Effect of Policies for Building Low-Carbon Cities and Evaluating Them in Asia: From Mitigation Around Buildings

Ms. Yukiko Yoshida* and Dr. Toshiaki Ichinose

* National Institute for Environmental Studies / Tokyo University of Science, Japan
Environment and Energy around Building Blocks (EEBB)

Environmental Information System
- Change of urban form (past - present)
- 3D surface form of land covering and buildings

Buildings
Energy Saving Potential
(Household size, Building form, etc)

Building Blocks
Reduction potential estimation in terms of population density etc.

Energy Saving Potential Distribution

Figure: Concept of developed system

Collation of building model and survey → Making environmental evaluation
Research flow on EEBB (Environment and Energy around Building Blocks)

EEBB-model (1km × 1km)

Analysis of local characteristics

⑥ Population density of a block
⑦ Heat island effects of quantitative evaluation

① Block form extracted
② Average block model value computed
③ Indoor configuration (population, lighting, electric outlets)
④ Amount of heat inflow computed from weather data
⑤ Air conditioning level calculated (day/hour)

Figure: Research flow on EEBB (Yoshida et al. 2008)

SVF is the key factor in this system
Center of Nagoya in 2005

Building blocks: Average building height 21.5m  Number of stories: 7F (floor height 3.2m)
Daytime population: About 20,000 people Day-and-night population ratio: About 500%

Building coverd ratio | Road coverd ratio | Tree coverd ratio | Bare land ratio
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50 | 0 | 13 | 3 | 16 | 18

Figure. Research site (Nagoya) on Google earth  Figure. Sky view factor from photo with fisheye (Nikon CoolPix-P5100 +FC-E8)
Cooling load of building blocks

**EEBB Building blocks (Nagoya)**

- Window ①: 263 TJ/km²
- Window ②: 224 TJ/km²
- Window ③: 227 TJ/km²

**Interior heating load**
- 9%

**Perimeter heating load**
- 28%

**Interior cooling load**
- 46%

**Perimeter cooling load**
- 17%

**Cooling load**
- Office: 160,000 GJ/km²/year
- Department store: 140,000 GJ/km²/year
- Hotel: 120,000 GJ/km²/year
- Hospital: 100,000 GJ/km²/year
- School: 80,000 GJ/km²/year
- Restaurant: 60,000 GJ/km²/year
- Assembly house: 40,000 GJ/km²/year

**Cooling load distribution**

- Office: 46%
- Department store: 46%
- Hotel: 28%
- Hospital: 17%
- School: 9%
- Restaurant: 9%
- Assembly house: 9%
Characteristics of building environment using natural ventilation

This result shows the southern perimeter zone has a beneficial effect on high specification windows.

The north, west and east sides of buildings have little effect on cooling with the high specification windows in the Nagoya building blocks (road width 8 m, building height 20 m).
Heat load calculation (UCSS-MOE)

Reference: Urban Climate Simulation System (UCSS) developed by Dr. Ashie, Japan. MOE developed a simple calculation tool, March 2002.

Figure: Heat load versus building height (Nagoya)
Analysis by RayMan1.2 model

Andrea Albedo: 0.3, Bowen ratio: 1.3

Road width: 8m
Building height: 20m

Figure. SVF on 3D-model of Canopy

Figure. RayMan1.2 model of parameters

Figure. 3D-model of Canopy
When we changed the width of roads to 4m, the effect of wind change was not significant.

When the wind velocity decreased, the PMV/SET* value also decreased, thus reducing the thermal stress.
When planning the building blocks in Nagoya we found that the values of SVF less than 45% are appropriate.
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Figure SET* and sky view factor in Nagoya (RanMan model)
When planning the building blocks in Nagoya we found that the values of Road width 6m or 8m are appropriate.
Mecanizum of

4m
Heat load calculation (UCSS-MOE)

- Compare heat balance of outdoor and indoor environments for energy saving.
- Determine whether natural ventilation can be used to improve cooling.

Reference: Urban Climate Simulation System (UCSS) developed by Dr. Ashie, Japan. MOE developed a simple calculation tool, March 2002.
Conclusion

For comfort the sky view factor can be set to 45% or less, such as in case of Nagoya.

When planning the building blocks in Nagoya we found that the values of Road width 6m or 8m are appropriate (without tree).

This study can be applied to calculate energy saving potentials using basic data from different areas of Asia.
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Thank you