JP1.11 Mitigation of The Thermal Environment by Cheonggye Stream Restoration in Seoul, Korea

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1. INTRODUCTION

Urbanization, which includes residential, commercial, and industrial developments, produces radical changes in radiation, thermodynamic, and aerodynamic characteristics of the surface from those of the surrounding rural area. Therefore, it is not surprising that as urbanization proceeds the weather and climate often are modified substantially (Arya, 1988).

For this reason, the restoration project of Cheonggye stream is not just a part of Seoul's urban planning but a greater task that the entire nation is interested in as a symbolic project to revive an important part of Korea's historical and natural heritage at the start of the 21st century. The restored Cheonggye stream will take an important role in the change of thermal environment of the city (See Fig. 1). That is expected to help mitigate Seoul's thermal stress by changing the urban hydrology, and road level wind fields. All the components of the energy balance in the urban canopy will be modified. Intensive observations in the urban area have been performed to understand these changes and effects.

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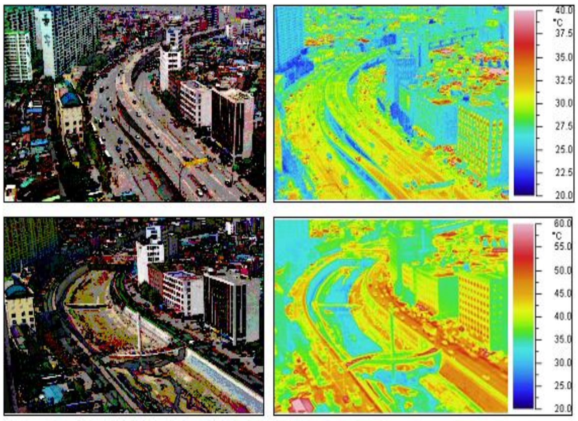

Fig. 1 The change of thermal environment by Cheonggye stream restoration. Right-hand pictures are taken by Thermography. The upper part of figures denotes before restoration (2003) and lower part of figures denotes after restoration (2005).

2. OBSERVATION SYSTEM

To monitor and predict of urban climate change by the Cheonggye stream restoration in Seoul, long-term meteorological monitoring system was constructed like Automatic Weather Station (AWS) and temperature and humidity data logger around this area. Especially, intensive observation has performed in this area by using temperature and humidity data logger (HIOKI), Net Radiometer (CNR), 3-Dimensional Sonic Anemometer (CSAT), temperature and humidity measurement system (HMP), and Scintillometer to understand the changes of thermal environment before and after restoration (See Fig. 2). The first intensive observation was performed for 19-25 Jung 2003, 11-17 August 2003. The second intensive observation was performed 9-15 August 2004, and third intensive observation was performed for 8-12 August 2005, 23-30 September 2005. The post-restoration monitoring will be carried out until 2006.

From these routine and intensive observations, we can understand the thermal environment change with respect to the change of land-use using by the data of AWS and HIOKI near the Cheonggye stream, the spatial characteristics of the urban heat island (UHI) effect by deploying a network of sensors (HIOKI) across a Cheonggye stream area, the vertical wind profile by CSAT, and the energy balance by sensible heat flux and net radiation observations using Scintillometer and CNR.

3. RESULTS

According to Rider et al. (1963), differences in albedo, emissivities, and other thermal properties of natural surfaces lead to their different surface temperatures, even under a fixed synoptic weather (e.g. land-sea breeze). Most dramatic changes in surface temperature occur across lake shorelines and coastlines. When the mean wind speed is weak, the thermally induced local circulations are observed above the stream between banks and when the mean wind speed is strong, the wind road is performed along the stream and the wind blows parallel with the stream. Fig. 3 shows the differences of mean temperatures between near the Cheonggye stream area and over the Seoul city throughout the 3 times intensive observation period from 2004 to 2005. First of all, the difference of mean temperatures (△T) of near the Cheonggye area and Seoul city is the highest for the first IOP and lowest for the third IOP. Especially, station 7 shows the highest temperature compared to the other sites during the first IOP, while it is relatively lower than the other sites during the second and third IOP (It was reduced about 1.3℃).

