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Impact of Temperature Distributions on Forest and Vegetation in Jeju Island with Remote Sensing Data

Lee, Byung-Gul[1] and Kang, In Joon[2]

[1] Department of Civil and Environmental Engineering, Cheju National University, Associate Professor(leebg@cheju.ac.kr)
[2] Department of Civil Engineering, Pusan National University, Professor(kangprof@hanmail.net)

요 지

본 연구에서는 Landsat 7 ETM+위성영상을 이용하여 제주도의 표면온도분포를 구하여 제주도의 식생분포와 비교해 보았다. 계산결과 온도분포는 제주의 남쪽지역이 북쪽보다 약3℃정도 높게 나타났으며, 이러한 온도분포로 인하여 제주도의 남쪽에는 활엽수가 북쪽보다 침엽수가 대체적으로 많이 분포하였으며, 나무의 성장과 관련된 나무목의 둘레가 대체적으로 굵게은 것으로 나타났다. 이러한 경향으로 보아 제주도의 경우 같은 고도의 남쪽과 북쪽의 온도분포가 다르게 나타나며, 이러한 영향으로 인해 한라산 식생분포특성이 달라지는 것으로 판단되었다.

1. Introduction

In the remote sensing data, the Landsat satellites have been widely used for the land classification and the image interpretation, respectively. The LANDSAT program was initiated by the U.S. Sugal et al. (2000) provided a verification study on the surface temperature derived from the thermal infrared image data of Landsat 7 for the estimation of thermal condition around Hiroshima city and bay area based on NASA method. Barsi et al. (2003) estimated the on board thermal calibration of Landsat 7 through the ground measurements and showed validation of the temperature values of the Landsat 7. From these studies, we found that the thermal band proposed the reasonable temperature distribution of land and water. In this paper, the thermal band of Landsat 7 was applied to Jeju Island to estimate the temperature distribution impact for the vegetation and forest of the area. The calculated results of Landsat data will be also compared to the observation data supported by KMA (2003).

2. Data and Research Site

In this study, Landsat 7/ETM+ data (2898 x 1897 Landsat pixels) from the cloud-free day of January 6, 2003 was selected. The study area, Jeju Island is a volcanic island located off the southern coast of Korea, the shape of the island is flat and oval-shaped (approximately 126 05 ′ 10 ″ N to 126 58 ′ 37 ″ N and 33 06 ′ 31 ″ E to 33 35 ′ 55 ″ E) with high mountain Halla (Fig. 1).

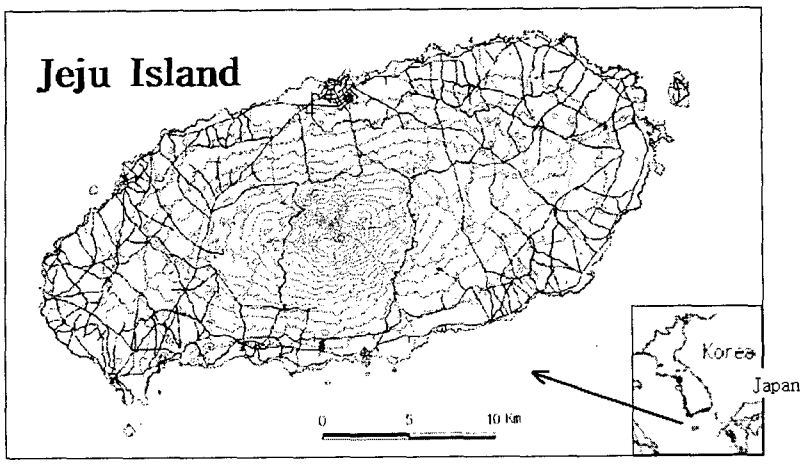

Fig. 1 The study area of Jeju Island. Green line is contour line of the Jeju Island with Mountain Halla.

To analyze the ocean surface and the land temperature distributions in the study area based on Landsat 7 data, Image Analyst software was used, that was developed by Inergraph company. Using the software, we extracted the surface temperature from the value of the radiance of DN (Digital Number) in band 6 which is called thermal band. At the same time, we implemented image rectification using the 1:25,000 digital map.

3. Methodology

For calculating the temperature distributions of Jeju Island using thermal band of Landsat 7/ETM+ thermal band, the following equations were used (Jo et. al, 2002)

$$T = \frac{K2}{\ln\left(\frac{K1}{L_k} + 1\right)} \quad \text{----------(1)}$$

where $L_k = gain^* DN + offset$, $gain = \frac{L_{max} - L_{min}}{Q_{max} - Q_{min}}$, $offset = L_{min}$

The equations are also known as NASA method. The gain and the offset values are provided by Barsi, et al. (2003), that were calculated by continually monitoring the ground surface temperature observation. The estimated parameters are shown in Table 1 which can be also derived from Landsat 7 project database system (USGS, 2000).

