A Study on Thermal Comfortable following the Thermal Environment Migration in Detached Housing Area in Korea

2013. 5. 21

Ph.D. Ji-Won Ryu
Prof. Dr.-Ing. Eung-Ho Jung
Dr.-Ing. Dae-Wuk Kim
Prof. Ph.D. Akira Hoyano

1. Purpose

➢ ***Improved of the thermal comfortable following the thermal environment migration in detached housing areas***

- Focus on the greening effect and examine the differences in thermal environment of external spaces of other areas

- Greening methods considering the materials or shape of external space as a systematic approach to improving the surface temperature

- Quantitative prediction and evaluation for the thermal environment

2. Methodology

➢ ***Quantitative prediction and evaluation for the thermal environment***

1. Analysis of the thermal environment improvement measures used in the design

   ➡ Visible output of surface temperatures to 3D-CAD models in color images

2. Reduction of the thermal load to the surroundings

   The sensible heat load to the atmosphere ➡ Heat Island Potential (HIP) (Sensible heat flux from all surfaces of an analyzed area)

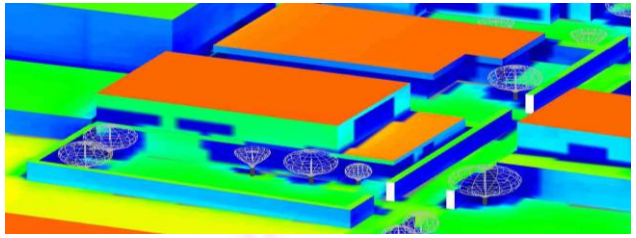
   The environmental load ➡ Air-conditioning load and CO_2 emissions

3. Creation of a comfortable outdoor living space

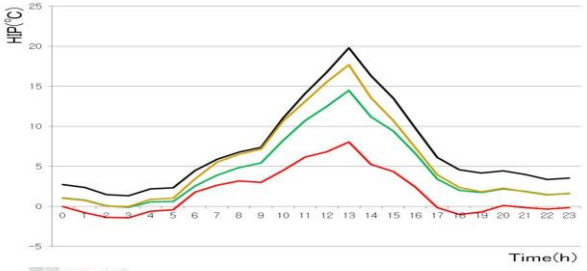
   The thermal radiation environment ➡ Mean Radiative Temperature (MRT) at a height of 1.5m above the ground

   The Evaluation of cool spot ➡ Calculation of SET* combined with CFD

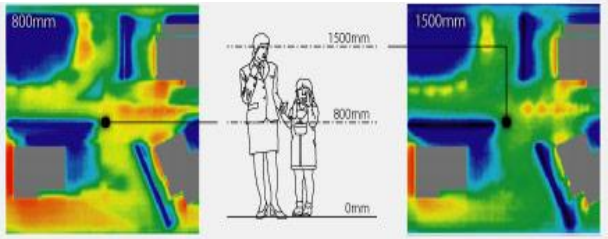
Surface temperature



HIP (Heat Island potential)



MRT (Mean Radiant Temperature)



2. Methodology

REAL CORP 2013

HIP : Heat Island Potential

The sensible heat load to the atmosphere
(The sensible heat flux from all surfaces in an analyzed area)

Heat Island Potential (Heat)

Temperature of a small surface (℃)

Air temperature (℃)

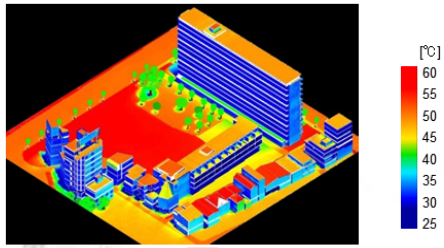
Convection heat transmission(W/m²℃)

$$HIP[W/m^2] = \frac{\int_{all\_surfaces} \alpha_c (T_s - T_a) dS}{A}$$

Horizontal area of an analyzed urban block (m²)

Heat Island Potential (Temperature)

$$HIP[°C] = \frac{\int_{all\_surfaces} (T_s - T_a) dS}{A}$$



20℃(HIP) + 30℃(Air temp.)
=50℃(Surface temp.)

