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CLIMATE ANALYSIS FOR URBAN PLANNING IN OSAKA

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Abstract: Osaka prefecture is located approximately in the center of Japan. However, its monthly average air temperature in August is the second highest in Japan. One of the reasons for that is the influence of urban climate, which is obvious through from the yearly changes of air temperature. In this paper, data and researches related to urban climate in Osaka prefecture is reviewed.

Key words: Urban Climate, Air temperature, Wind rose, Artificial waste heat

1. THE GEOGRAPHICAL SITUATION OF OSAKA PREFECTURE

Osaka prefecture is located approximately in the center of Japan. The population is 8.7 million, which is the second largest in Japan, and it corresponds to approximately 7% of the total population of Japan. On the other hand, the area of Osaka prefecture is 1,886km^2 and it corresponds to only 0.5% of Japan. About 45% of total area is occupied by building sites and transportation facilities. Figure 1 shows the geographical situation of Osaka prefecture. Thirty percent of total population (2.6 million) is concentrated in Osaka city area, which is located in the center of Osaka prefecture.

Its monthly average air temperature in August in the average year is 28.2 ℃, which is the second highest in Japan. One of the reasons for that is supposed to the geographical situation that the Osaka is located on the coastal land area of the Inland Sea. However, urbanization is supposed to be more influential.

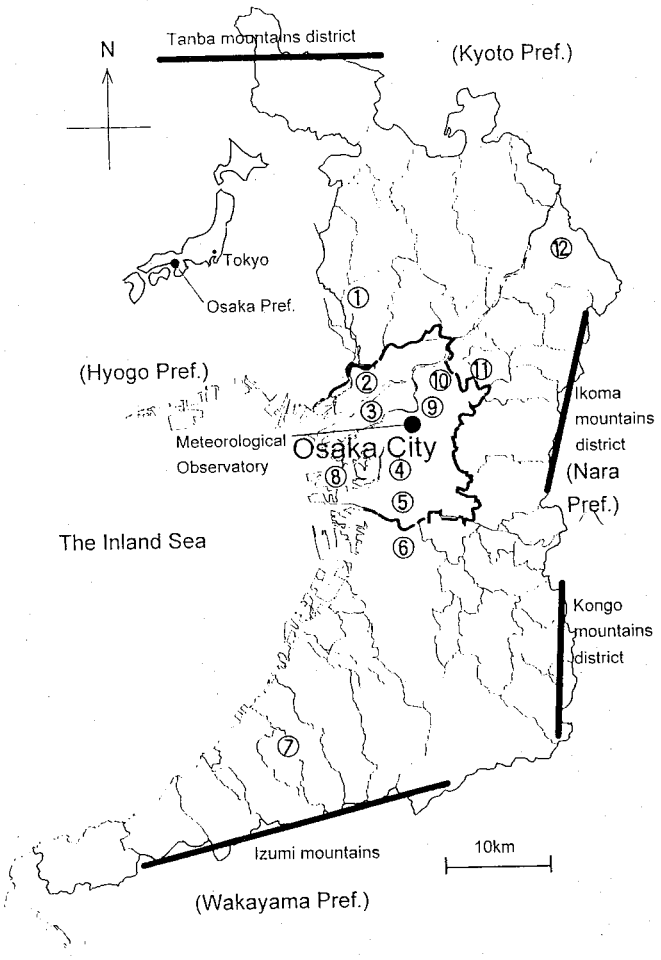


Fig.1 Geographical Situation of Osaka Prefecture
(①~⑫ denotes the observation points shown in fig.5,6)

2. URBAN CLIMATE IN OSAKA

(1) Air temperature

Figure 2 shows the changes of the annual average air temperature in Osaka city for the past 113 years. In the last 100 years, it has increased by about 1.5K. Especially, the increase after the 1950's is larger.

In Japan, the night that the minimum air temperature exceeds 25 ℃ is called as "Nettaiya" (sweltering night). The number of "Nettaiya" has also increased dramatically after the 1950's as shown in figure 3.

The sort of temperature increase varies according to the location. Figure 4[1] shows the air temperature distribution in the afternoon and the morning in summer, and in the morning in winter. The difference of the temperature in the afternoon in summer exceeds 2K. As shown in figure 5[2], the number of "Nettaiya" and the length of the time when the air temperature is higher than 25 ℃ in the Osaka city area are also larger than in the Surroundings.

