The Effectiveness of Roof Planting for Reducing Urban Heat Island Phenomenon

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Abstract: Presently, heat island phenomenon, leading towards global warming, is one of the major environmental problems. As a solution of this problem, roof and surface wall planting is considered to be effective. Accordingly, the objective of this study is to examine the effectiveness of roof planting in reducing the heat island phenomenon. The results of the study show that, planted area of the observed house roof had lower average temperature, in between 15-20^{0}C, in comparison with that of the unplanted area of the roof.

Keywords: Heat island, Roof planting, Thermal camera, Photometer

1.Introduction

Recently global warming developed into one of the biggest environmental problems. Global warming arises due to the heat island phenomenon, which again occurs due to the rise in the average temperature in the center of urban areas compared to that of the suburbs. The temperature in the center of the urban city rises because of concentration of concrete structures conserving the heat and temperature for long.

As one of the solutions for reducing this heat island phenomenon and thus in turn global warming, increasing green plantation and vegetation activities in the center of the city is advocated. In this respect, roof planting is also suggested nowadays for increasing greenery, as open spaces required for plantation are not sufficient inside the center of the urban city.

Accordingly it is of great interest to investigate the effectiveness of roof planting in reducing temperature and the occurrence of heat island phenomenon. This study aims to do so by using ground remote sensing technology and conducted observation study in one roof planted private house in Omura City of Nagasaki Prefecture Japan. As the instrument of ground remote sensing we have used a thermal camera and a photometer.

2.Description of Investigation

The location of the investigated house is shown in **Fig.1** [1]. **Fig.2** shows the picture of two houses A and B. As can be seen form the picture, House A is a roof planted house and House B is a non-roof planted normal house. This side-by-side location of the two houses would give us the rare opportunity to compare the difference in temperature between them. Investigation is conducted on 10 June 2004 from 12:00～16:00.

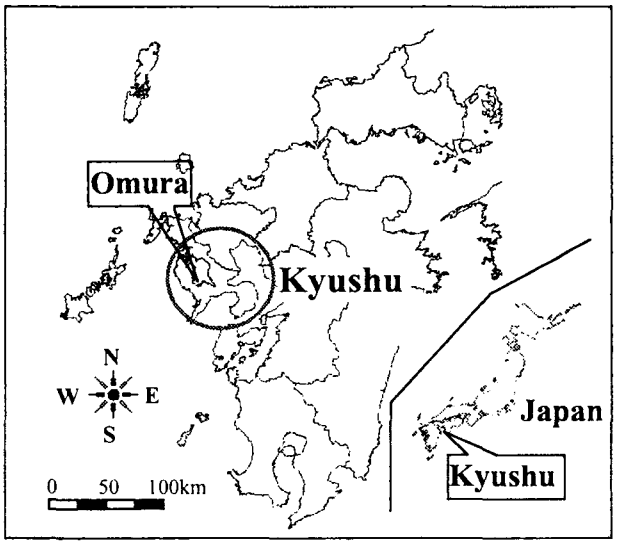

Fig. 1. Location of the study area.

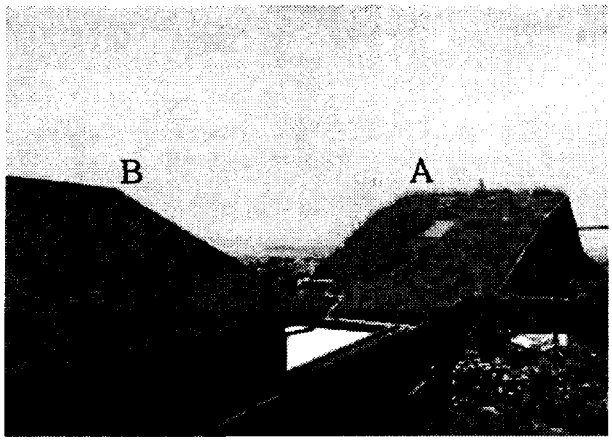

Fig. 2. Picture showing investigated houses.

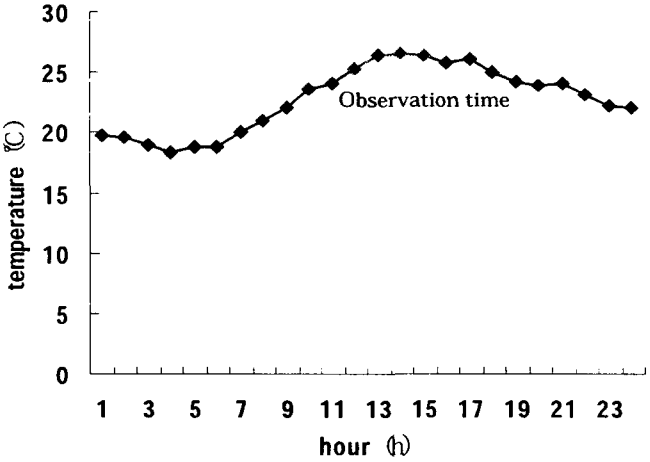

Fig. 3. Temperature on the observation day.

