Analyzing the correlation between urban forestry and surface temperature using Landsat TM data

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Abstract: In this study, the correlation between the heat island effect and the vegetation in Deagu Korea was performed through using Landsat TM data.

the island effect, presents high temperature on air like island, is connected with correlation between the surface temperature and the temperature on the air. In this study, surface temperature was analyzed by detecting the change of urban forestry with remote sensing using the vegetation vitality statistics reference (ratio change of the Park greens in Daegu) the heat island effect not only brings the environment pollution but also brings serious problem such as the destruction of ecosystem to city as a whole.

Jeff Luvall has studied to restrain the heat island effect by making urban forestry.

Even though Daegu had been the serious high temperature urban area the current temperature of Daegu has been dropped. The correlation between the heat island effect and the vegetation index was analyzed by using satellite images.

Keywords: MSAVI, Surface temperature, urban forestry, vegetation vitality

1. Introduction

As Korea has been getting developed, an overpopulated city has been increasing.

Because of this phenomenon, the greens space has been decreased so that the temperature has been dramatically raised. Thus, the heat island effect has been occurred.

According to the studies, Daegu had been in the highest temperature until 1933 referencing atmospheric phenomena data also recorded the highest day temperature until 1995 so that clarified as a typical basin urban.

However, recently, Daegu has been recoded lower temperature than another inland city such as Seoul, Kwangju, Daejeon and even is similar to another seaside city such as Busan, Ulsan, Incheon in the view of highest day temperature. Though the results of this study, Meteorological agency analyzed even though the north pacific high pressure had been weak between 1994 and 1995. Also, the other had expected Daegu was risen average temperature because urban forestry has been made in Daegu.

Lee I. J has been studied about the heat island effect with the urban temperature and the horizontal distribution of the

relative humidity (1993). Jung I. S also has been studied about the heat island effect in Jun-ju province in Korea. This study, the correlation between the surface temperature, which is the factor of the heat island effect, and the vegetation index and the reason of resent rare temperature summer time in Daegu were verified by using satellite images.
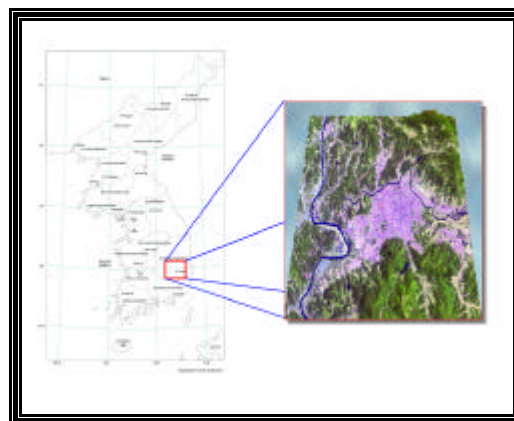

Fig.1. The study area, Daegu city, Korea

2. Materials and method

In this paper, the change of forestry in Daegu was detected though using multi-temporal (1994. 6. 1 and 2000. 6. 1) Moreover, the vegetation index in study area is derived by using MSAVI so that the ratio change of park greens is clarified.

The other area except the center of Daegu was settled by masking (Fig.1)

In order to produce the surface temperature properly, NASA model is applied and COST model is used to generate the e rror of the radiation and atmosphere after geocorrection. For those image processes, IMAGINE 8.5 and Arcview 3.2 were used through referencing digital scaled on 1:25,000 and atmosphere data.

3. The ratio change of park greens in Daegu

Table 1. A Change of green park rate   unit:

Section	94(area)	95(area)	96(area)	97(area)	98(area)	99(area)
C.P	0.49	0.49	0.48	0.51	0.66	0.67
N.P	8.59	8.59	8.59	8.59	8.98	12.08
U.N.P	38.0	38.0	36.07	36.07	36.07	65.37
A.P	0	0	0	1.93	1.93	1.92
NA.P	43.59	43.59	43.59	43.59	43.59	43.59
B.Z	2.36	2.55	2.58	3.10	3.10	4.84
S.Z	1.07	1.01	1.01	0.97	0.97	1.05
SUM	99.92	100.73	99.98	100.49	100.98	135.25
P.G.Z	11.28%	11.37%	11.29%	11.34%	11.40%	15.64%
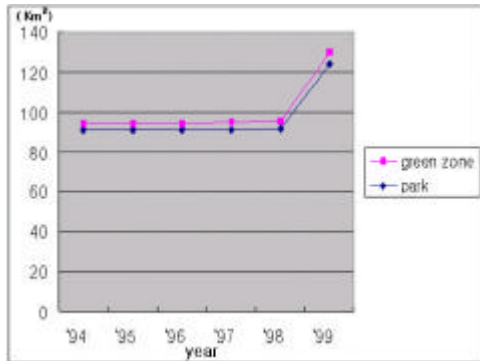
C.P: Children's Park   **N.P:** Neighborhood Park

U.N.P: Urban Nature Park   **A.P:** Athletic Park

N.U.P: Natural Park   **B.Z:** buffing green zone

S.Z: scenery green zone

P.G.Z: percentage of green zone

Table 1 the green park was expanded about 135.25   and it occupies about 35% of the entire study area. Especially, urban forestry had been made intensively between 1998 and 1999.