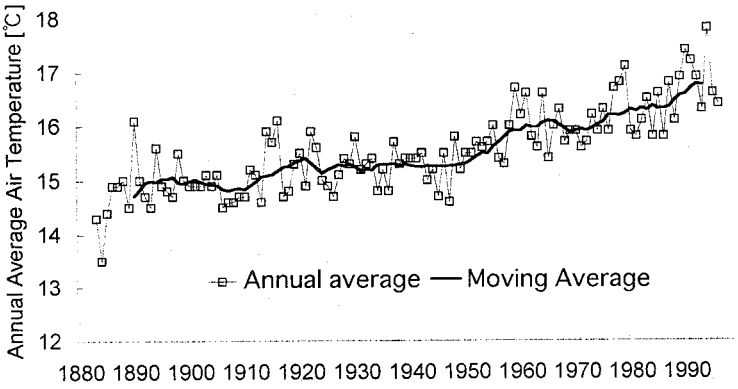


Fig.2 Change of Annual average air temperature in Osaka City

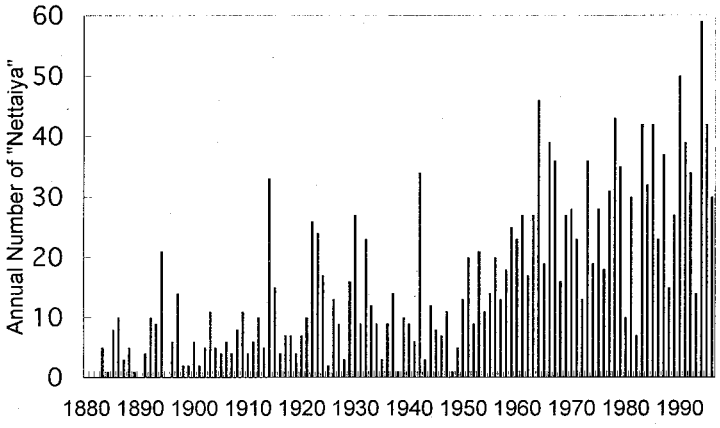


Fig.3 Change of Annual Number of "Nettaiya" in Osaka City.

(2) Wind

Figure 6 shows the wind roses and average wind velocities which are made from the observed data in daytime and nighttime in August 1990 at seven points in Osaka prefecture. In Osaka city area, sea breeze is prevailed in daytime. Therefore, in order to conserve the outdoor thermal environment in summer daytime, consideration of the see breeze direction in land use plannning would be effective.

