

MOVING OBSERVATION OF WATERWAY COOLING EFFECTS IN OSAKA

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Abstract

The distributions of thermal environments for three streets across the East Yokobori River in central Osaka were measured during daytime in summer using moving observations. The magnitude and extent of the cooling effect of the river on urban warming were investigated. Temperatures were lower at divisions with the river. With higher west winds, the cooling effects moved east. The air velocity was lowest at divisions with the river. Results showed that the cooling effects of high-rise buildings were not negligible. They were sometimes superior to those of the river.

Key words: Urban warming, Waterway, Moving observation

1. INTRODUCTION

The East (Higashi) Yokobori River flows through central Osaka city from north to south. An earlier study clarified that the daily temperature in summer was 0.2–2.0 K lower in the district adjacent to the river than in districts without rivers. A thermal sensation survey for pedestrians also showed that they felt significantly cooler in the district with the river. Heat mitigation effects of the waterway were recognized in quantity, but the effects of microclimate on the thermal environment cannot be denied because the towns' configurations were not same in both districts.

This study investigates the range of the effects according to the moving measurements taken while walking across the river along three streets.

2. METHOD

The distribution of temperature and air movement were measured for the length of 600 m along the streets crossing Ote-bashi Bridge, Hirano-bashi Bridge, and Kourai-bashi Bridge (Fig. 1). Measurements were conducted on August 12, August 27, and September 10 during 12:00–15:30. Three measuring carts were moved up and down the streets for one hour from 12:00, 13:15, and 14:30. Data around crossings were deleted (Fig. 2). Table 1 shows measured items. Solar shields were used for temperature and humidity sensors. Directional anemometers were for the advance direction. Wind direction was observed at the points of '*' in Fig. 1. Trends in temperature were adjusted according to the standard moving average values s at 12:30, 13:45 and 15:00. Mean moving speeds were subtracted from the air velocity for each division.

Street widths were approximately 10 m, although Hirano-bashi Street is wider, with sidewalks and roadside trees for both sides (except for division H4). Differences in elevation in Hirano-bashi Street were greater than those of other streets. Divisions K5 and K6 have sidewalks and roadside trees. Traffic on the three streets (Figs. 3-5) was almost identical.

3. RESULTS AND DISCUSSION

Figure 6 shows measurements for three days at a meteorological observatory in Osaka. Figure 7 portrays the distribution of air temperature and air velocity for the divisions.

3.1. August 12

The temperature at division O4 is lower than those at O3 and O5. It is lower for the east divisions except for O4. The temperature for Hirano-bashi Street is lower than for the east divisions. Of all measurements, H5 is the lowest at 12:30 and 15:00. The air velocity is lower at H2 than at H1 and H3. Effects of the super high-rise building are presumed. The air velocity at division H4 is low. The temperature for Kourai-bashi Street is higher for east divisions. The maximum difference is about 1 K. The temperature at K4 and K5 is lower. West winds might move the lowest division in temperature. The air velocity is higher for west districts. Here also, the effects of high-rise buildings are presumed. Being clear with higher west wind, the lowest divisions are divisions 4 or 5 for all streets. At divisions with high-rise buildings, effects of the buildings are sometimes stronger than those of the river.

3.2. August 27

The temperature for Ote-bashi Street is higher for east divisions. The temperature at O4 is 0.1–0.2K lower than O5 and O3. Air velocity is extremely high at O1, with high-rise buildings. The temperature for Hirano-bashi Street

is lowest at H4, the division with the river. It is lower than H1: approximately 3.5 K. The cooling effect of the river goes beyond the measured range. The temperature for Kourai-bashi Street is low at west divisions and high at east divisions K5 and K6. On cloudy and cooler days, the river's cooling effects are slight. The effects do not extend to the east because the wind speed is not high.

3.3. September 10

The temperature for Ote-bashi is high for the west divisions at 12:30 and 15:00. It is higher at O5 than O4. There seems to be little difference among divisions at 13:45. The air velocity is highest at O3. The temperature for Hirano-bashi Street is lowest at H3 and H4. Slight differences are recognized in air velocity among divisions. The temperature differences for Kourai-bashi Street among divisions are small. Temperatures are lowest at K4. It is 0.1–0.3 K lower than K3 and K5. The air velocity is lowest at divisions over the river. Temperatures are 0.1–0.5 K lower at divisions with the river. The air velocity is lowest at divisions with the river for all streets.

4. CONCLUSIONS

1) The cooling effect of the river is 1 K at maximum for distances of 300 m. 2) Cooling effects of the river extend beyond 300 m from the river. 3) Data of three runs per day show similar values and distributions. 4) Temperature distributions for a street are similar for all days, except on Ote-bashi Street. 5) The lowest temperature is recognized at division 5 for days of higher west winds. 6) The air velocity is low at divisions with the river. 7) Cooling effects of high-rise buildings are sometimes superior to those of the river.

References

Umekiya N, Kawamoto M, Okura R and Tanaka T. 2007, Cooling effects of waterway on thermal comfort in urban districts in summer" Proceedings of the Tenth International IBPSA Conference, 475-482.