4. The change of vegetation vitality in urban forestry

NDVI explains has the vegetation index value, which is generalized by the band calculation as the technique known generally.

MSAVI is expended the value of SAVI including soil correction factor, which band calculation of NDVI, minimize the effect of soil at the first spectrum reaction of soil based on plants.

In order to apply to this MSAVI, the atmosphere effect has been corrected with eliminating precise revision, considering molecule dispersion and ozone effect at image.

Table 2. Modified Soil-Adjusted Vegetation Index

$$SAVI = \frac{(1+L)(NIR - red)}{NIR + red + L}$$

NIR = Near Infrared band   red = Red band
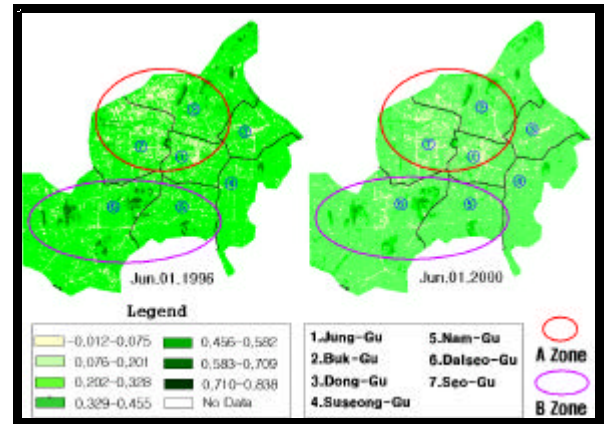L = soil correction factor

Fig. 2. MSAVI distribution map

At the result of analyze vegetation vitality of urban forestry using the vegetation index, the index value A area had been reduced between 1996 and 2000.

However, the average value of vegetation vitality in Daegu is getting lower than before and the value was about 0.138 in 1996 but about 0.122 in 2000.

The result defined that the value B area, where was overred in forestry, had lower the vegetation vitality.

5. The surface temperature change in Daegu city

Surface temperature was derived from the NASA model, that has radiation brightness extracted from the DN (digital number) value of Land sat TM band 6(Table.3).

Table 3. NASA Model

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda} + 1\right)}$$

Where, T = temperature in degrees Kelvin

L   = spectral radiance in w· m-2· ster-1· mm-1

ln = natural logarithm

K2 = calibration constant 2 in degree Kelvin

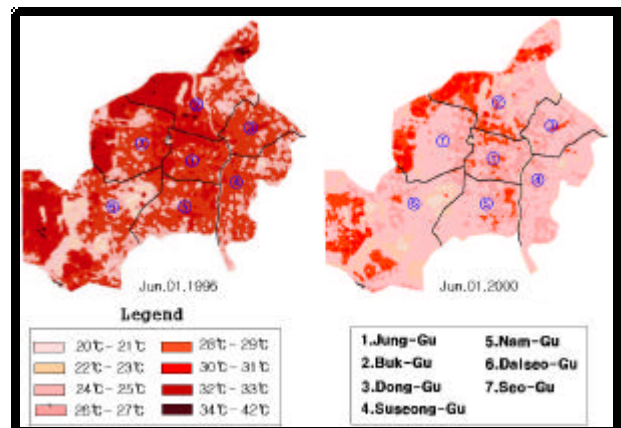K1 = calibration constant 1 in w· m-2· ster-1· mm-1

Fig. 3. Surface temperature distribution map

The result that analyzes temperature of the surface in Daegu was the minimum 20-degree, the maximum 42-degree, an average 29-degree in 1996 and the minimum 20-degree, the maximum 35-degree, an average 26-degree in 2000. A distribution range of temperature in 2000 was lower than in 1996 and the vegetation vitality was also relatively in lower distribution range of lower temperature at the higher value area.

It had been higher surface temperature value than others in 1996 comparing the central area that is formed by commercial facilities.

However, it has the similar surface temperature range in 2000 comparing it of other area. That was analyzed as the result which the higher temperature value of the surface had been reduced by constantly green parks in the heart of the Daegu.

6. Conclusion

The correlation between surface temperature and vegetation vitality was extracted using multi-temporal satellite images to monitor both the heat island effect and urban forestry change. The vegetation vitality in the heart of the city could be estimated by getting more detail analysis result than that of NDVI.

In addition, as increasing the green ratio, the surface temperature in Daegu is getting lower and whole the vegetation vitality is getting higher.

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