A STUDY ON EXTRACTING THE SURFACE TEMPERATURE USING THERMAL INFRARED OF ASTER IMAGES IN URBAN AREA

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ABSTRACT:

Recently as large sized urban development and the city ward drifting of population are caused, the urban surface temperature is raised very seriously and rapidly. These artificial developments have destroyed the inner and outer landscapes such as topography and have changed complex local climate such as a sudden rise in temperature, the change of wind field and air pollution.

In order to clarify this problem visually, the studies on extracting the thermal infrared and the characteristic analysis of local climate in urban area had been performed by using the sixth band of Landsat TM and ETM+.

However, there is a need to alternate Landsat TM and ETM+ because these satellite images are not applied any more. Therefore, in this paper it is proposed to use 2 Aster image (2004.4.17 daily 2b03, 2004.10.10 night 2b03) of EOS AM and to extract the surface temperature. Also, the pattern of surface temperature in urban area and the application possibility in local climate study are proposed by verifying the correlation with AWS data. Also, IKONOS image was used to figure out the artificial development area in visual.

Keyword: ASTER, AWS, thermal infrared, surface temperature

1. INTRODUCTION

Recently as large sized urban development and the city ward drifting of population are caused, the urban surface temperature is raised very seriously and rapidly. These artificial developments have destroyed the inner and outer landscapes such as topography and have changed complex local climate such as a sudden rise in temperature, the change of wind field and air pollution.

In order to present this problem visually and especially to clarify, there is need to use satellite images. Also this is to overcome the preventive data problem of AWS.

For this using the sixth band of Landsat TM and ETM+ had performed the previous studies on extracting the thermal infrared and the characteristic analysis of local climate in urban area. However, there is a need to alternate Landsat TM and ETM+ because these satellite images are not applied any more.

Therefore, in this paper it is proposed to use 2 Aster image of EOS AM-1 and to understand the surface pattern and local climate.

There existed the previous research about it such as evaluating the heat island in 3 cities in Korea based on sixth band of Landsat TM, AWS climate data and vegetation index (Park In Hwan, 1999), clarifying the urban surface temperature environment using Landsat TM images (Myung - Hee Jo, 2004), studying the surface fire case using surface temperature of Landsat TM in India (Prakash A, 1999) and analyzing the coast surface temperature using Landsat 7/ETM+ band 6(Yuzo Suga, 2000).

In this paper it is proposed to use TIR (Thermal Infrared) of 2 Aster image (2004.4.17 daily 2b03, 2004.10.10 night 2b03) of EOS AM and to extract the surface temperature. Also, the pattern of surface temperature in urban area and the application possibility in local climate study are proposed by verifying the correlation with AWS data.

Also, IKONOS image was used to figure out the artificial development area in visual. Also it is expected to apply the integration of RS and GIS

to analyze the spatial distribution characteristic of surface temperature.

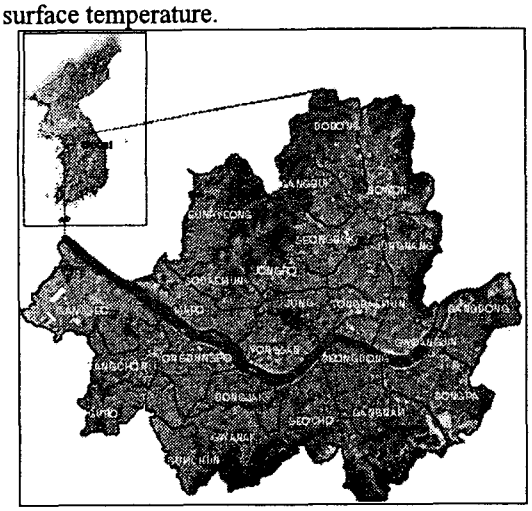


Fig. 1 Study area [Seoul]

2. STUDY MATERIAL AND METHOD

In this study there are two types Aster images, which is called as ASTER 1A Product for the analysis of urban environment in Seoul area and ASTER 2B03 Product for the extraction of surface temperature (April. 17. 2004. AM: 10:30 & October. 10. 2004 PM: 11:21).

Moreover, AWS data at 32 places in Seoul and high-resolution satellite images, IKONOS, (2000) were referenced for images analysis and validation data.

As you know ASTER 2B03 Product was already had fundamental geometric correction and emission correction. In addition, this image has the detailed geometric correction having 0.31m RMS Error and then resample based on nearest neighbor interpolation method (90m by 90m).

3. URBAN ENVIRONMENT ANALYSIS USING ASTER IMAGES

3.1 Aster Images

ASTER (Advanced Space borne Thermal Emission and Reflection Radiometer) image has 14 bands, which are visible ray through thermal infrared. Also, it provides TIR mode, which has operated in night period and DEM mode using VNIR N 3band and VNIR 3B band.