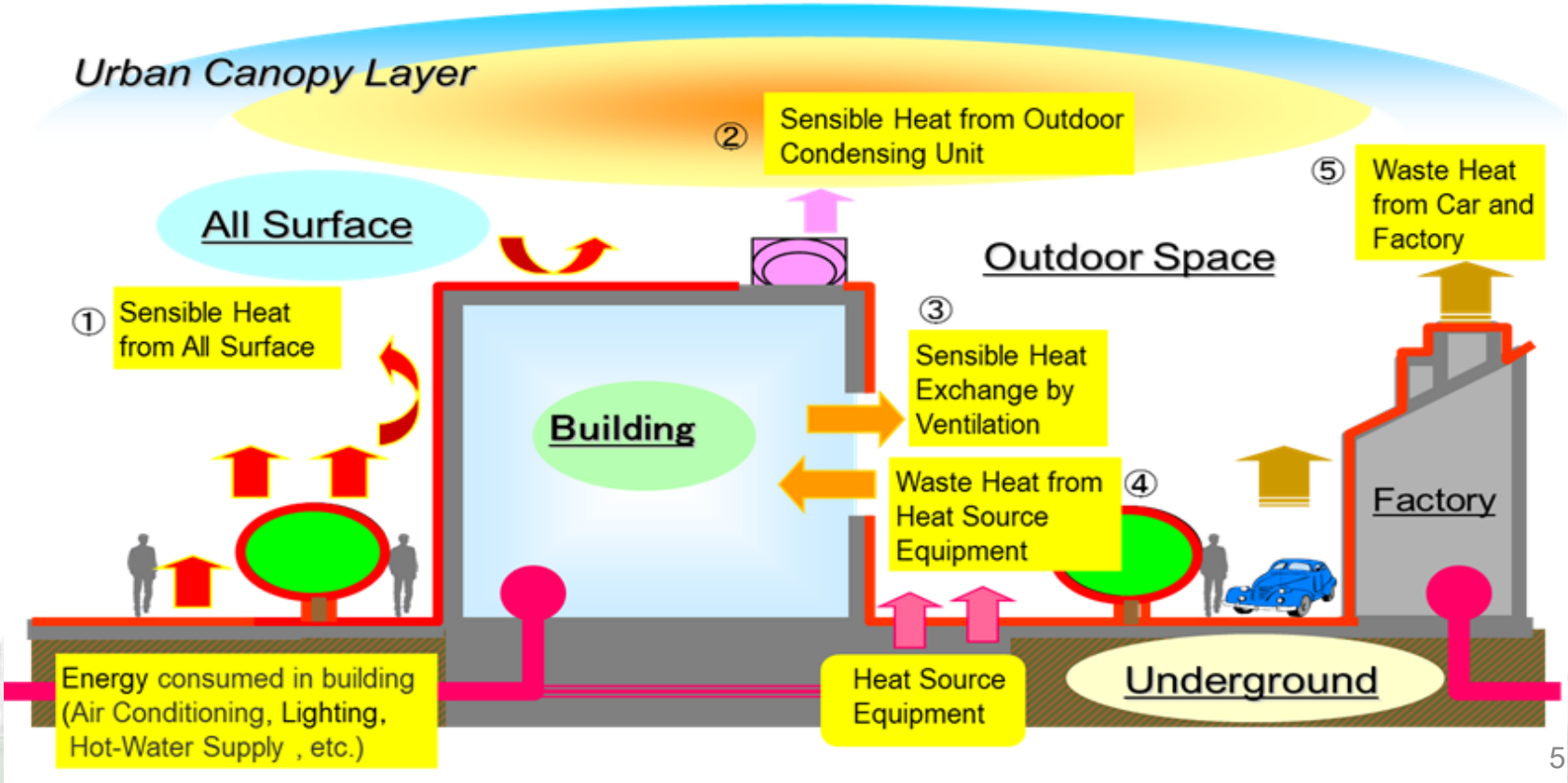
HIP=20℃

(ex. : air temp.=30℃ → surface temp.=50℃)

2. Methodology

➢ *Sensible Heat Load to Atmosphere*

Sensible Heat Load to Atmosphere＝①Sensible Heat from All Surface
＋②Sensible Heat from Outdoor Condensing Unit
＋③Sensible Heat Exchange by Ventilation
＋④Waste Heat from Heat Source Equipment
＋⑤Waste Heat from Car and Factory, etc.

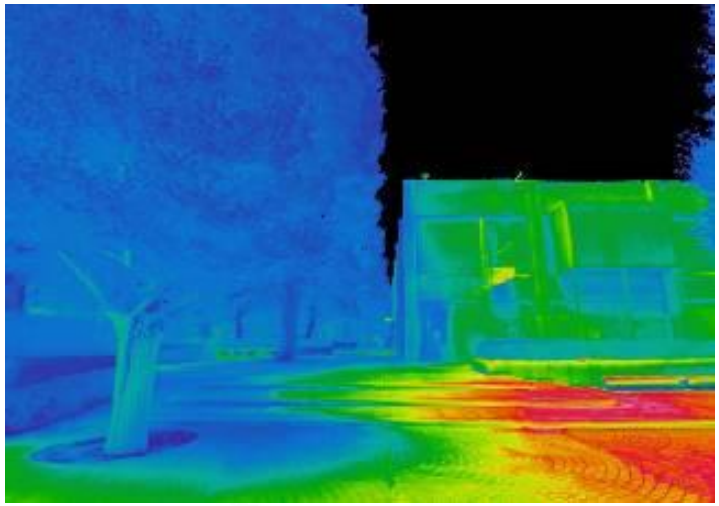


2. Methodology

➢ *Control effect of thermal environment by greening*

- Temperature reduction
- Wind speed reduction
- Humidity increase
- Surface temperature reduction