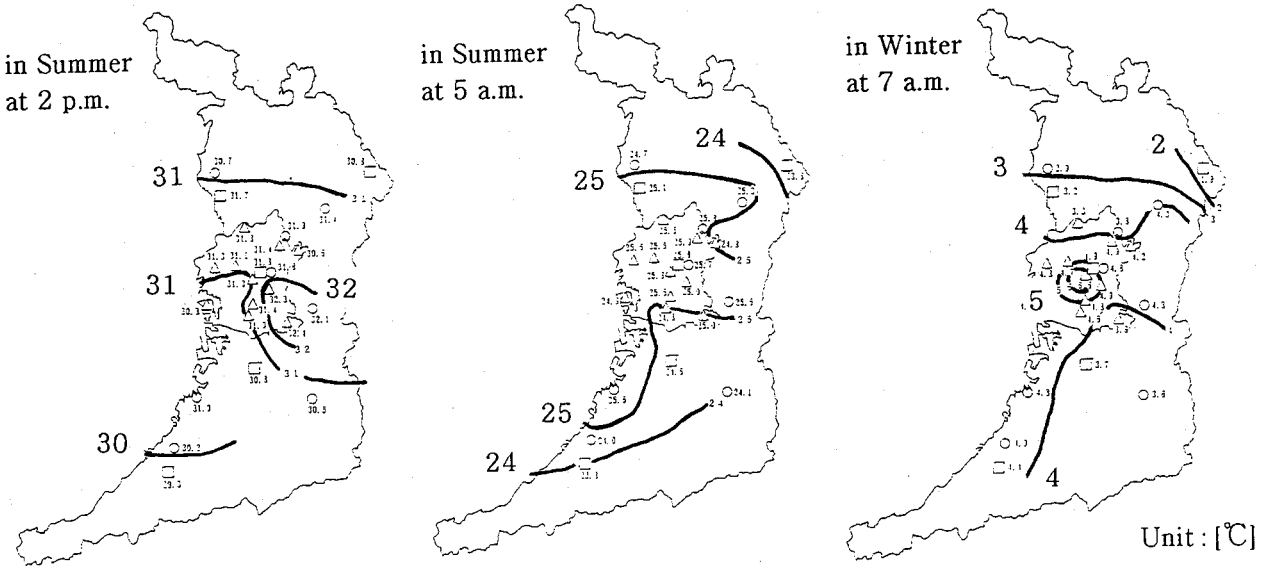
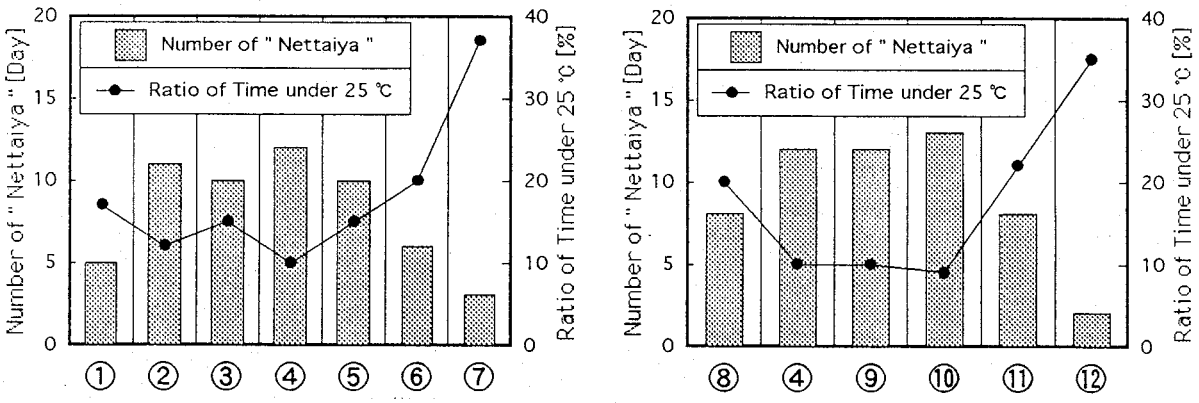
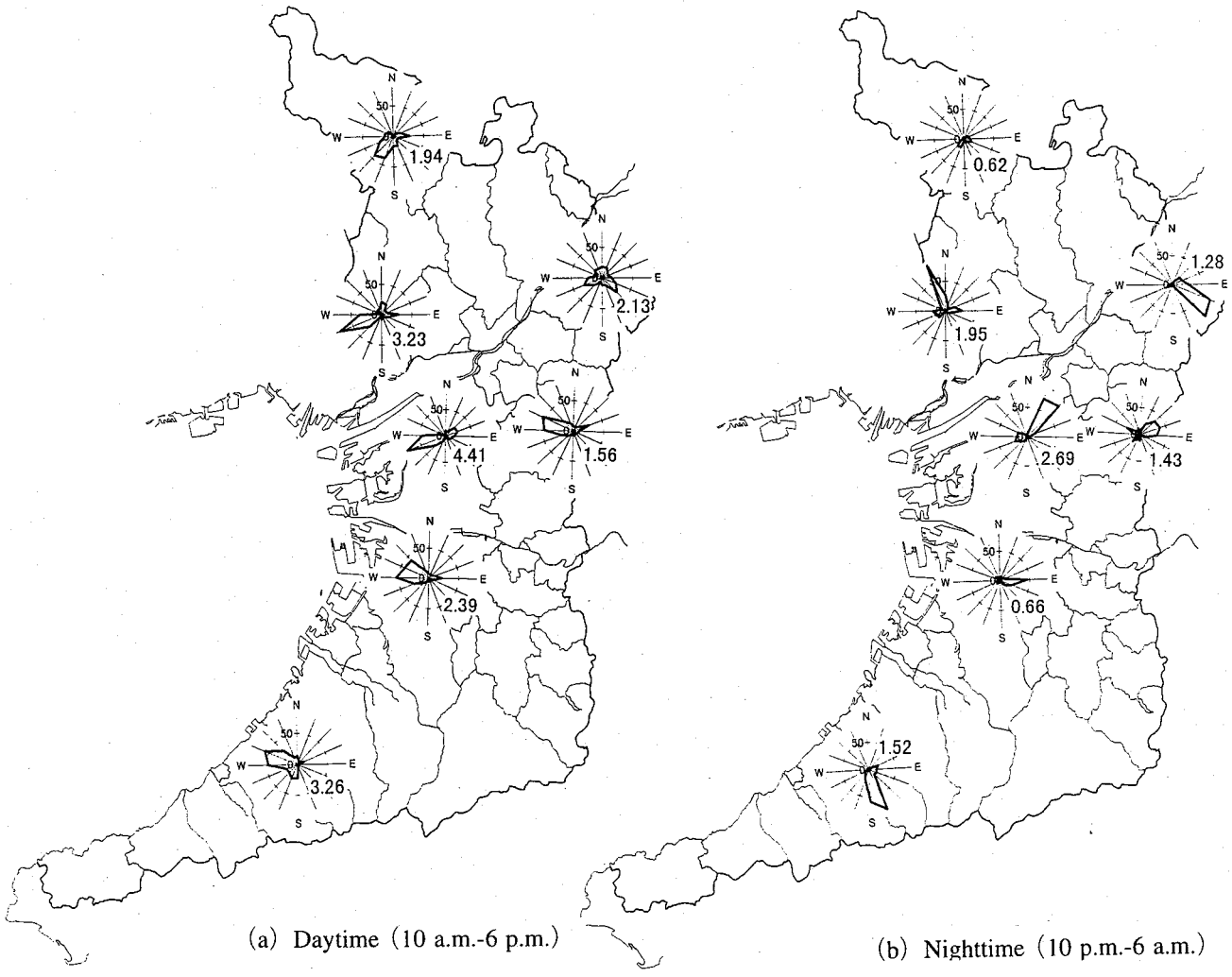