Figure 1 Object areas

Table 1 Measurement items

measurement items	height	logging time	response time
air temperature	1.3m	1sec	<1sec
relative humidity	1.3m	1sec	5min
globe temperature	1.3m	1sec	–
solar radiation	1.8m	1sec	<1sec
wind speed	2.0m	10sec	1sec
wind direction	2.0m	3 points	–



Figure 2 Measurement Divisions

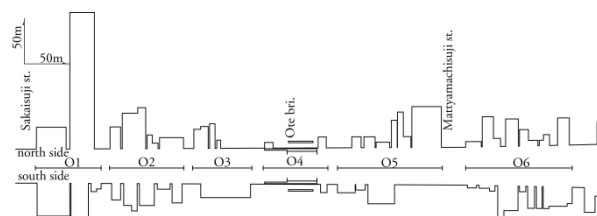


Figure 3 Ote-bashi Street



Figure 4 Hirano-bashi Street

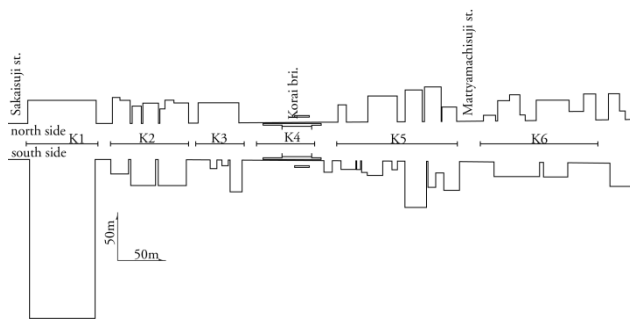


Figure 5 Kourai-bashi Street

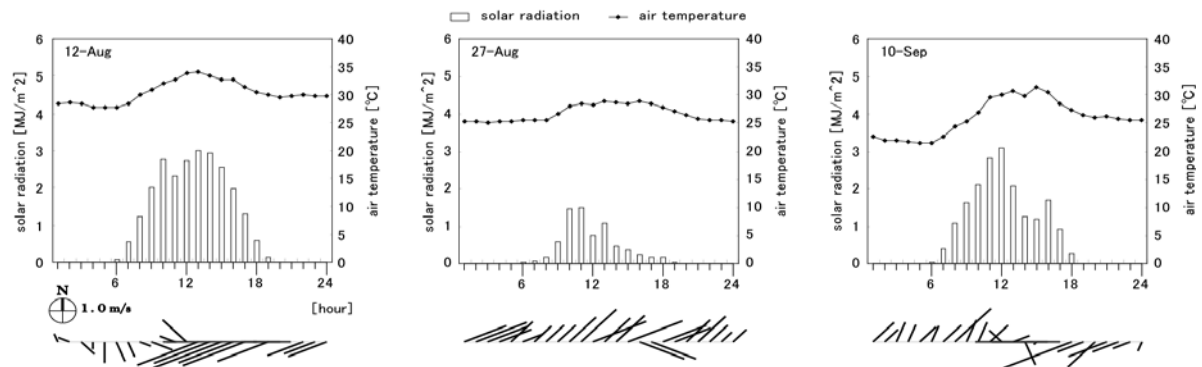


Figure 6 Meteorological data of measurement days

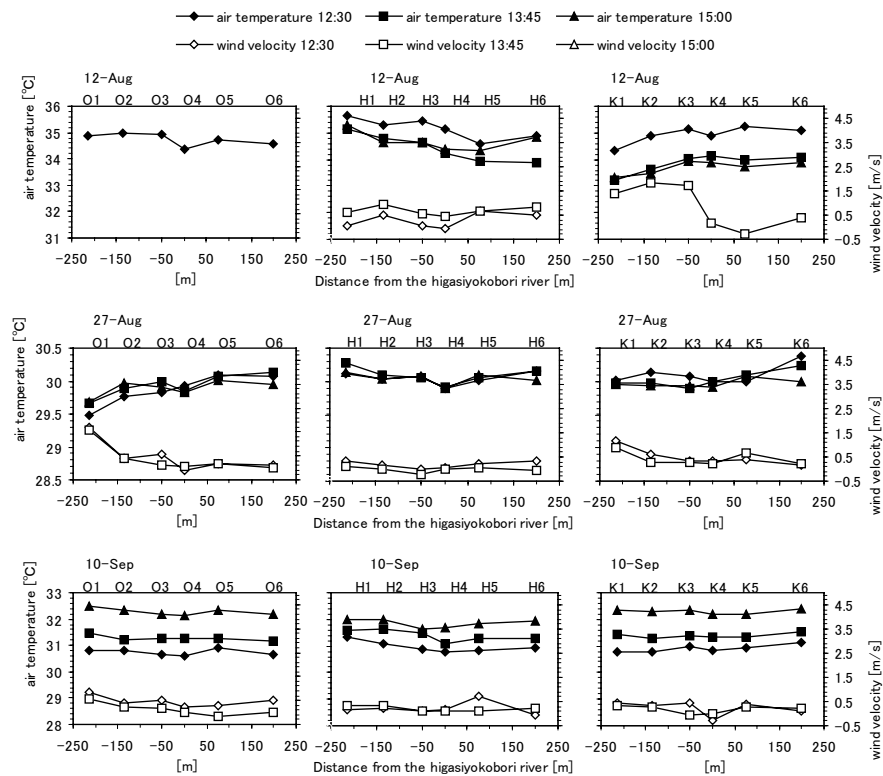


Figure 7 Mean temperature and air velocity for divisions