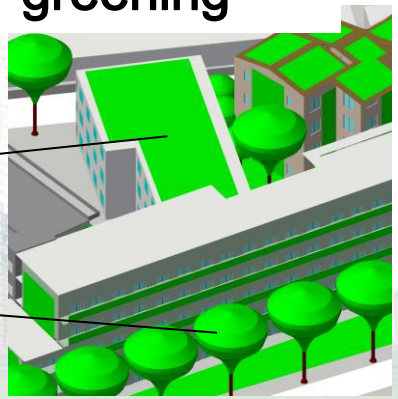
Contributing to reduce the heat load of the atmosphere → Highlight to the effect of the surface temperature reduction



The surface temperature reduction effect by greening

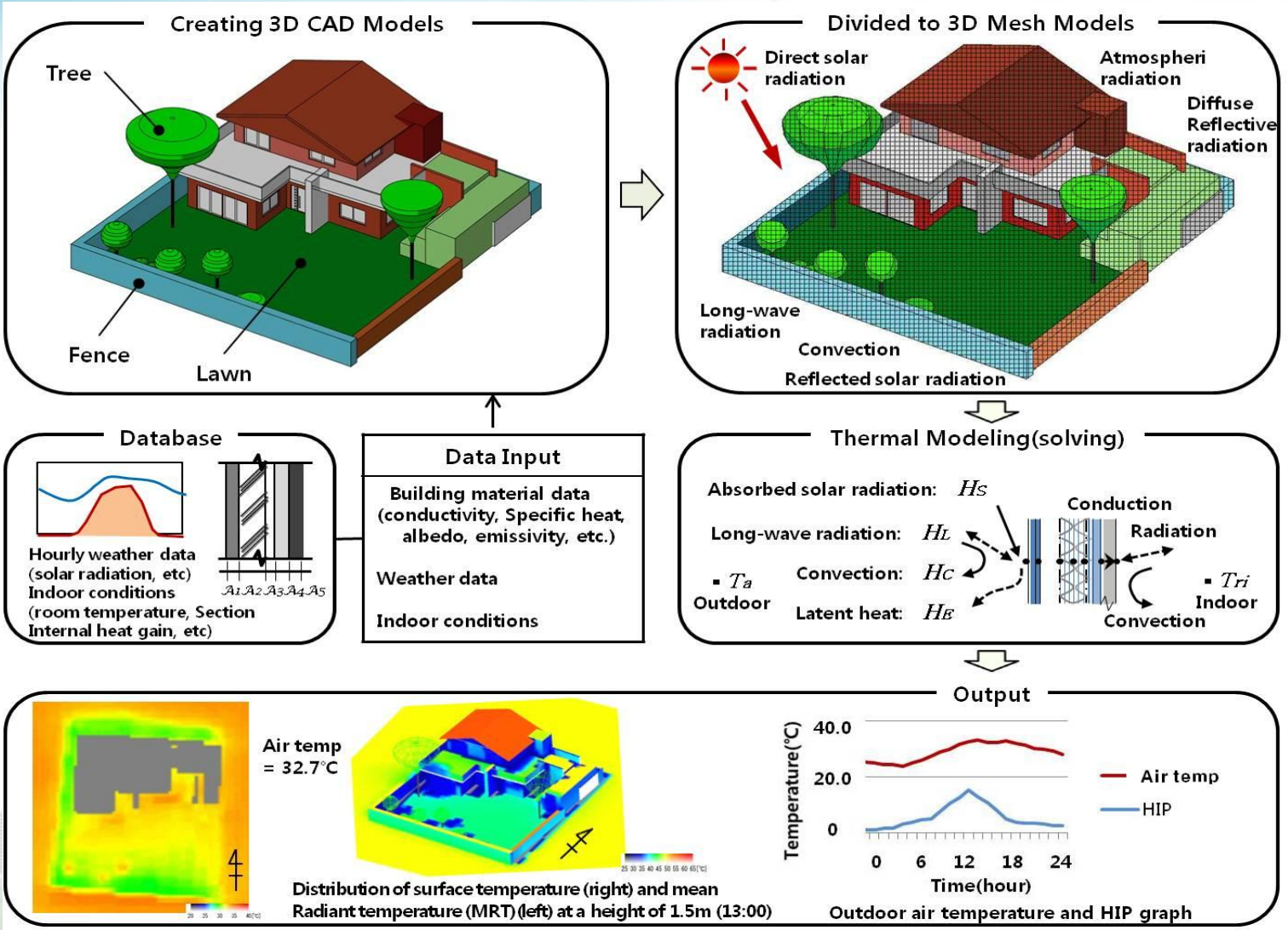
- By the effect of reduced surface temperature on the green coverage surface