Fig.4 Temperature Distribution in Osaka Prefecture[1].
(in summer : from August 22 to September 8, 1991. in Winter : from January 22 to February 9.)



(North and south direction) (East and west direction)

Fig.5 Difference of the Number of " Nettaiya " between Central Osaka City and its suburbs[1)]



(a) Daytime (10 a.m.-6 p.m.) (b) Nighttime (10 p.m.-6 a.m.)

Fig. 6 Wind roses and average wind velocity (m/sec) in August 1990

(3) Artificial Waste heat

To analyze the effect of artificial waste heat to urban thermal environment, it is important to clarify not only the amount of waste heat but also the phase and spatial distribution of waste heat. The authors[2)]

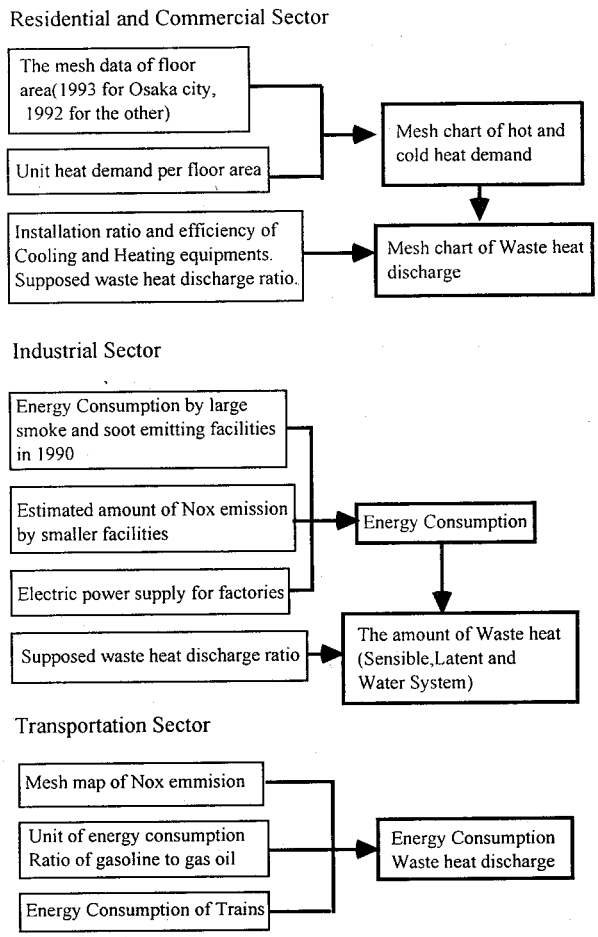


Fig. 7 Flowchart of waste heat estimation.

