

GIS Database for Environmental and Energy System Planning in Tokyo

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Abstract:

Tokyo is a high-dense megalopolis, and has the city environmental problem of Heat Island. Heat Island is brought by the increase of artificial land covering, of discharged heat from building air-conditioning and of the number of cars, and the decrease of green land and surface water. It's important to increase more greenery, and reduce heat discharged from buildings by rationalizing the energy system.

We tried to prepare of a GIS database to grasp the present environment in Tokyo, before making the tool available for supporting and evaluating how to improve urban environmental problems such as the heat island.

Introduction:

Tokyo Megalopolis has such high-density that it has many environmental problems. The heat island problem is the most focused of them now. (Figure 1.) Heat island is brought by the increase of artificial land covering, discharged heat from building air-conditioning and the number of cars, and the decrease of green land and of surface water. It's important to increase more greenery, and to reduce discharged heat from buildings by rationalizing the energy system.

Now Japan is in an economic depression, low price package air conditioners are on the increase as the air conditioner equipment of buildings. But package air conditioners encourage heat island because air-conditioning discharged heat is thrown away directly in the air though it is useful because independent control can be done. So air-conditioning systems which throw discharged heat away by making water evaporate in the cooling tower are being reevaluated. The introduction of District Heating and Cooling Systems with cooling towers are also being looked at.

District Heating and Cooling Systems is becoming a more effective tool.

The input energy of the city can be reduced by using heat from waste incineration plants, and DHC can reduce the Heat Island impact by using rivers and drainage, and seawater, too.

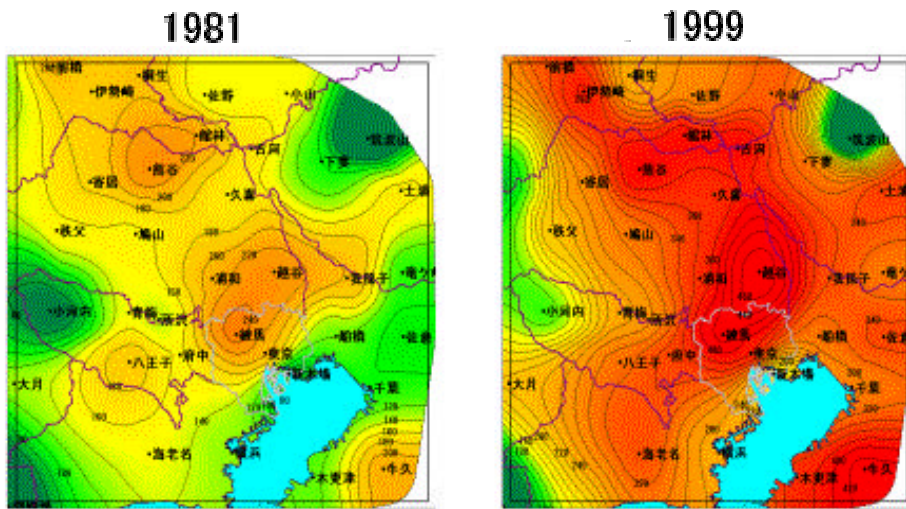


Figure 1. Thermal Environment Map, Tokyo (Ministry of Environment)

Image of this studies' Goal:

We aim to develop a tool to examine the introduction of District Heating and Cooling Systems by using GIS and the GIS database. This tool allows urban planners to perform several DHC analyses.

- 1) Extract the areas whose heat demand density is high, and areas where density will be made high by redevelopment
 - 2) Analyze the distance between those areas and a nearest waste incineration plant, a river, the sea, and a sewage disposal place
 - 3) Examine energy systems that have less impact on Heat Island and save energy.
- And, this tool supports other systems for evaluating the urban thermal environments such as Heat Island.