- Shielding effect of solar radiation by trees



2. Methodology

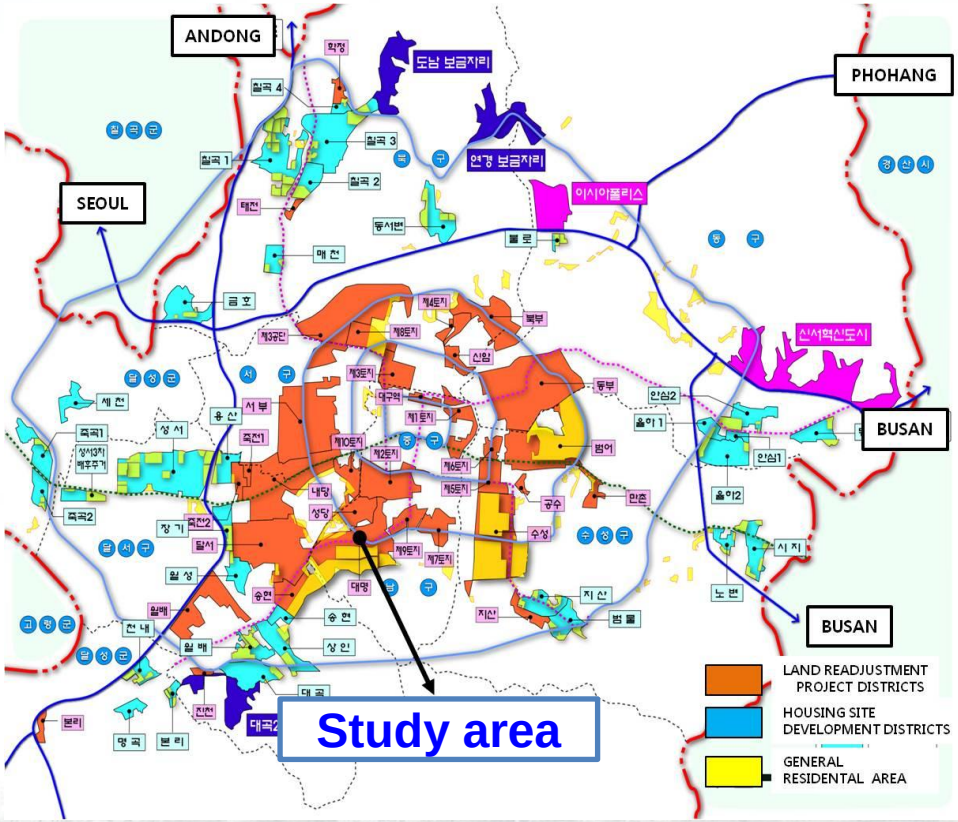
➢ *Diagram of the simulation tool*

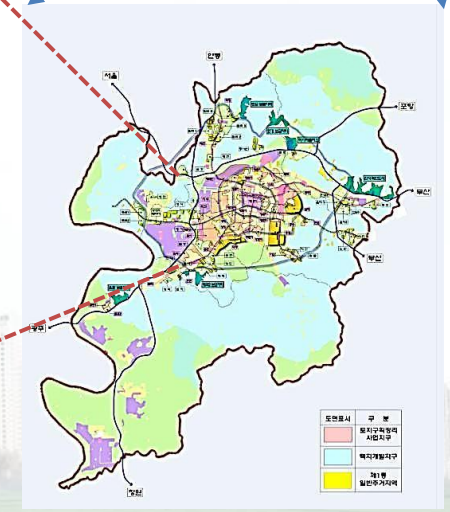


3. Case study

➢ *Daegu, Korea (2012)*

- Area : 884.07㎢
