APPLICATION OF REMOTE SENSING TECHNOLOGIES TO TIME SERIES ANALYSES OF SURFACE TEMPERATURES IN DAEGU CITY

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1. INTRODUCTION

Surface temperatures are affected by the states of land covers and, in particular, they are greatly affected by the states of vegetation and water. As a result, correlations between NDVI and NDWI indexes were studied [1][2]. As a study that compared two periods, Xian[3] analyzed correlations between city expansions, development densities, and surface temperatures. However, previous studies of continuous surface temperature changes are insufficient. To analyze continuous surface temperature changes, some criteria suitable for relative comparisons will be presented. Landsat data for the same season in 10 consecutive years were used. The surface temperature values of the images were rearranged along an axis. In addition, the method was objectively verified.

2. TIME SERIES ANALYSES

Temperature characteristics can be elucidated using 10 images obtained in the same season (Table 1). Daegu is in a form of basin and the downtown is surrounded by mountains with vegetation. Therefore, 53 school playgrounds were selected as reference sites(529 pixels). The second quartile STs of individual playgrounds are defined as STP_y. Differences between ST values in pixels in the entire images and STP values are obtained. These values are defined as STD_y (1).

Y/M/D	19940509	19950512	19960403	19970517	19980520	19990507	20000508	20010418	20020523	20030510
Landsat	TM 5	TM 5	TM 5	TM 5	TM 5	TM 5	ETM 7	ETM 7	ETM 7	ETM 7
Path Low	114 35	114 35	115 35	114 35	114 35	114 35	115 35	114 35	114 35	114 35
Sun Azimuth	118.0	113.0	126.0	118.0	120.0	124.0	128.2	134.3	121.5	126.4
Sun Elv.	58.0	56.0	46.0	61.0	63.0	60.0	62.8	57.1	64.6	62.5
Atm. Temp (℃)	20.4	15.2	5.3	21.4	22.8	22.3	20.4	19.4	23.0	16.3

Table 1. List of images used in this study.

$$STD_y = ST_y - STP_y \quad (1)$$

Where STD_y = surface temperature difference, Nomalized surface temperature values of individual pixels (˚C)

ST_y = temperatures of individual pixels calculated in the thermal band (˚C) [4][5].

STP_y = the observed value(˚C) that will become the reference value for the values of the playground in the year

y = year, 1994~2003

3. RESULTS

3.1. STD temperature distribution diagram

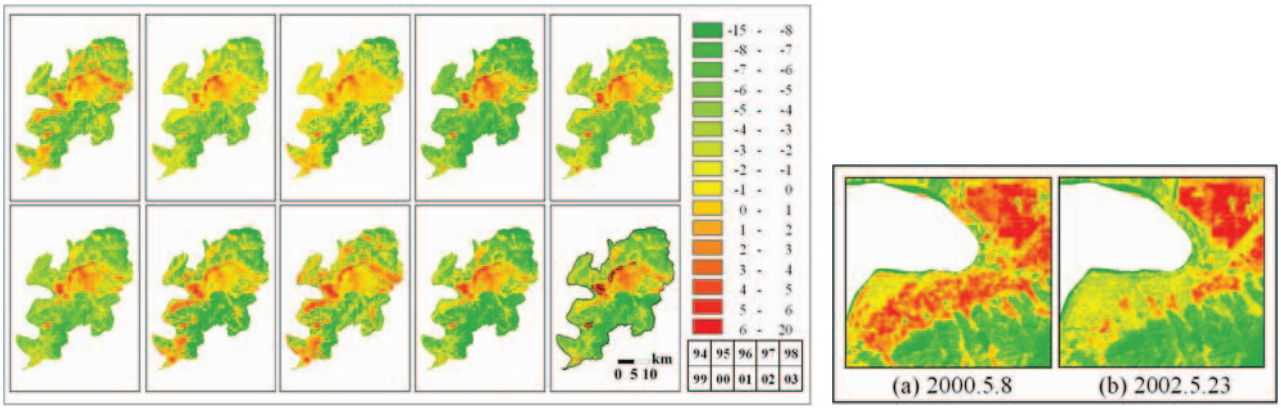

Figure 1.L: STD distribution diagram for 1994-2003 and locations of industrial complexes.
R: Comparison of surface temperatures in relation to the water conditions in paddy fields.

Temperature distributions in 1994-2003 can be visually identified (Figure 1.L). Daegu is in a form of basin. The mountain regions surrounding the downtown are vegetated regions generally having 0°C or lower STD values. The downtown region in the center is a residential and commercial region with higher temperatures than the vegetated regions [6][7].

3.2. STD temperature in paddy fields

In the 10 STD distribution diagrams, temperature characteristics of the downtown, factory areas, and mountain regions are similar. However, there are parts where continued temperature changes are large and of them, paddy fields are explained as follows. There are paddy fields in Sindang-ri and Gyohyang-ri located in the western part of Daegu(Figure 1). In Daegu, rice planting begins later than mid-May based on the characteristics of seasons. The STD_{2000} in the paddy fields on May 5, 2000, are higher at least by 0°C on average(Figure 1.R). The much lower STD_{2002} in the paddy field at the same location on May 5, 2002, is a distinguished characteristic. This means that, in the case of May 23, the difference means that the paddy field was filled with agricultural water.

3.3. Application to industrial complexes

STDs of six industrial complexes in Daegu were surveyed. Third quartiles of STDs from the 10 images were calculated. It was identified that all the six industrial complexes in Daegu showed lower temperature increase

rates in 1999 when the industrial complexes were affected by the IMF economic crisis. Also, the temperatures increased by at least 2.8°C in 2003 compared with 1994(Figure 2).

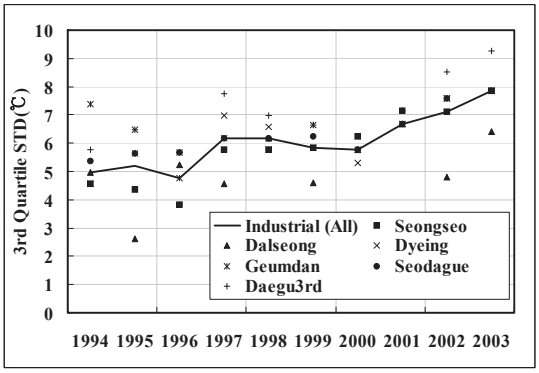

Figure 2. Third quartile STD(°C) values of all industrial complexes and those of six individual industrial complex.

4. CONCLUSION

To analyze continuous ST changes, some criteria suitable for relative comparisons were presented. Through the criteria, STs could be interpreted more systematically. Reference sites were selected to prepare STD distribution diagrams. STD interpretation methods were applied to industrial complexes in Daegu and, as a result, it was seen that the STDs of industrial complexes in Daegu increased by 2.8°C in 2003 compared with 1994. Artificial heat generated in industrial complexes was significantly related with industrial economic conditions. By analyzing STDs in two or more periods, diverse information for human lives can be provided. In addition, site experiments and causal analyses based on collections of diverse data are necessary.

5. REFERENCES

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