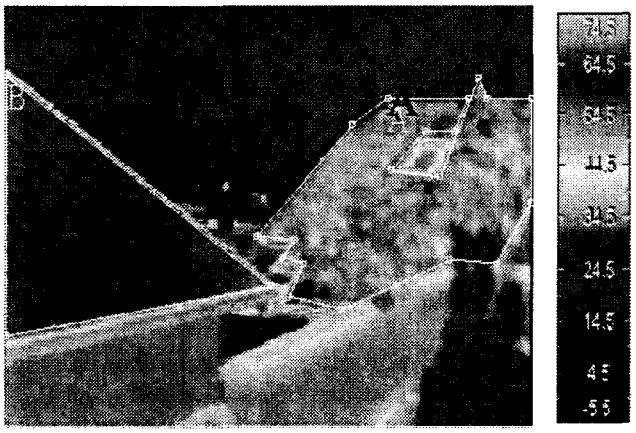

Fig. 4. Thermal infrared image of the houses.

House A – roof planted house
House B – normal house (non-roof planted)

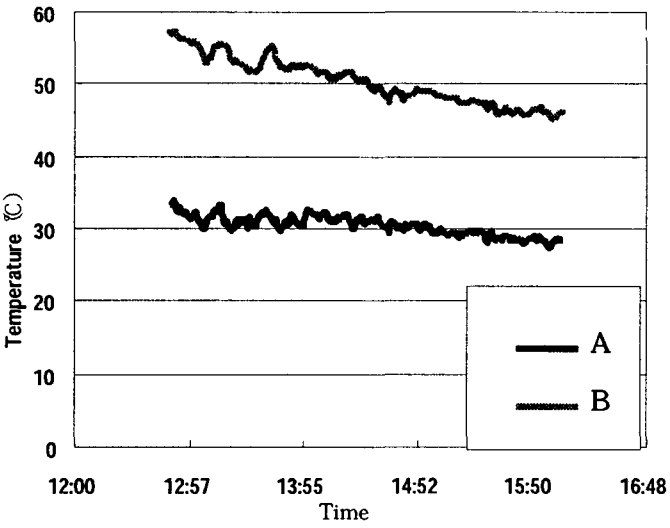

Fig. 5. Temperature change of the appointed domain.

The weather condition was fine. The hourly temperature of that day obtained form Meteorological Agency, is shown in **Fig. 3** [2].

3. Analysis Using Thermal Camera

1) About thermal camera

Heat infrared imaging camera can measure the temperature of the object through infrared image unlike the usual camera that only grasps the appearance of the object.

2) Results

Thermal infrared image is shown in **Fig. 4**. House A is roof planted and house B is normal house (Non-roof planted). **Fig. 5** summarizes the analysis result obtained from the thermal infrared images. From the figure we can see that, the roof planted house A is showing temperature close to 30 degrees, whereas the non-roof planted house B is showing temperature close to 50 degrees.

Thus a difference of about 20 degrees in temperature is observed between the two houses. Later with the passage of time from 12:00~16:00 temperature in both the houses fell gradually as house A is faced east and house B is faced north, both not facing to the sunlight at that time. Also from the figure we can see that the fall in temperature in house A is not so sudden as compared to that of house B.

4. Analysis Using Photometer

1) About photometer

The photographic instrument called photometer measures the health of plants or vegetation through reflection characteristic. The plant can be said to be healthy if the reflectance is increasing at wavelength of 700 nm or more. We went up to the roof of the house A and executed the observation where roof planting was initiated about two years ago.

Fig. 6. Photometer and situation of observation.

Fig. 7. Observed plant (Clover).

Fig. 9. Thermometer and printer.

2) Results

The observation position is shown by **Figs. 6 and 7**, and the observed plant is clover. In addition plant, such as the Kentucky bluegrass etc, were also grown at the roof. The plant observation results are shown in **Fig. 8**. From the figure we can say that the clover plant is healthy as the wavelength is crossing 700 nm. Although the roof planting is done with thin soil layer, the plant health condition is good due to direct flow of sunlight.