- Population : 2.509,187





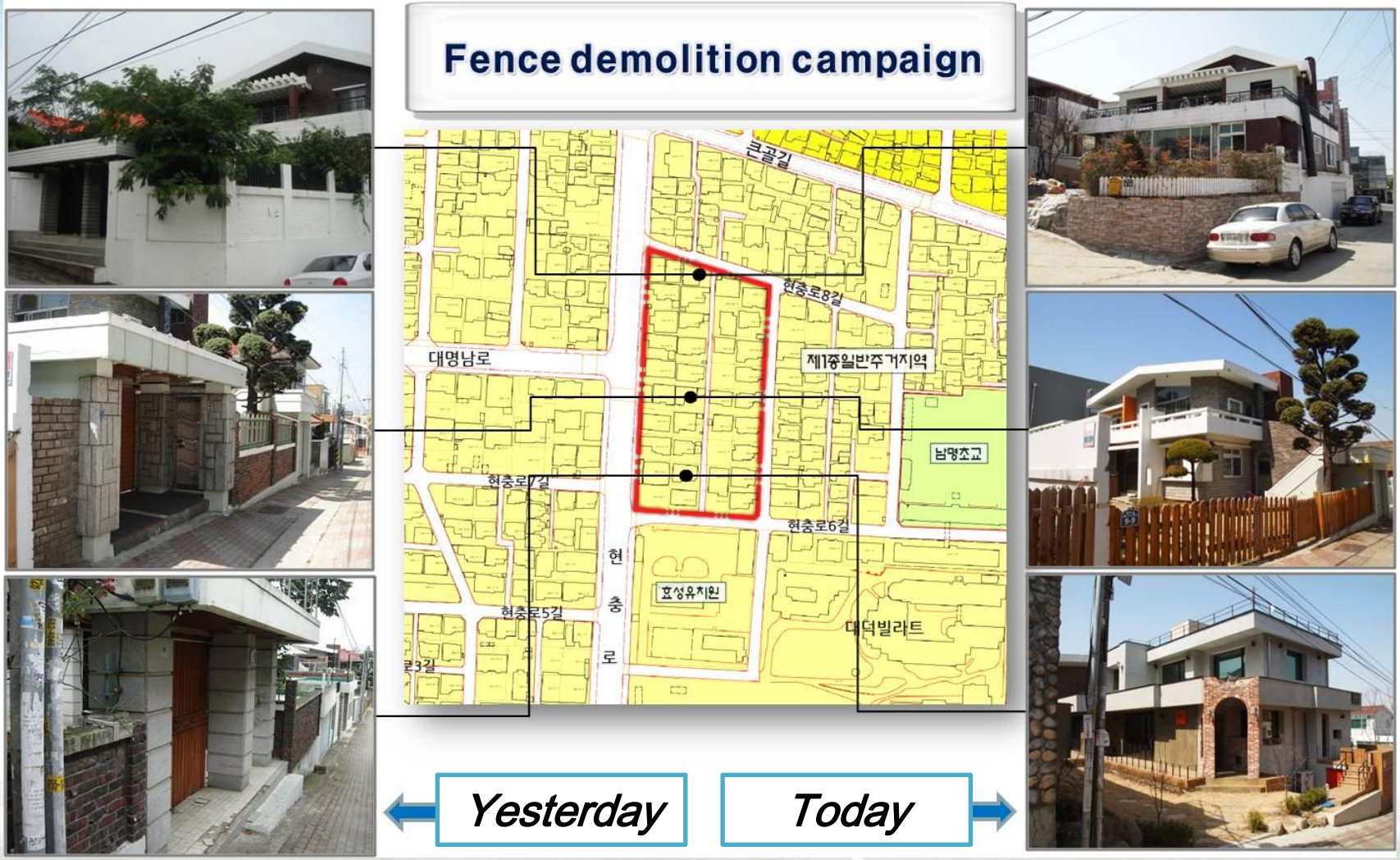
3. Case study

➢ *Study area(extenal views)*

3. Case study

REAL CORP 2013

➢ *Fence demolition campaign*



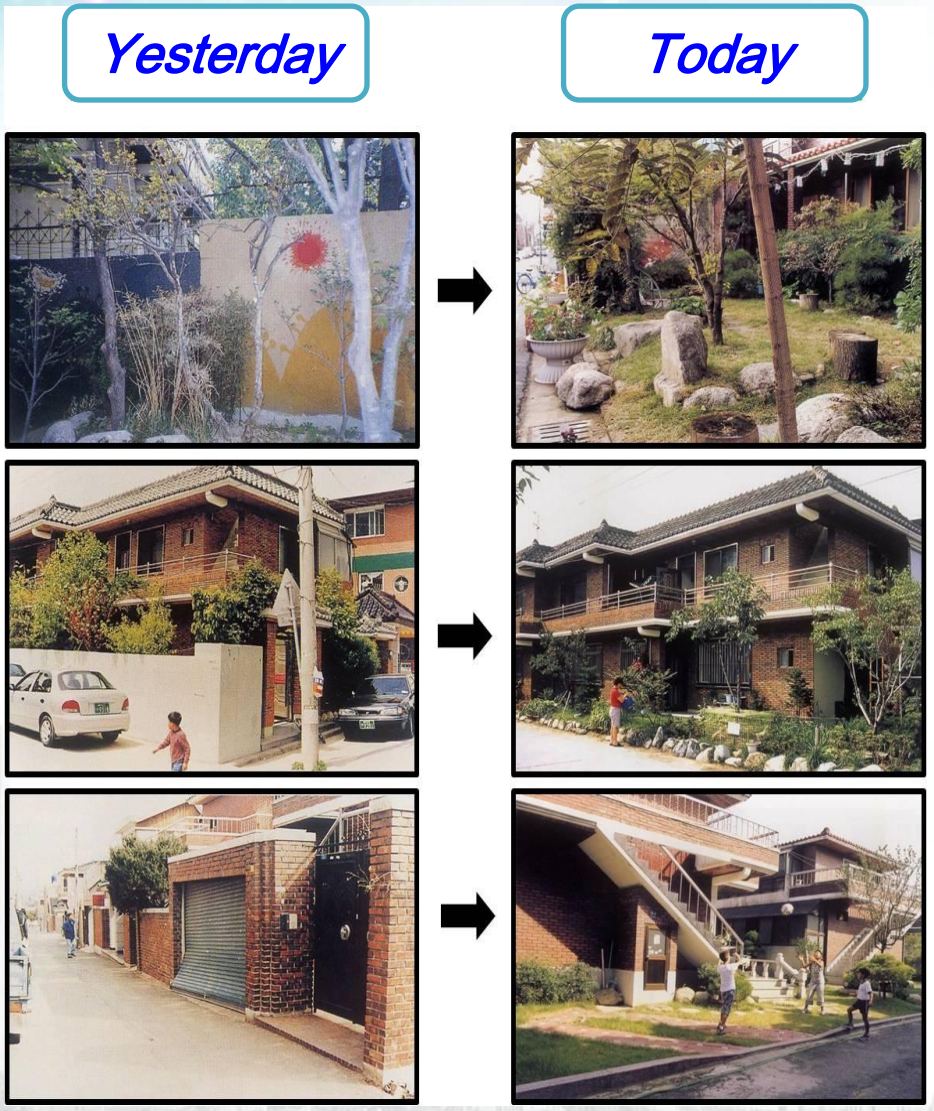
3. Fence demolition campaign?

