The effects of a small river on the thermal environments as a ventilation path in coastal cities

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1. Introduction

In Germany, the concept of ventilation path has been developed as a measure to mitigate air pollution in basin cities that is focused on inducing nocturnal cold fresh air from surrounding hill slopes. On the other hand, in Japan, the cooling effect of ventilation path is expected as a measure to mitigate urban heat island especially in coastal cities. The river, flowing through the cities, is considered to be particularly important, because it introduces the see breeze to the inner part of the city without losing its coldness. However, the air mass running above the river water is heating from both sides of built-up area, then the cooling effect of a ventilation path will depend on the width of rivers and the inclination to the direction of see breeze. In this paper, results are shown from micro-climatological observations performed in and around a small river;"Meguro River", during summer. Its width is 25 m, and it flows through southern part of Tokyo almost toward east direction and runs into Tokyo Bay at near Shinagawa.

2. Observation method

Air temperature, wind speed and direction were measured on the five bridges between near the mouth of the river and 4.5 km upstream point. At totally 27 points around the river within this section, air temperature was also collected to know the city-averaged temperature. And background wind condition was measured at the building roof (126 m high) near the mouth. Besides, the sonic anemometer-thermometer was set at the riverside about 2.8 km upstream point (near Osaki station), where high-rise buildings were stood along the river. Supplemental moving observations of air temperature were also conducted along the three streets crossing the river.

3. Results

Air temperature at the river mouth was about 4 degrees lower than the city-averaged air temperature around midday on fine days. In the east wind condition, that means parallel wind condition to the river, the air temperature on the bridges increased gradually along the river toward upstream. However, in the south wind condition, which is the prevailing sea breeze direction, the air temperature in coastal area was higher than that in built-up area located more upstream. Because the river wanders northward between this built-up area and the mouth, the wind direction on the bridge in coastal area was eastward, that is to the downstream direction. Even for such situation, the wind was running up along the river toward upstream except for coastal area.

According to the sonic data, the riverside high-rise buildings trapped upper layer southerly sea breeze and led the strong downflow near the windward walls. It turned to a spiral flow within the river space between the both side buildings. These results showed that the origin of running air along the river was not the surface level sea breeze flow into the mouth but that of upper layer over the city area. This upper layer sea breeze was cooler than surface layer. In consequence, the river contributed to make a cool and comfortable space in an urban area, namely had a cooling effect as a ventilation path. But then, thermal environment in the leeward area of these high-rise building was not so good; warm and calm, discomfort condition.

4. Concluding remarks

In the case of narrow rivers, it is possible to act as a ventilation path because the riverside buildings induce the upper layer sea breeze in many places. The depth of see breeze is remarkably larger than that of slope cold air drainage, therefore, it may be good idea to consider the way of three dimensional use of sea breeze in all over the city to mitigate urban heat island.

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