NEWSLETTER ON URBAN HEAT ISLAND COUNTERMEASURES

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What are heat islands 🦾

SUBCOMMITTEE ON HEAT ISLAND COMMITTEE on the Global Environment, Architectural Institute of Japan

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http://news-sv.aij.or.jp/tkankyo/s3/

What are heat islands?

When the temperature of an urban area is higher than that of the suburbs, it is called a heat island. The phrase "Heat Island" came from the temperature contour lines that looked like an island in the ocean. Heat island phenomena were first described in 19th century England, and afterwards were found in many cities throughout the world. Since the temperature rise due to heat islands is several times greater than that due to global warming, the influence of heat islands is significant in urban areas. About 0.6-0.7°C temperature rise is observed annually worldwide, but the speed of temperature rise observed in mega-cities around the world is much higher than the speed of temperature rise observed globally. Above all, thetemperature of Tokyo is growing at a significant speed.

Environmental influence by the urban heat island

Temperature is one of the important environmental factors for people and buildings. Since heat island phenomena occur in the city where many people meet, it is thought to have a direct influence on human beings. Also, remarkable temperature variation is observed in the city, compared to nature, so the environmental influences are also worrying. Temperature increase in the summer time produces negative influences, such as increasing demand on cooling facilities and increasing number of heat stroke patients. On the other hand, temperature



Temperature change of major cities from 1900-2000.



Redevelopment project in the coastal area of Tokyo (Shiodome area)

increase in the winter has positive influences such as mitigation of heat stress. However undesirable events are also observed, such as wintering harmful organisms. Thus, it is important to comprehensively take into account these environmental influences. Major environmental influences are described below.

a. Energy demand

When a temperature increase is observed in the summer, the air-conditioning loads of buildings increase. In the southern Kanto-district including Tokyo , an approximately 1,600,000 kW electric demand increase is observed as temperatures increase 1°C. This electric volume is equivalent to two medium size nuclear reactors. Electric demand also increases in the winter, when temperature decreases, but variation of electric demand is not as considerable as in the summer. This is not only restricted to electricity. Hot-water supply systems, gas used in heating, and sales of kerosene also increase in the winter. In the summer, most of the energy is dependent on electricity in the peak-time of air-conditioning, so the annual operation ratio of power plants decrease.

b. Influence toward human beings

The increasing days of day time high temperature and tropical nights during the summer are problems related to peoples' living in the city, since they provoke discomfort due to the hot whether and increase the risk of heat strokes. The data of the Tokyo Fire Department shows that the numbers of people taken to the hospital for heat stroke doubled in the last 20 years. By the examination of highest temperature of a day and the numbers of heat stroke patients taken to the hospital, heat stroke occurred over 30°C, and the numbers of patients increased as the temperature increased. It is assumed that the recurring diseases associated with the hot whether, such as heat stroke, dehydration, and urethral calculus are largely influenced by physiological functions, such as sweat.

c. cosystem

It is worriesome that a temperature change in the city influence terrestrial and water ecosystem. The northern limit of Aedes albopictus, a mosquito that transmits the Dengue virus is expanding year by year. Currently, there are no cases of Dengue fever in Japan, but there was a trend of Dengue fever spread by Aedes albopictus in the 1940's. Dengue mosquitos have not been seen in Japan since 1970. Dengue mosquitoes have a tendency to inhabit on small containers and cans, which bring them in close contact with people. The government of Singapore is having a hard time exterminating Dengue mosquitoes. The lowest temperature of a year is increasing by the heat island, and a 4°C increase was observed in the past 100 years. If the warm weather continues during the winter, wintering of harmful organisms will be another hazard for the city life.

d. Local downpour

Recently, several heavy local downpours were observed in the center of Tokyo. It is proposed that in the afternoon of sunny days in the summer, sea breezes converge in the urban area, which likely produce local downpours. Formation of cumulonimbus by heated air in the city and by steam from cool-



ing towers are indicated as causes of local downpours. Prediction of precipitation is an issue of the meteorological field, and the answer to whether the local downpours are occurring by the influence of city or not must wait for the future examination.

Causes of heat islands

What are the major causes of heat island phenomena? In an urban area, the temperature of the ground surface increases as a result of the non-permeability of the ground surface. Also, anthropogenic exhaust heat is generated by various urban activities. In addition, building clusters lower the wind velocity, so the ventilation of the urban area decreases. As a result, urban areas have a tendency to heat up. This warming is in addition to the warming from greenhouse gasses and aerosols.

Factor 1: Ground surface cover

The land use ratio for the city of Tokyo includes 56.6% for residence and 21.1% for roads, a total of 77.7% of the total land of the city of Tokyo. On the other hand, forest, water, farmland, moor, and parks occupy only 13.8% of the total land area of Tokyo. Thus, about 80% of the ground surface is covered by artificial surfaces, such as buildings and roads. Evaporative cooling over artificial surfaces is much smaller

than that over natural surfaces. This difference eventually induces a temperature rise in urban areas.

Factor 2: Anthropogenic exhaust heat

The Ministry of Land, Infrastructure and Transport and the Ministry of the Environment analyzed the newest data on anthropogenic exhaust heat generated from buildings, traffic, and business offices in the city of Tokyo, and established a space-time database in the report entitled "Examination of heat island countermeasures by restricting anthropogenic exhaust heat in an urban area." (Chairperson: Shuzo Murakami, Professor of Keio University of Science and Technology)

Factor 3: Ventilation of an urban area

Ground surface roughness is an important factor when examining the ventilation of an urban area. Urban structures are the primary roughness elements of an urban area. In the 1960's, the wind around buildings became an environmental problem, along with the emergence of high rise buildings. An environmental assessment on the strong wind around high rise buildings began to take place. On



Land Surface and anthropogenic heat in the summer (23 wards of Tokyo)

the other hand, construction of skyscraper clusters is now proceeding in the central part of Tokyo as a part of an urban regeneration project (Shiodome Sio-site called Tokyo Wall). The thermal conditions of urban areas are becoming worse with time. Now is the time to reconsider the ventilation of urban areas.

AlJ activities on urban environment and urban climate

The Architectural Institute of Japan (AIJ) has been giving special attention to urban heat island phenomena, and many systematic studies have been performed by the related research committees over a long period of time. From the 1990's, the AIJ started to establish subcommittees related to heat island phenomena, and many workshops and symposium have been held. Various themes were discussed in the workshops and symposium with researchers, urban planners, architects, public officers and manufacturers.

a. Newsletter on Urban Heat Island Countermeasures

With the support of AIJ, the publication of an English newsletter was initiated, with the purpose of letting people all around the world know what heat island studies are being carried out in Japan.

In the newsletter, the main themes are given, and outstanding examples of research are explained in simple terms. For Volume 1, the actual conditions of heat island phenomena in Japan and current heat island studies were introduced. We will continue to publish news letters. Interesting subjects are selected in the news letters, such as observations and numerical simulations of heat islands, and relations of building materials and urban designing.



b. Proposal for Urban Heat Island Countermeasures (2005.7)

In August 2005, the "Proposal for Urban Heat Island Reduction Strategies" was announced, and research continues with this proposal in mind. From the stance of creating high quality urban spaces by heat island countermeasures, AIJ recommends heat island countermeasures to architecture and urban specialists for various projects. Also, AIJ continues to develop and disseminate scientific design methods to create healthy and comfortable environments.

http://www.aij.or.jp/scripts/request/ document/heat_island/index.html

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