- Goal : To improve scenery, expand of green space and promote the “community” among residents

- Projects :
  - Residents : voluntarily joined
  - Local governments : financial supports

- Problems :
  - Lack of voluntary participation of residents
  - Highlighted improve the physical environment

Urban Regeneration Project :
- Eco-friendly Urban creating
- Good condition residential environment (Quality of life)



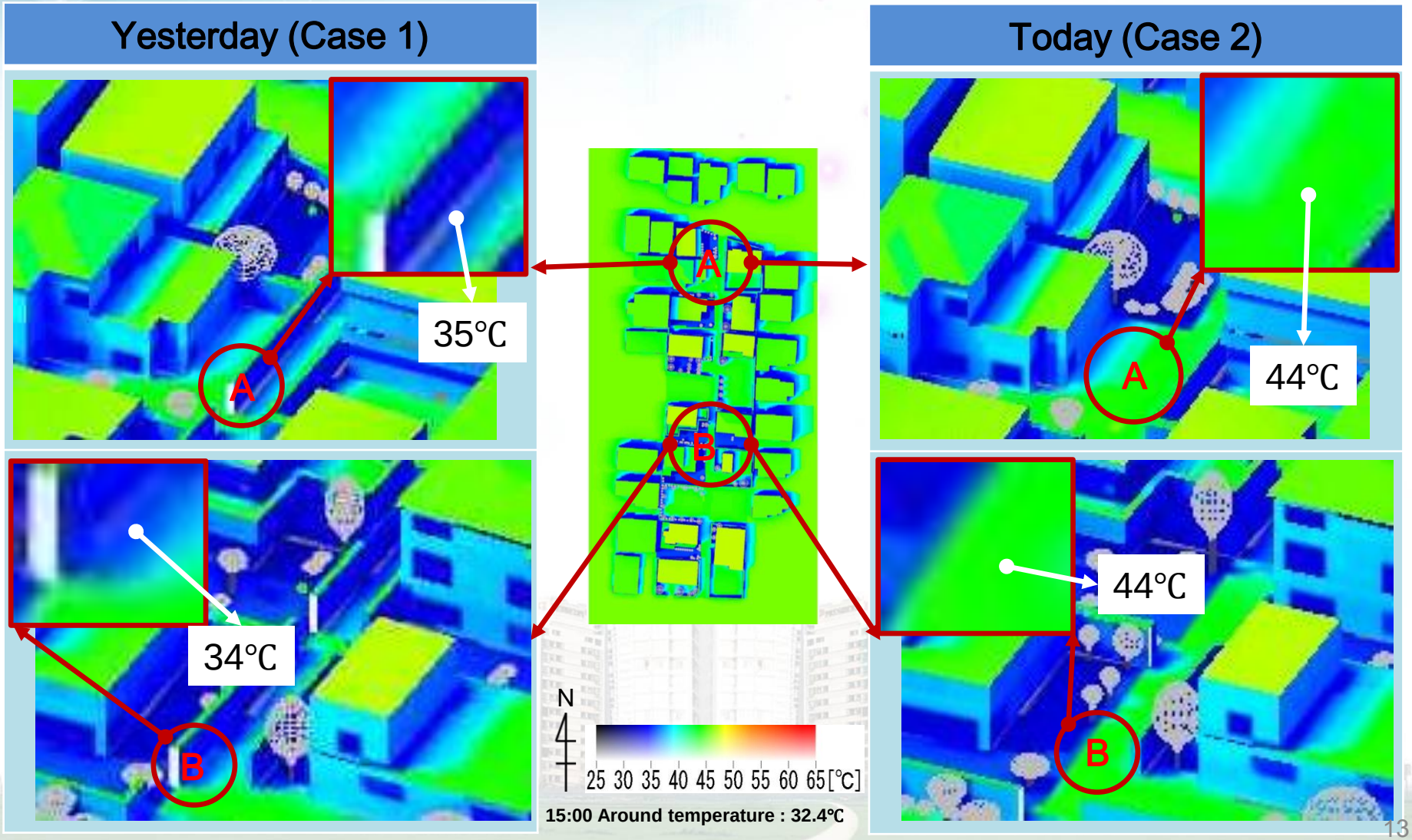
4. Thermo Environmental Analysis

➢ *Housing areas conditions for the analysis of the thermal environment*

Cases		Conditions
 Before the fence demolition	Yesterday (Case 1)	- Surface: concrete - Road: asphalt - Vacant land and parking lot: vacant - Wall: cement bricks, R.C - Roof: concrete, slates - Green coverage: 5%
 After the fence demolition	Today (Case 2)	- 8 houses fence demolition - Green coverage: 7% - Surface: grass and water retaining pavement - Tree planting