The Fig. 4 below shows the comparison of energy fluxes (net radiation (R_N) and sensible heat flux (Hs)) for the before (2003) and after (2005) restoration of Cheonggye stream. The sensible heat flux after restoration of Cheonggye stream has remarkably reduced compared to before restoration. Therefore, we can estimate the temperature difference by energy balance. That is, the formation of water area can lead to the temperature reduction of 0.8℃ in daytime.

The sensible heat was induced the restoration was reduced and therefore contributed to its cooling. Cheonggye stream can also have an effect on the reduction of surface temperature by the thermally driven local circulation and wind road. But to understand more accurate the effect of Cheoggye stream we need to validate other data and numerical simulation.

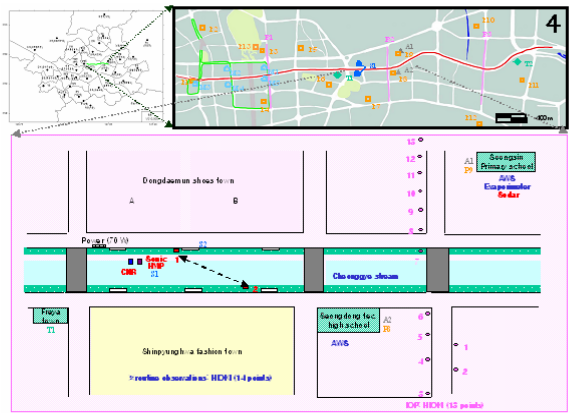

Fig. 2 The map of including restoration zone of Cheonggye stream in Seoul. The right part and lower part of figure denote the monitoring sites of thermal environment in Chgonggye stream.

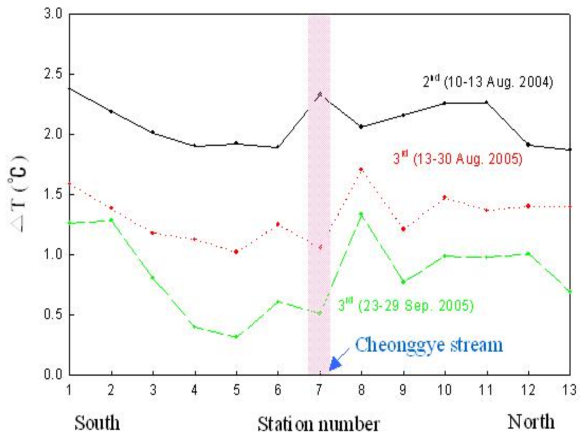

Fig. 3 Mean temperature difference between Cheonggye stream area and the Seoul city. The x-axis represents the 13-observational sites near the Cheonggye areas across the Cheonggye stream. Where, station number 7 located on the grass nearby Cheonggye stream and other sites are located on the road.

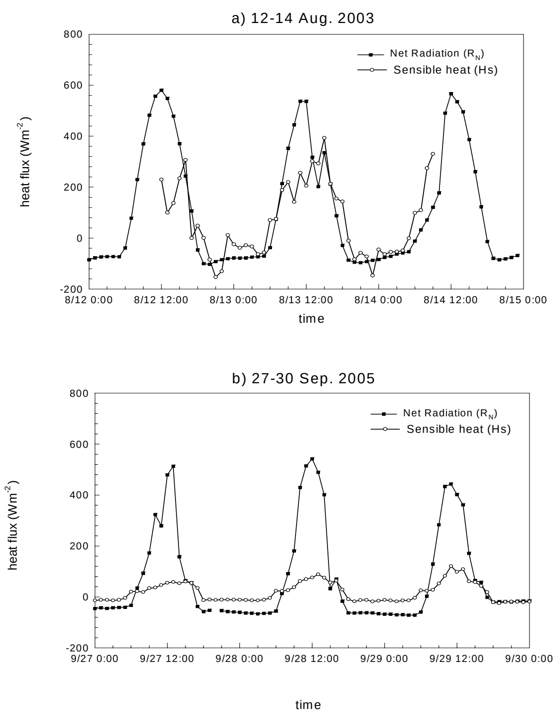

Fig. 4 Comparison of energy fluxes (net radiation (R_N) and sensible heat flux (H_S)) for the before (2003) and after (2005) restoration of Cheonggye stream.

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