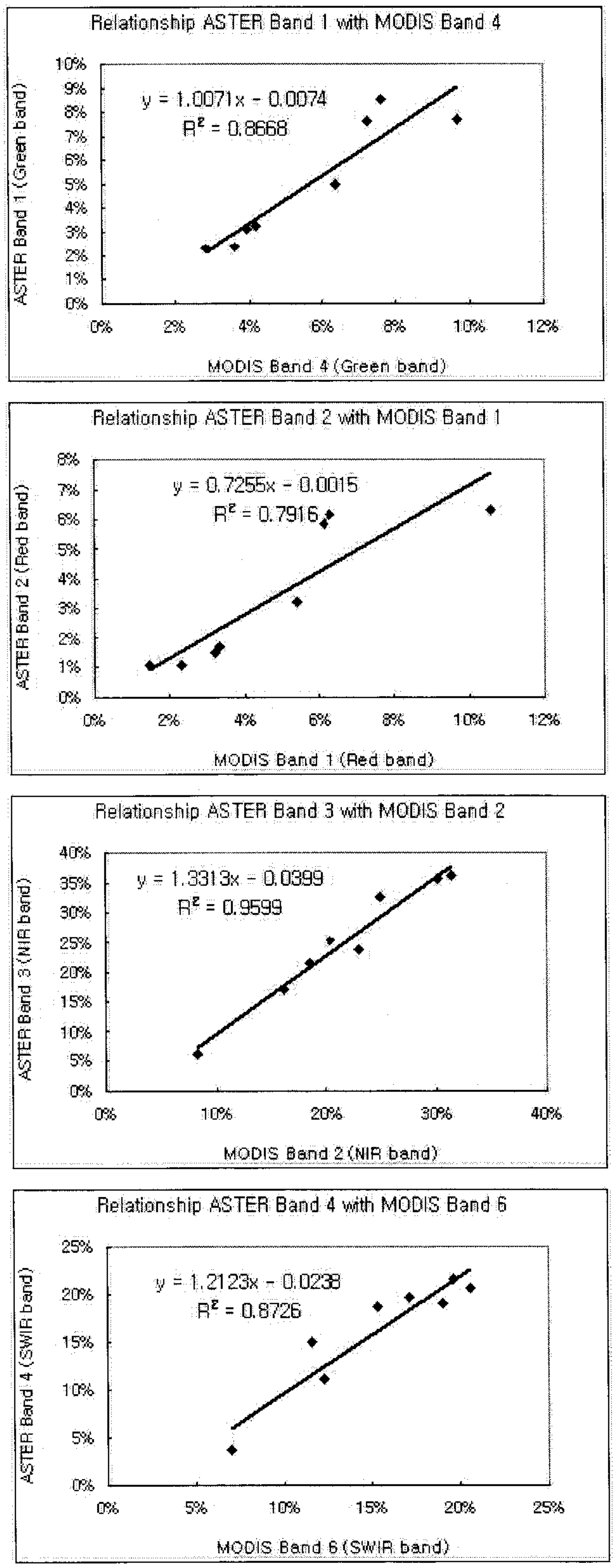

Fig 2. Relationship between end-member reflectance value from high resolution image data (ASTER data) and from low resolution image data (MODIS data)

To evaluate the forest fraction image with MODIS end-member reflectance derived from fraction image along with end-member available with high resolution image (ASTER data), the forest fraction image with MODIS data were compared with that with ASTER data in study area. In Figure 3, the top image is the forest fraction images for mixed forested area and the bottom image is the urban fraction image in South Korea.

The most forested area of South Korea is covered by mixed deciduous and coniferous, which is well represented in top image. And the bottom image shows that the area fraction value of urban region is higher than the other region. Although we attempted to evaluate the forest fraction image with MODIS data by visual inspection, we found the fraction values of each end-member could be used to separate forest cover.

Fig 3. The fraction image generated from MODIS image data (Top : fraction image Mixed forested region, Bottom : fraction image Urban region)

4. CONCLUSIONS

The forest fraction image with low resolution image data is generated by applying the end-member and its fraction image extracted from high resolution image data. The end-member reflectance value observed from ASTER data over study site is very close to that derived by applying linear mixture inversion method with MODIS image data. The derived MODIS end-member reflectance allows the expansion of information about the forest area fraction across a larger area.

The approach used in this study can help to interpret the information of mixed-pixel in low resolution image data.

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