It has Swath Width (60km), swath (Day/ Night), TIR, SWIR+TIR, Temporal resolution, 16days, 15m spectral resolution, 15m visible-near infrared (VNIR), 30m shortwave infrared (SWIR), 90m Thermal infrared (TIR).

Fig. 2 shows the flow of ASTER data products and the comparison of wavelength on different satellites (KOMPSAT EOC, ASTER, LANDSAT ETM+)

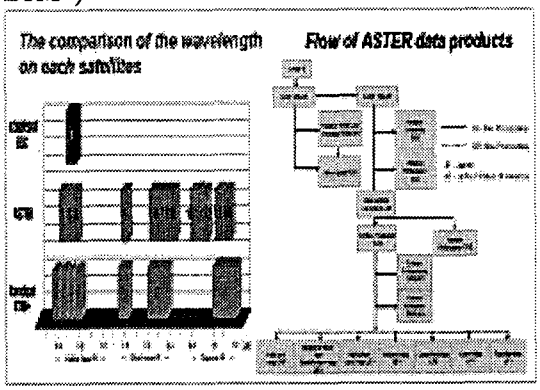


Fig. 2 ASTER data products and the comparison of wavelength on different satellites

3.2 Surface Temperature Extraction using ASTER TIR DN Value

In this study in order to extract the surface temperature in Seoul ASTER 2b03 Product was use while generally Landsat TM/ETM+ images had been used based on NASA Model (Markham and Becker, 1986).

However there has been an assumption that the emission rate between earth and atmosphere was regular thus the validate variable of satellite sensor was used. It means that the less exact surface temperature could be acquired while ASTER 2b03 Product considers emission, absorption and scattered.

Fig. 3 shows the surface temperature distribution map in Seoul, which has unit of Celsius temperature scale.

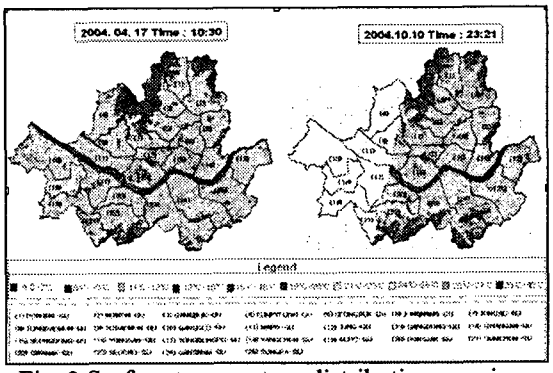


Fig. 3 Surface temperature distribution map in Seoul

Through this, Jung-Gu district was figured out as the most high surface temperature area (24.17℃) and Yangchon-Gu (24.04℃), and

Songpa-Gu (24.00℃) in order while Gangbuk-Gu(18.97℃), Dobong-Gu(19.66℃), Mapo-Gu(19.79℃) as shown in Fig. 4.

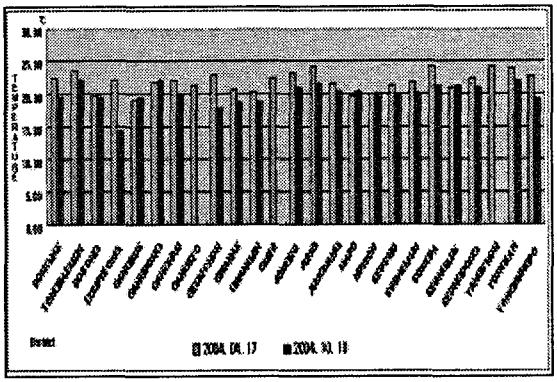
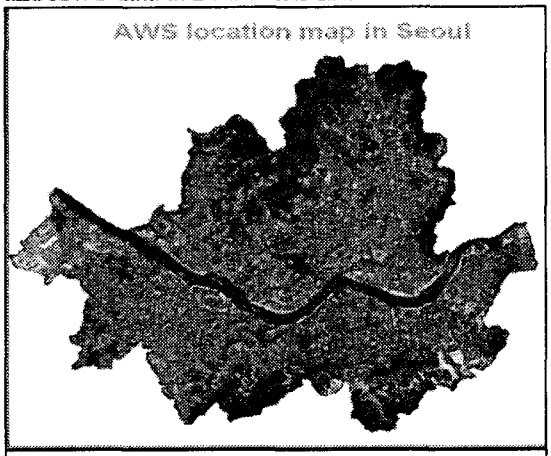


Fig. 4 The average surface temperature at 25 districts in Seoul

4. Surface Temperature Correlation Analysis between ASTER TIR Data and AWS data

In this study the surface temperature correlation analysis was performed using ASTER TIR Data and AWS data at 24 districts in Seoul.