Table 1. ETM+ spectral radiance range and thermal constants

L_{max}	L_{min}	Q_{max}	Q_{min}	K1	K2
17.04	0.0	255	0.0	666.09	1282.71

4. The Temperature and Vegetation Distributions of Jeju Island

Fig. 2 shows the results of spatial temperature patterns of the island based on Landsat 7/ETM+ in January 2003. In the figure, we know that the temperature variations are from 0 to 15 Celsius degree. Around top of the Halla mountain is less than 0 degree, and the coastal ocean is about 15 degrees that is almost the same temperature distribution in the ocean since the horizontal and the vertical mixing process in the coastal ocean.

Fig. 3 and 4 show the vegetation, forest and the tree diameter characteristics of Jeju Island. Based on the different temperature of the island(Fig. 2), we checked the tree and vegetation distributions in Halla mountain of the temperature one. From the checking, we found that at the same height, the coniferous forest are mostly distributed in north part although the deciduous are in south part. The tree diameter of south parts is also larger than that of the north. As the deciduous are relatively living in warm area comparing to the coniferous, the impact of temperature was important role of distributions of forest and vegetation in the island.

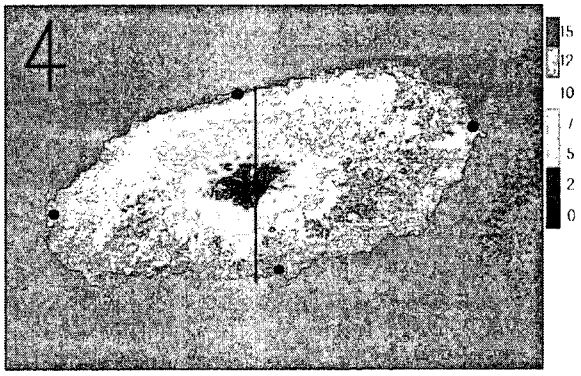

Fig. 2. The temperature distributions of Jeju Island and around ocean using Landsat 7 image. The black spots showed the observation ones.

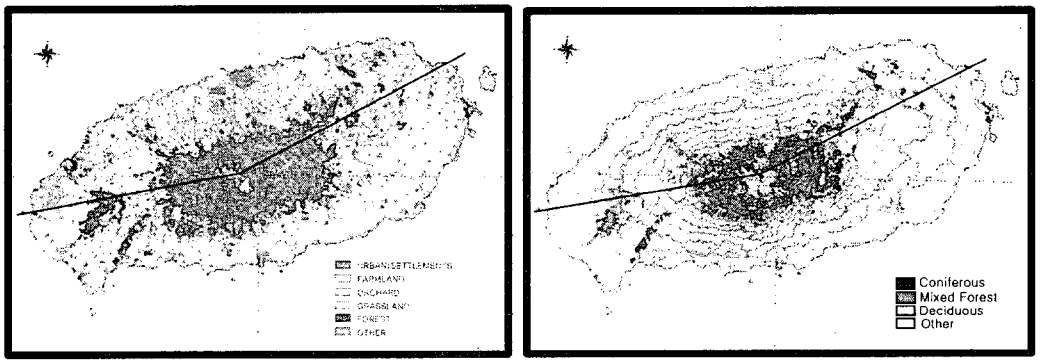

Fig. 3. Vegetation and forest distributionsof Jeju Island.

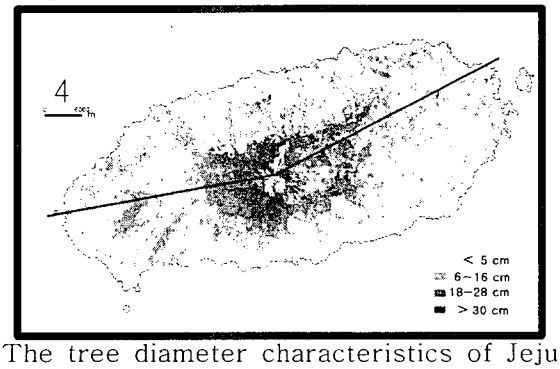

Fig. 4. The tree diameter characteristics of Jeju Island.

5. Summary and Conclusions

In this study, the estimation of the surface temperature distribution of Jeju Island with coastal ocean derived from the thermal band of Landsat 7/ETM+ was carried out. The interesting thing of the temperature distribution is that the temperature of the north part of the island is relatively lower than that of the south at the same height. The temperature difference between the north and the south from the bottom to the top of the mountain, respectively is about 2~3 degrees. Based on the different temperature of the island, we checked the tree and vegetation distributions in Halla mountain. From the results, we found that at the same height, the coniferous forest are mostly distributed in north part although the deciduous are in south part. The tree diameter of south parts is also larger than that of the north. As the deciduous are relatively living in warm area comparing to the coniferous, the impact of temperature was important role of distributions of forest and vegetation in the island.

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