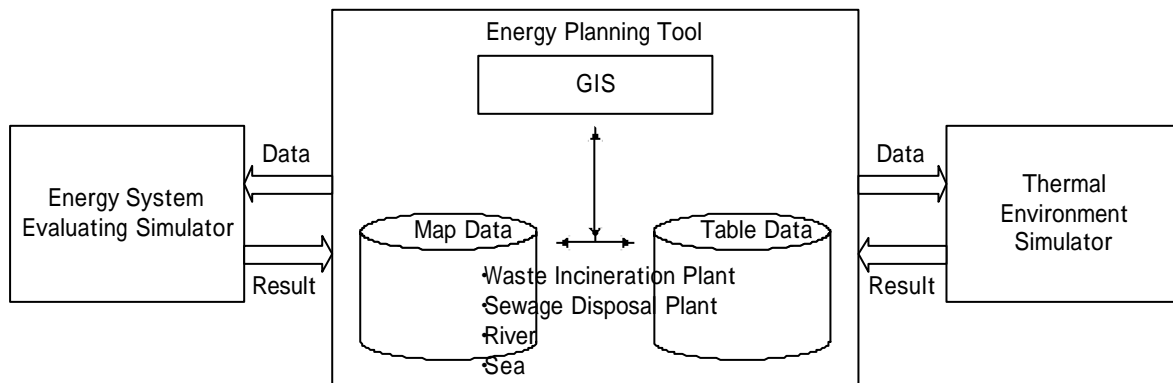


Figure 2. Environmet and Energy Planning Support System

GIS Database:

We prepared the following GIS data (Table 1. 2.).

Table 1. GIS data list

Data	Feature	Items	Data Source
Building	Polygon	Kind of usage, Area	Tokyo Metropolitan Government
Town block	Polygon	Floorage by usage type	
Redevelopment promotion area	Polygon	-	
Waste incineration plant	Point		
Sewage disposal plant	Point		
Sewage pumping station	Point		
River	Polygon		
Sea	Polygon		

Table 2. Relating table data list

Data	Items
Redevelopment promotion area	Floorage by usage, Population, Heat demand,
Waste incineration plant	Amount of waste incinerating, Amount of exhaust heat, Temperature
Sewage disposal plant	Amount of sewage disposing, Temperature
Sewage pumping station	Amount of sewage flow, Temperature
River	Amount of flow, Temperature

Using building data and town block data, we calculated total floorage by building usage type for every town block. An energy demand unit for each type of building usage was factored into the floorage values, and the amount of heat demand per year was calculated within every town block.

The amount of heat demand by 1 ha in every town Block is mapped in Figure 3.

Next we made data of redevelopment promotion area local government'.

Figure 4 shows the re-development promotion area that the government

administration specifies. Total floorage by building usage type after re-development is stored as the attribute data.