Comparing the value of TIR DN and AWS

NAME	2004. 04. 17		2004. 10. 18	
	ASTER	AWS	ASTER	AWS
1. GANGNAM	23.35	20.60	20.05	20.10
2. SEOCHO	24.05	21.40	21.15	19.30
3. GANGDONG	21.85	20.50	16.95	15.90
4. SONGPA	25.15	20.60	19.05	18.60
5. GANGSEO	21.95	19.90	–	–
6. YANGCHON	24.65	20.40	–	–
7. DOBONG	18.45	20.10	20.75	15.50
8. NOWON	21.25	19.70	19.85	15.10
9. TONGDAEMUN	24.65	21.70	24.55	19.50
10. JUNGNANG	22.95	20.00	21.25	18.50
11. GUSANGCHEONG	22.65	20.40	–	–
12. MAPO	24.05	19.70	20.45	19.00
13. SODAEMUN	18.75	20.40	–	–
14. GWANGJIN	20.85	20.40	16.25	20.10
15. SEONGBUK	19.45	19.10	18.15	15.10
16. YONGSAN	23.95	20.40	19.35	19.90
17. EUNPYEONG	21.85	19.10	–	–
18. GUACHON	23.45	20.40	–	–
19. NANGANG	24.25	21.00	20.95	19.40
20. JUNG	19.45	19.80	17.45	17.60
21. BUKNANJE	17.25	19.50	14.75	17.10
22. SEONGDONG	21.25	21.10	19.65	19.40
23. GWANAK	20.55	19.80	16.45	14.00
24. YONGDUNGPO	23.75	20.60	–	–
Mean	22.09	20.19	17.4	17.07
Correlation coefficient	0.72		0.42	

Fig. 5 Correlation between surface temperatures of ASTER TIR and AWS Data

As the result, 0.72 and 0.42 correlation coefficients were acquired on each Apr. 17. 2004 and Oct. 10. 2004 respectively. In addition, the differences of average temperature between ASTER TIR Data(22.0℃, 17.4℃) and AWS data(20.1℃, 17.07℃) was 1.9℃ and 3.6℃ on Apr. 17. 2004 and Oct. 10. 2004 respectively.

5. Spatial Distribution Characteristic of High Surface Temperature Area in Seoul

As the result of overlaying the surface temperature data on satellite images (IKONOS) by using transparent method, Gumchon-Gu and Gangseo-Gu in Kimpo airport area, Yongdungpo-Gu, Yongsan-Gu, Jung-Gu and Tongdaemun-Gu are figured out as higher temperature area.

Especially, military facility area in Yongsan-Gu, artificial lawn area in Tongdaemun stadium, LotteWorld and Garack market in Songpa-Gu were figured out as significant high temperature area(29℃~35℃) as shown in Fig. 6.

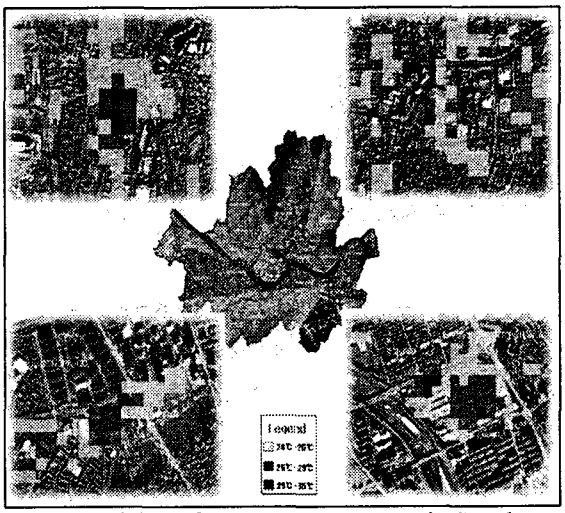


Fig. 6 High surface temperature area in Seoul

6. Conclusions and Further Study

In this study the coefficient value and the high surface temperature distribution area in Seoul were figured out by constructing surface temperature distribution map based on ASTER TIR and AWS data.

Through this study, the surface temperature data of ASTER for daily time has higher correlation with AWS data than ASTER data for night time (72% correlation daily time and 42% correlation night time)

Secondly, Jung-Gu in Seoul was figured out the most high temperature area(24.17℃ on Apr. 17.

2002 daily time and 22.16℃ on Oct. 10. 2002 night time) while Gangbuk-Gu and Eunpyung-Gu were figured out the most low temperature area(18.97℃ on Apr. 17. 2002 daily time and 22.16℃ on Oct. 10. 2002 nighttime) respectively. In addition, these area, Jung-Gu and Tongdaemun-Gu are located in urban area especially CBD (Centerior Business District) and large size artificial building area while Gangbuk-Gu and Eunpyung-Gu are located in forest area and less building).

Finally, most of high temperature area are clearly known as less vegetation rate and composed with concrete, asphalt and artificial lawn.

For the further works, the urban spatial information can be detected by analyzing the surface temperature distribution characteristic more scientifically using remote sensing technique. The substitute data should be addition so that this result should be verified. Also, the various application of Aster images such as extracting surface temperature should be considered in Korea and the continuous monitoring of urban and local meteorology could be performed by developing the surface temperature extraction model and verifying meteorology data based on Aster images.

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