Cooling effects of large green park on urban atmosphere observed at the Osaka Castle Park in Osaka, Japan

Yoshinori SHIGETA [1], Yukitaka OHASHI [2], Yukihiro KIKEGAWA [3], Yusuke NAKAMURA [4]
Tomohiko IHARA [5], Minako NABESHIMA [6] and Yujiro HIRANO [7]

1 Tottori University of Environmental Studies, Japan ; e-mail address : shigeta@kankyo-u.ac.jp
2 Okayama University of Science, Japan ; 3 Meisei University, Japan ; 4 Rissho University, Japan
5 The University of Tokyo, Japan ; 6 Osaka City University, Japan
7 National Institute for Environmental Studies, Japan

Dated: 15 June 2015

Key words : urban climate, cool island, green park, sky view factor, green coverage, nocturnal cooling

1. Introduction

It is important for urban planning and heat island countermeasure to clarify cooling effects of urban green park on the urban atmosphere. We investigated those at the Osaka Castle Park in Japan during the summer in 2007 and 2013. The Osaka Castle Park is located at the center of Osaka City (about 2.6 million population) and has an area of about 1 million square meters. Because this park is the largest of urban green parks in the Osaka city, urban cooling is expected here (Fig.1 a,b). Osaka Castle Park looking at the surface temperature has become a low temperature than the surrounding (Fig.2).

Our observations were conducted by static and moving measuring methods for the air temperature, wind speed and wind direction at some observational points inside and outside the park.

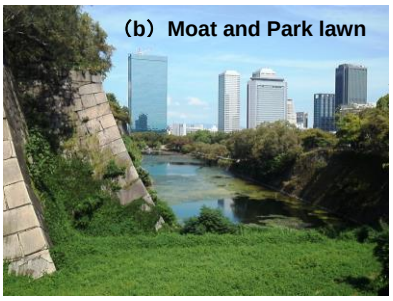

Fig. 1 The state of the Osaka Castle Park. (a) Park forest, (b) Moat and Park lawn.

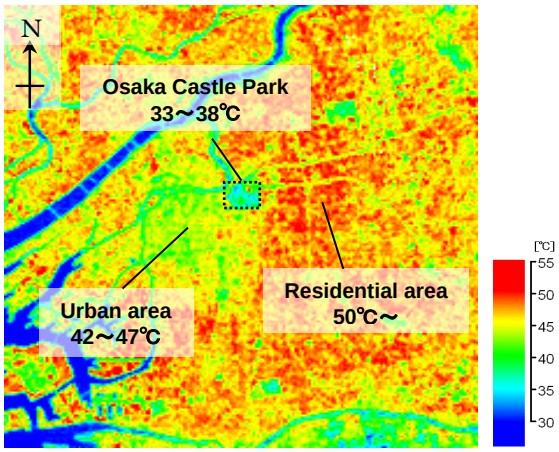

Fig. 2 Surface temperature of Osaka Castle Park and its surrounding areas from the thermal image (at 10:30 am on July 28, 2007).

2. Result

During the 2007 August observations, the cool island intensity of the Osaka Castle Park was recorded as the magnitude of 2-3°C at 04-05 Local Standard Time (Fig.3). This cooler park condition was maintained

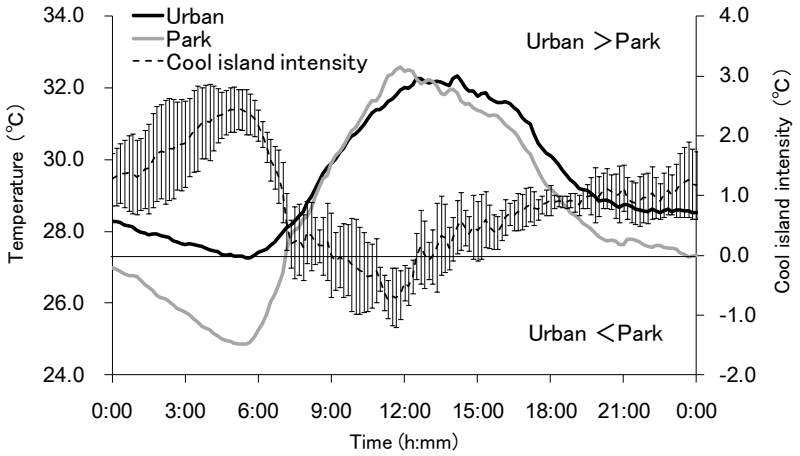

Fig. 3 Temporal change of urban and park air temperatures, the cool-island intensity (August 5-12, 2007). Error bar indicate standard deviation.

from sunset（around 18 LST）to the next sunrise（around 06 LST）In addition, very weak winds（about 0.5m/s）were observed outside the park, which flowed outward from the park. In particular, this phenomenon was remarkable at the east side of the park and the cold flow extended leeward of about 250m（Fig.4 a,b）. Scatter diagram of the daily minimum air temperature and green coverage ratio was obtained. The daily minimum air temperature and the ratio showed a positive correlation（r = 0.96）in the park（Fig.5）.

Next, we analyzed the air temperature difference between the lawn area and forest area inside the park in order to specify a source of the cold air of the park（Fig.6）. As a result, a downward motion process of the air cooled at the upper layer of park forests was suggested rather than an outward transport process of the air cooled on park lawn areas. Hence, generations of the cold air within dense forests at the east of the park are probably related to the cold outflow from the Osaka Castel Park as mentioned above.