4. Thermo Environmental Analysis

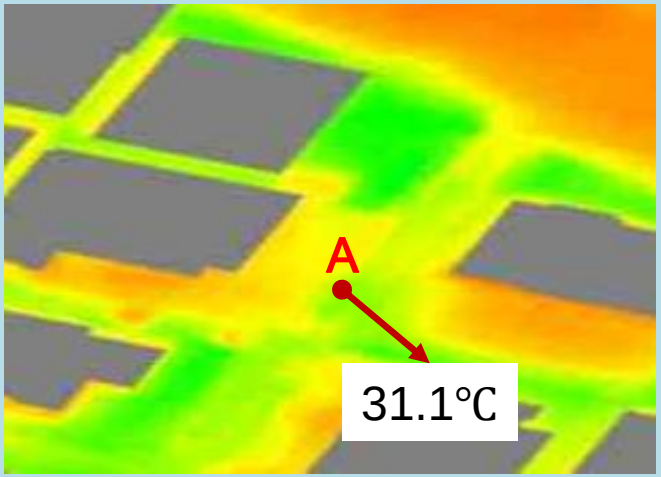
➢ *Surface temperature distribution(15:00)*

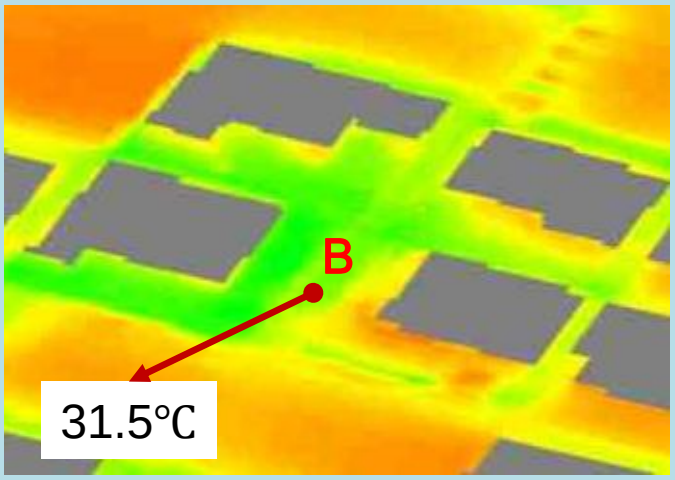


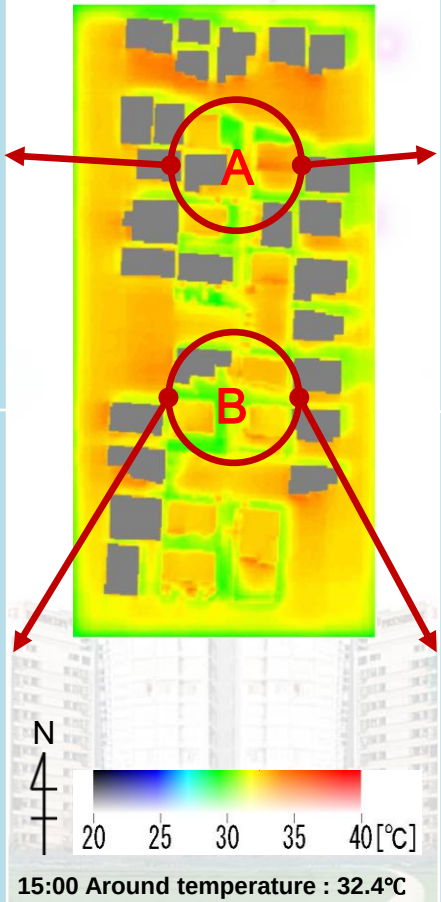
4. Thermo Environmental Analysis

➢ *MRT distribution(15:00)*

Yesterday (Case 1)