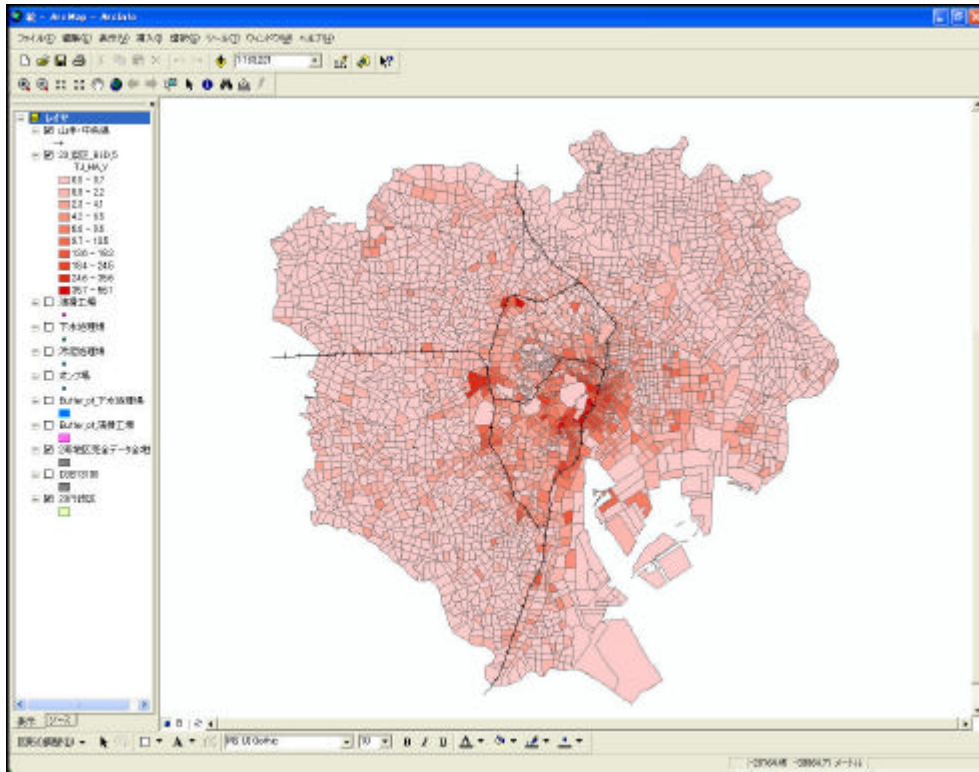


Figure 3. Heat Demand Density Map, Tokyo

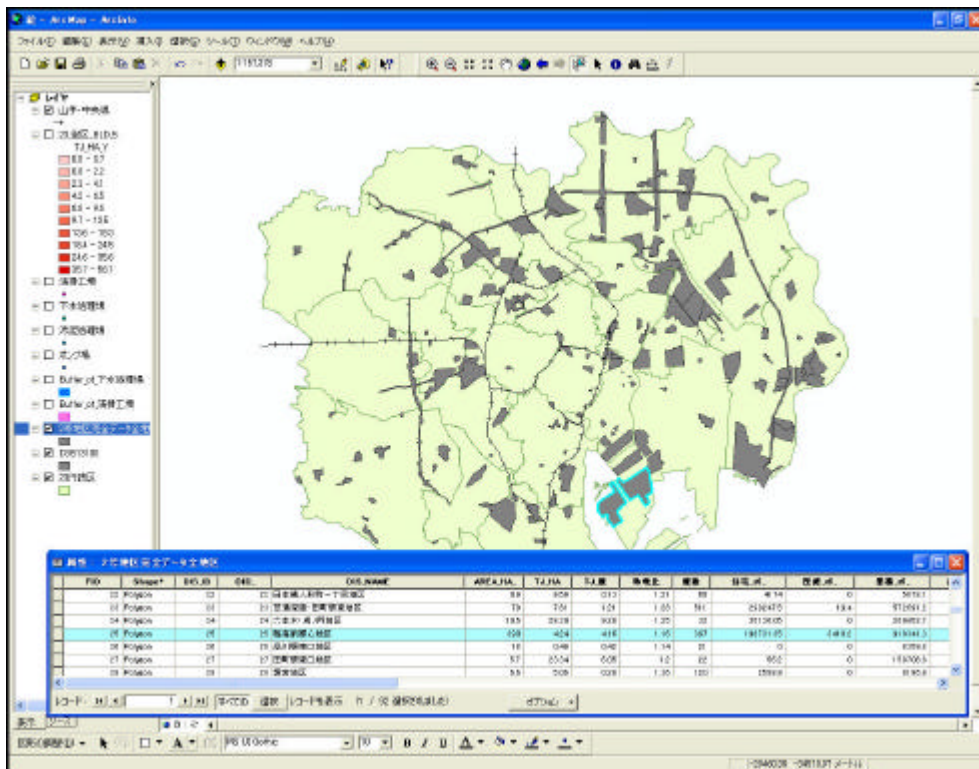


Figure 4. Redevelopment Promotion Area Map, Tokyo

Figure 5 shows the distribution of waste incineration plants. Quantity of the usable heat from waste incineration is stored as attribute data.

Figure 6 shows a 5km buffer from the waste incineration plants. The examination of the new saving energy system becomes possible by overlaying the heat demand density map and the re-development promotion area map.

Conclusion and Future outlook:

A GIS database to support environment and energy planning was made for Tokyo, where the heat island problem is serious.

Connection between the energy evaluation simulator and thermal environment evaluation simulator will be examined in future research. In detail, ways of providing data for each simulator from the GIS database and ways of visually expressing each result will be examined.