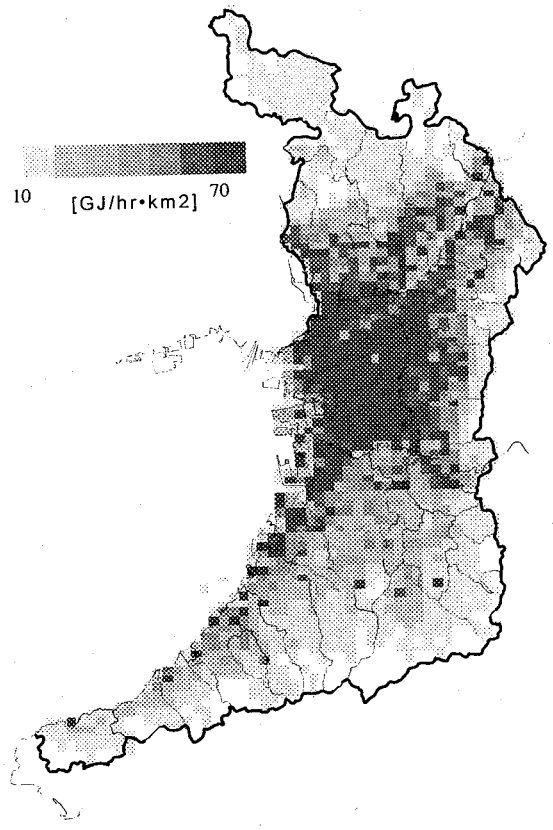


Fig.8 Distribution of sensible waste heat at 8 p.m. in July[2)]

estimated the spatial distribution of artificial waste heat in Osaka prefecture by sensible heat to atmosphere, latent heat to atmosphere and waste heat to water system respectively. Figure 7 shows the flowchart of waste heat discharge estimation and figure 8 shows the distribution of estimated amount of sensible waste heat, which directly affects air temperature, at 8 p.m. in July. The areas where sensible waste heat discharge is large are located in the high density residential and commercial areas in Osaka city and factory areas along the coast.

3. COUNTERMEASURES

In this paper, data and survey results related to climate analysis for urban planning in Osaka prefectural area are reviewed. From these results, following two fundamental countermeasures to mitigate hot thermal environment in summer are proposed:

1) In daytime, there is a possibility of introduction of cool air into the center of the city by utilizing sea breeze. However, the land use of the coast area, which is located on windward side of the city center, consists of large factory area and small green area at present.

2) In nighttime, reduction of artificial sensible waste heat by energy saving and conversion to latent heat is supposed to be effective.

However, executing these countermeasures to wide area in Osaka is difficult and it requires a long time. As a practical way, temperature control by planning land use in micro scale is supposed to be effective.

In Osaka area, many studies related in this field have been done as follows:

Miyazaki et al.[3] measured the thermal effect of green canopies in Osaka city in summer. The difference of air temperature between in the large park and its surroundings was measured between 0.4 ~ 1.9 ℃ in daytime and 0.7 ~ 1.3 ℃ in the evening. However, in case of small urban green canopies, the difference of air temperature was measured -0.5 ~ 0.9 ℃.

Kohno et al.[4] measured air temperature distribution around parks and rivers in the central area of Osaka city. Air temperature measured in the riverside and green area in parks is lower than the air temperature in its surroundings by 2 ~ 3 ℃.

The authors[5] and Mizuno et al.[6] observed the air temperature distribution in small scale and analyzed the relationships between local air temperature and land use and the relationships between air temperature and sensible heat discharge. From the results of multi-rigression analysis between air temperature and land use, it was clear that air temperature is influenced by the land use of surrounding circle area about 50 ~ 100 m in radius.

To utilize these results in the field of land use planning, more detailed studies about the relationship between scale of land use and magnitude of influence on air temperature are required.

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