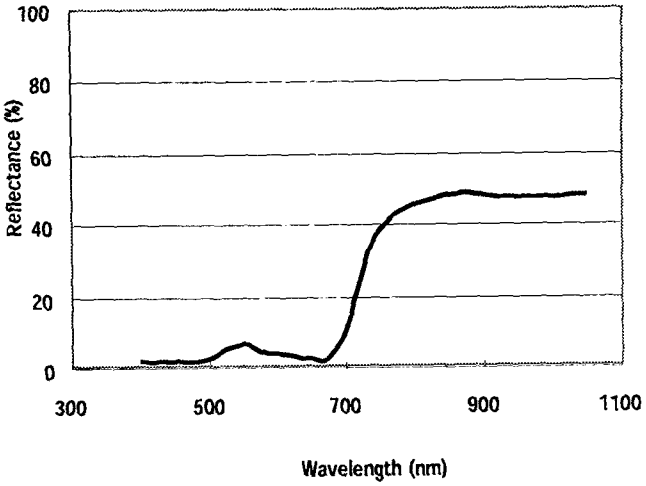

Fig. 8. The reflective characteristic curve of clover.

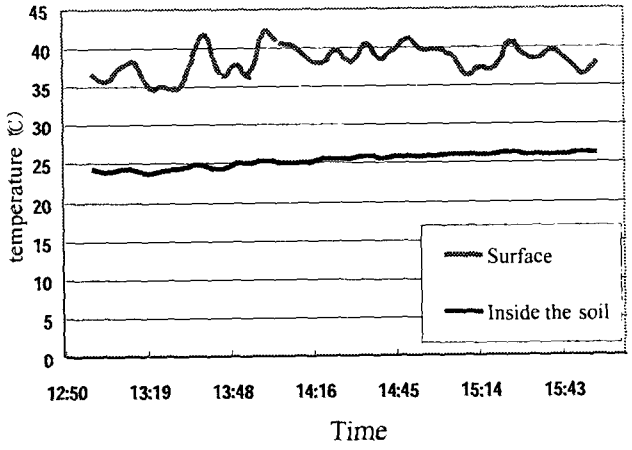

Fig. 10. Temperature change with the passage of time in the roof plant.

5. Analysis Using Thermometer

1) About thermometer

Finally we have used two thermometers: one placed inside the soil of the roof of House A and another on the surface of the roof. The position of the observation is shown in **Fig. 9.**

2) Results

Change in the temperature of roof surface and inside the soil is shown by **Fig. 10**. From the figure we can see a significant difference between the roof surface and inside the soil temperature. The average temperature is about 37 degrees and 25 degrees for roof surface and inside the roof respectively. This shows that roof planting makes transmission of external temperature difficult inside the house.

6. Summary and Conclusion

The findings of this study can be summarized and concluded as follows:

1. We have observed a difference of about 20 degrees in temperature between the roof planted house and non-roof planted house (see **Fig. 11**). This is directly contributing toward reduction of heat island phenomenon.
2. From photometer analysis we have also found that, the plants are healthy even after two years of plantation. This indicates that planting in the roof even with thin layer of soil is possible.
3. The analysis result from the thermometer showed that, roof planting also can prevent the flow of temperature inside the house. Thus roof planting can save energy, as plants naturally can conserve a certain level of heat through out all the seasons.

The results of the study is expected to reveal the effectiveness of roof and surface wall plating in reducing urban heat island phenomenon. We would like to continue our study further and see the effect in bigger scale by replicating it to the big cities in future.

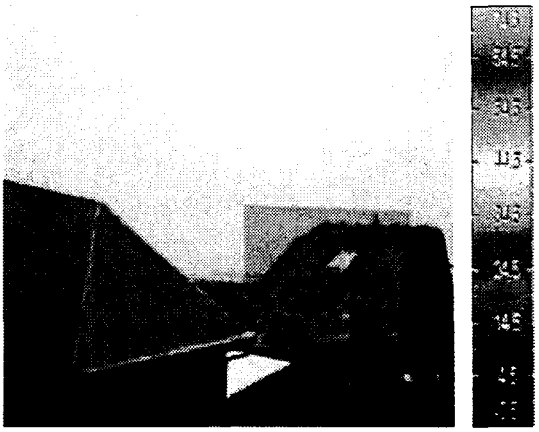

Fig. 11. Overlapped view of thermal image and photo.

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[1] **URL:** White Maps, Mapmap 6.0
Available at:
http://www5b.biglobe.ne.jp/~t-kamada/CBuilder/mapmap html

[2] **URL:** Meteorological Agency, Japan :
Available at:
http://www.jma.go.jp/JMA_HP/jma/index.html