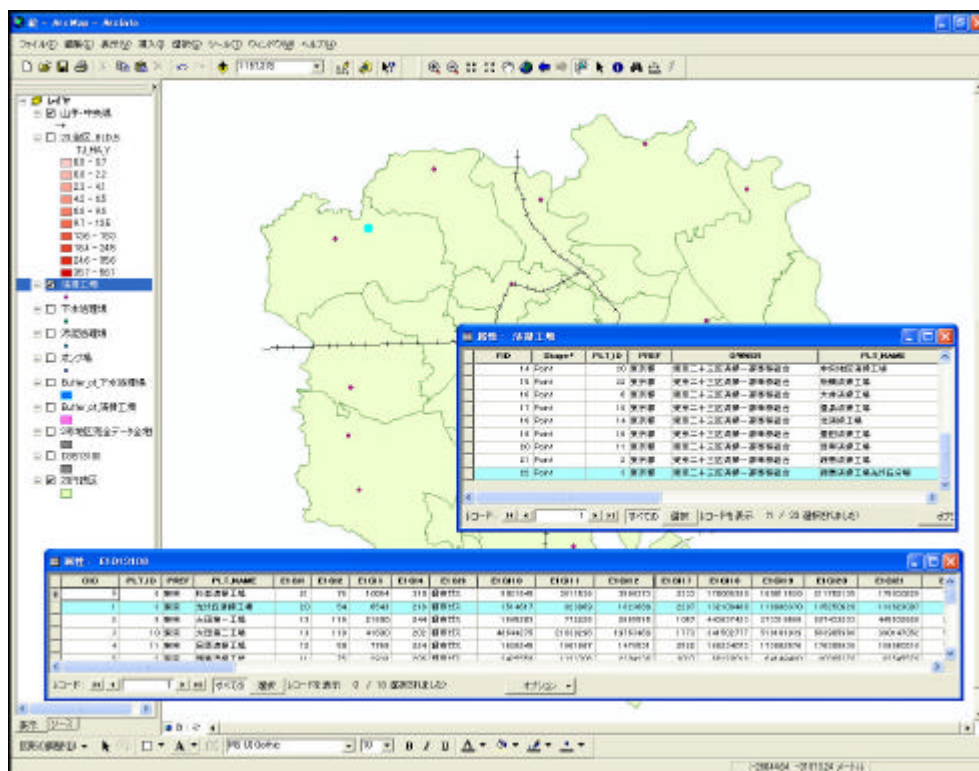


Figure 5. Waste Incineration Plant Map

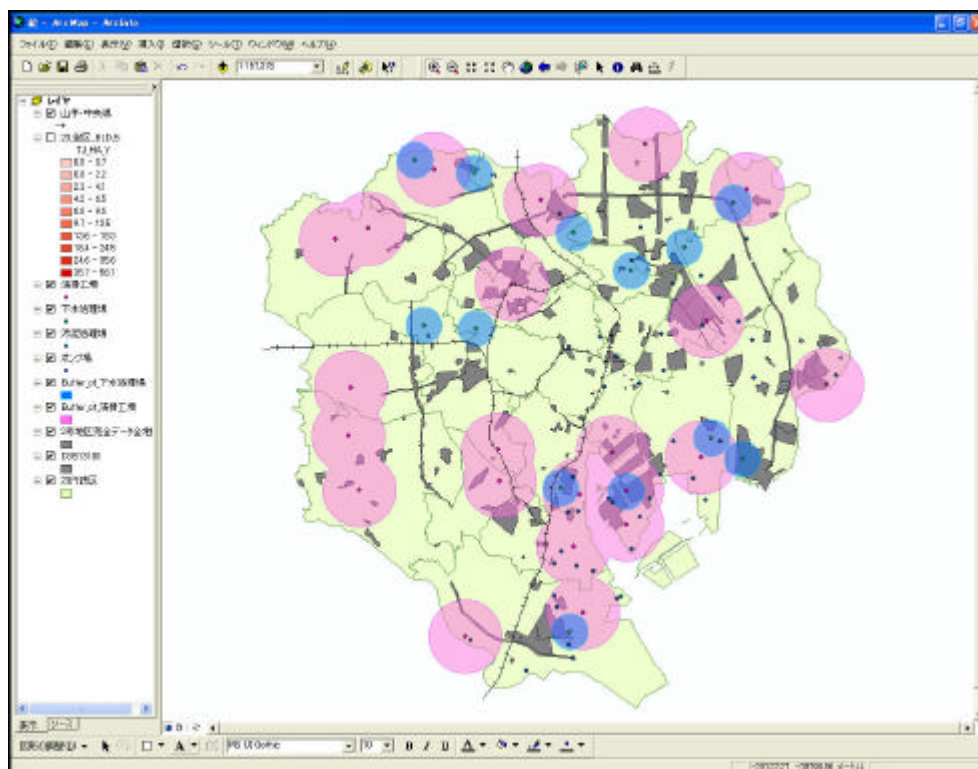


Figure 6. Buffered from Waste Incineration Plant and Sewage Disposal Plant

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