

Climatic changes due to the rapid urbanization in Tokyo metropolis

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In recent years, public concern for urban warming (Urban heat island effect) has been increased as much as that for global warming. Urban heat island was named after the shape of isothermal contour lines which is similar to the mountain island whose top is corresponding to the warmest urban center. In European cities such as in London, the urban warming was already recognized in late 19th century. It should be noted that the existence of urban heat island effect in Tokyo was already confirmed during the calm clear night in the winter of 1939, when the temperature difference between central Tokyo and its suburbs reached 5 degrees centigrade, by the mobile meteorological observations using several cars with temperature sensors for the first time in Japanese cities.

After the World War II, urban warming was considered to have been much reinforced due to the concentration of population into city area and also due to the rapid increase of energy consumption. We could see a typical example of urban warming of Tokyo in comparison with large cities in the United States and Europe . Annual mean temperatures in Tokyo Meteorological Observatory, which is located in downtown area, increased 3 degrees centigrade for the past 100 years. In New York, the increasing rate for the same period was 1.6 degrees which is around half of that in Tokyo. As global warming since the turn of last century is 0.74 degrees as described in IPCC-4th report, temperature increase in Tokyo is around 4 times as fast as that in global mean temperature. It is interesting that annual mean temperature in Paris show rather gradual decreasing trends since 1950s. The rapid urban warming in Tokyo since 1950s should be explained by the difference of urban surface materials from European and American cities, and by the accelerated energy consumption after World War II.

As for the changes in the structure of surface materials in Tokyo, the most of buildings in the city were made of wood before 1950s, and the percentage ratio of concrete buildings has been rising year by year since 1950s. On the other hand in American and European large cities, almost all buildings were built of stones and concrete from 19th century. These differences in the structure of surface materials among Japanese cities and European cities might have caused different trends in annual mean temperatures. Since the causes for urban warming are complicated due to the difference of heat budgets, it is not easy to explain only by the difference of urban structures. Rather we should pay more attention to the rapid increase of anthropogenic energy consumption such as the increase of air conditioning system in large office buildings in central Tokyo. Roughly estimating, annual mean anthropogenic energy consumption in central Tokyo reaches around 24 watts per square meter, which is nearly 20 percent of annual mean solar radiation received in Tokyo.

Although urban heat island effect in the city center is most prominent in winter morning due to the big difference of enhanced radiative cooling on the ground surface in the countryside, its impact on human society would be most serious in the daytime of middle summer season. According to the special report issued by the Japanese Ministry of Environment, the number of hours exceeding 30 degrees centigrade in a day during summer was tripled for the last 20 years in Tokyo. Such hot climate condition will increase the number of heat stroke patients and give various kind of damages to human bodies. Therefore the need for mitigating urban heat island effect in Tokyo is

urgent and inevitable from the view point of healthy human life.

Keywords: Tokyo metropolis, Urban heat island, global warming, anthropogenic energy consumption