The Mitigation of UHI Intensity by the Improvement of Land Use Plan in the Urban Central Area - Application to Osaka City, Japan -

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The population of Osaka City is 2.65 million and the city area is 222.3 km$^2$. The population density is very high. The Osaka area is among the hottest areas of Japan.
Heat Island Structure (calculated by WRF)

Horizontal and Vertical Profile of Air temperature (2m high) and Wind (10m high) (maximum time, sea breeze is stronger and blow to inland. Cooling effect of sea breeze)
Heat Island Structure (calculated by WRF)

Horizontal and Vertical Profile of Air temperature (2m high) and Wind (10m high)
(evening, sea breeze reached deepest area over mountain, atmosphere begin to stable)

2006/08/03  20:00

Vertical profile of Potential Temp

2006/08/03  22:00
Climate Analysis Map for Planning In Osaka

The earth surface of Osaka City is covered by dense built-up area. In daytime, sea breeze blows, and in nighttime, weak land breeze blows from the inland.
River and Streets (east-west) as ventilation corridors of Sea Breeze in Osaka Central Area

Plan of „Kaze-no-Michi“ (ventilation lane)
The north-side lane of the road has very high temperatures, because the road is wide and has no street trees. There is almost no shade. The improvement of road condition on thermal environment is needed.
Concept of Countermeasures to Urban Heat Island

Building Scale
Three basic factors to UHI measures:

1) Improvement of Land Cover

2) Reduction of Anthropogenic Heat

3) The utilization of the wind caused by local wind circulation

Urban Scale

1. Reduction of UHI Intensity by means of scattering green

2. Divide of UHI Boundary Layer by means of green zone

3. Disappearance of UHI Intensity by means of high rise buildings

4. Reduction of UHI Intensity by means of the wind caused by “Local Wind Circulation System”
Conclusion:
Green area ratio in Osaka central area needs at least about 30%.

Evaluation Graph of minimum air temperature rise depend on green area ratio and heat release.

One dimensional heat budget model was used for the simulation.

The calculation condition is fine summer, one week data.

The policy of plan is based on the current urban problems in Japanese cities to be solved under the view points of Safety and Symbiosis.

1) Increasing green spaces and restoring water front spaces inside central city area for amenity and climate control
   - preparing green spaces “30% of city area”
2) preparing good public transportation systems using existing underground train system and new transportation system for comfortable transportation system and pedestrian spaces
3) Preparing compact infrastructure system, such as water, energy and waste for conserving resources and for protecting pollutions, partly to concentrate mechanical services and to promote common utilization for decreasing environmental loads
How to Increase Green Space to 30%
How to compactify central urban area

The policy of new land use plan is as follows.

1) Making urban core zone (high-rise building zone) around the subway (junction) station.

2) Dividing all objective areas into 3 type land use categories
   (1) Urban core zone (high-rise building zone) mainly for office, commercial and public buildings
   (2) Residential zone (low-rise building zone) mainly for houses, residences
   (3) Green zone (10-30%) for Kaze-no-michi (Ventilation lane), recreation, ecosystem and historical buildings conservation

3) Green zones should be located far from the stations
Present Land Use

The area ratio of green spaces are about 4.9% (about 3km x 3km area) based on parcel unit.
The subway lines are located about every 1km intervals. Therefore the stations for changing trains (junctions) are located regularly.
The succession of land use pattern

Present Green 4.9%

Green zones, located far from the stations

Future Land Use Plan to compactify urban area

Green 10%

Core zone
Residential zone
Green zone

Case1 Green:10%, Core:45%, Residential:45%
Future Land Use Plan based on parcel unit

- **Case 1**: Green:10%, Core:45, Residential:45
- **Case 2**: Green:20%, Core:40, Residential:40
- **Case 3**: Green:30%, Core:35, Residential:35
Future Land Use Plan by **Grid Model**

based on street blocks

Green Area 10% Case
(about 3km x 3km area)

Green Area 30% Case
Almost equally distribute the existing street blocks to green zone, high-rise zone and low-rise zone

The roads in Osaka central area consist of about 86m grids (Street block size).
Image of Green zone

Osaka Castle Park

Utsubo Park

Osaka Ekimae Promenade

Nanko New Town

Green zone for Kaze-no-michi (Ventilation lane), recreation, ecosystem and historical buildings conservation
Osaka in 1845, there were many moats, rivers and bridges.

Now, a lot of moats and rivers are lost. They were reclaimed.

Historical area and historical buildings should be preserved. Partly in green, converting to a museum, restaurant, and so on.
The residential zone is a low-rise area for houses. The residential houses are located around the core zone with plentiful green.
For the viewpoint of wind flow, high-rise buildings at the central area would be more desirable than the type of courtyard that is popular in Europe.
Summary of Compact Eco-city Plan

The policy of plan is based on the current urban problems in Japanese cities to be solved.

1) Restoration of green and water front area - Formation of “Kaze-no-michi” (ventilation lane)
- For recreation, natural environmental preservation and countermeasures to Urban Heat Island
- Green spaces would be needed “30% of urban area”

2) Breakaway from cars – to good public transportation systems
- using existing underground train and new transportation system for comfortable transportation system and pedestrian spaces

3) Completing the urban infrastructure to the compact systems, water, energy and wastes - supply and management system
- For conserving resources and for protecting pollutions
- Partly to integrate mechanical services and to promote common utilization for decreasing environmental loads
Future Works

We need the forecast assessment as follows.
- Improvement effects of Urban Climate
  （Air Temperature, wind ventilation）
- Adaptation to Global warming
- Effects of Compactification
  > Energy conservation (buildings, cars)
  > Reduction of CO$_2$ exhaust (cars, buildings, green)
- Improvement effects of landscape, recreation spaces, disaster damage and so on.
A method for creating green and waterfront spaces (Future work)

- Land Readjustment Program for creating green blocks
  > adjusting the floor area to each building use

Image of Land Readjustment Program to create green and waterfront spaces
(from T. Ojima, Waseda University)
- Some new development areas also should be used for the Land Readjustment program.
Thank you very much for your attention.

Residential  Osaka Castle Park & Business District (OBP)  Commercial

Osaka City

http://osakawalker.com