On the other hand, the daytime air temperature of the park was higher than or comparable to that of surrounding urban areas. This phenomenon was probably induced by shading effects and large heat capacity of tall and dense buildings. The result means that the daytime park air is insignificant to decrease the surrounding urban atmosphere. Because the nighttime Osaka urban air temperature hard to decrease due to the urban heat island, cold outflows from the park have a potential cooling the surrounding urban atmosphere. In the present study, the recent 2013 observational results will be also included and summarized.

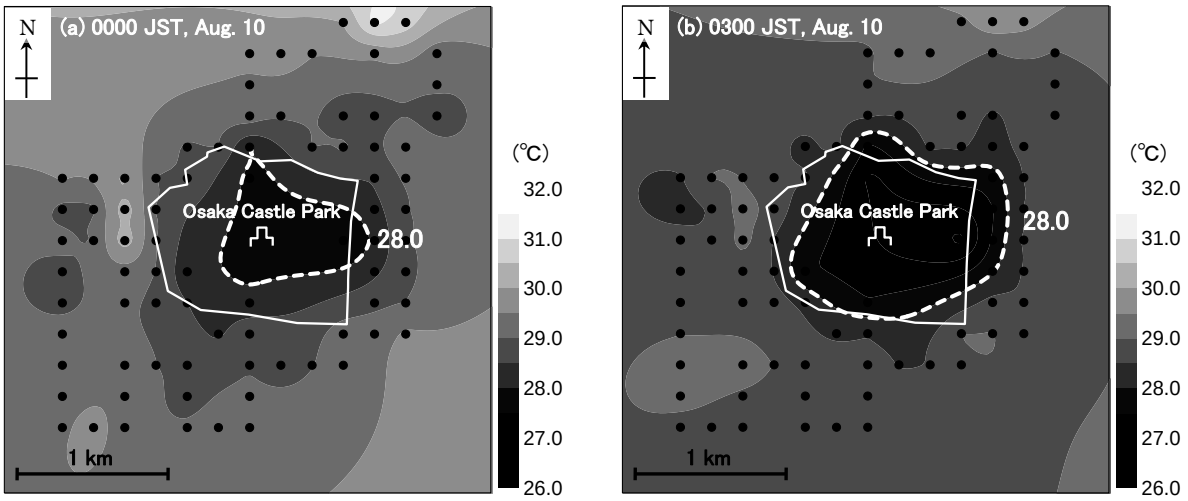

Fig. 4. Horizontal distribution of air temperature measured at (a) 0000 JST, Aug. 10, and (b) 0300 JST, Aug. 10 in 2007. ●:observation points of air temperature. White line indicates Osaka Castle Park. Dashed line Indicates area of cool influence.

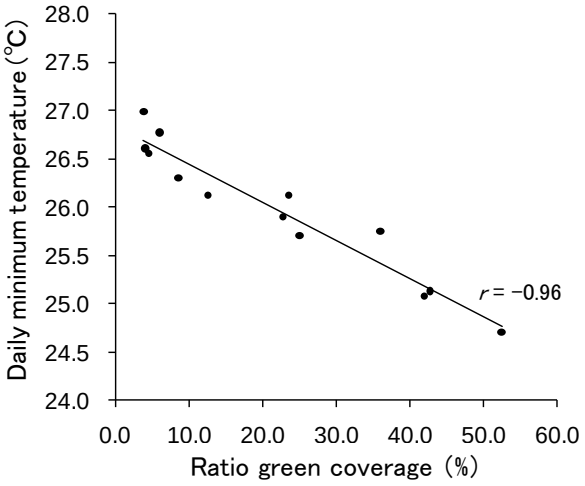

Fig. 5. Scatter diagrams of the ratio of green coverage and the daily minimum air temperature. The value of symbol r represents the correlation coefficient.

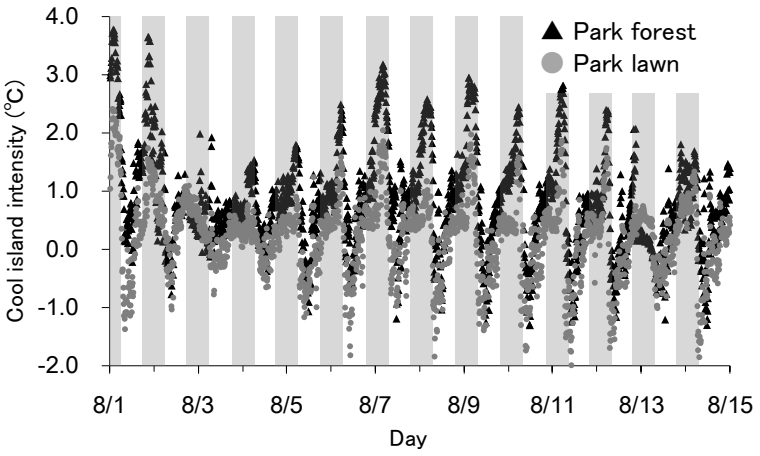

Fig.6. Comparison of cool-island intensities between the park lawn and the park forest（August 1-15, 2007）.