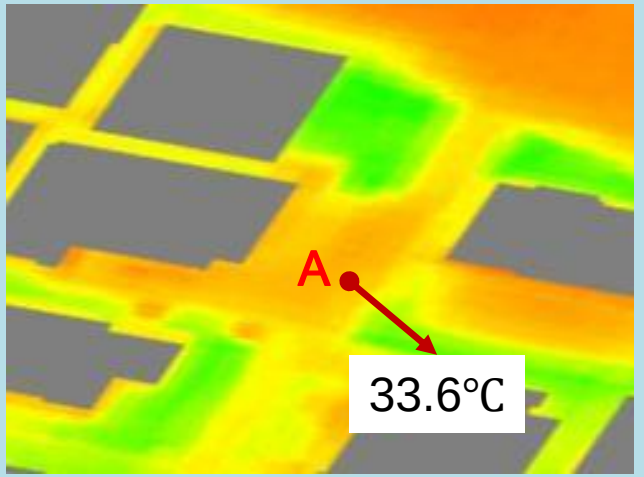


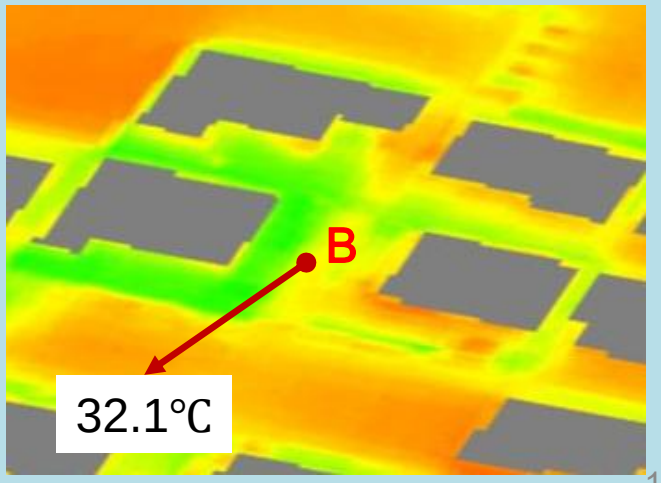




15:00 Around temperature : 32.4℃

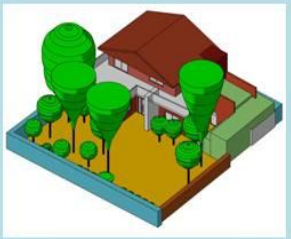
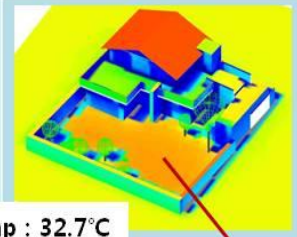
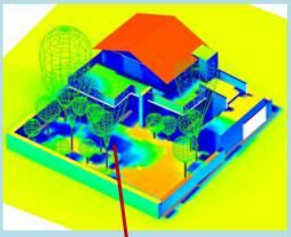
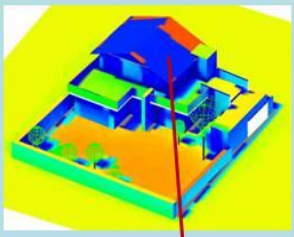
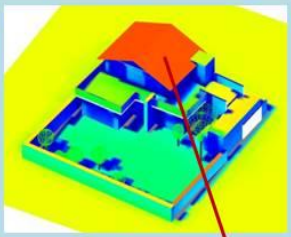
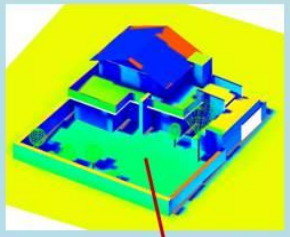
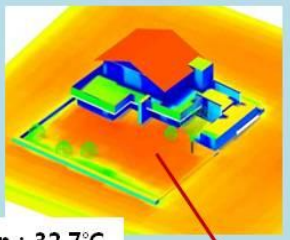
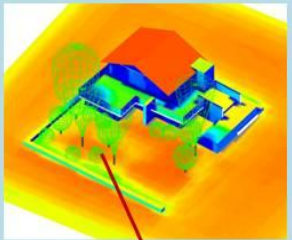
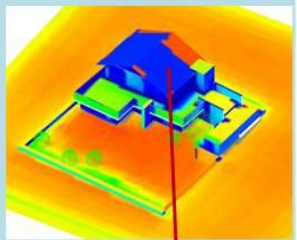
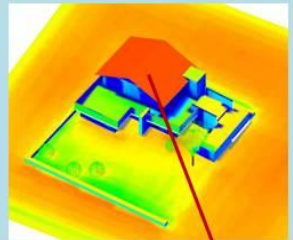
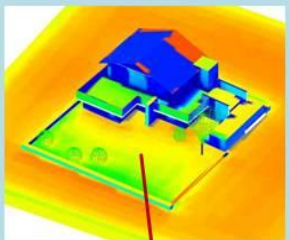
Today (Case 2)





4. Thermo Environmental Analysis

➢ *Thermal environmental distribution by greening type*

	Bare ground	Planting	Rooftop planting	Grass	Grass & Rooftop planting
Input Layer					
Surface Temp.	 Air temp : 32.7°C 25 30 35 40 45 50 55 60 65 [°C] Ground : 52°C	 Tree : 33°C	 Rooftop : 34°C	 Rooftop : 57°C	 Grass : 42°C
MRT (1.5m)	 Air temp : 32.7°C 20 25 30 35 40 [°C] Ground : 35.3°C	 Tree : 30.5°C	 Rooftop : 29.3°C	 Rooftop : 34.5°C	 Grass : 31.7°C

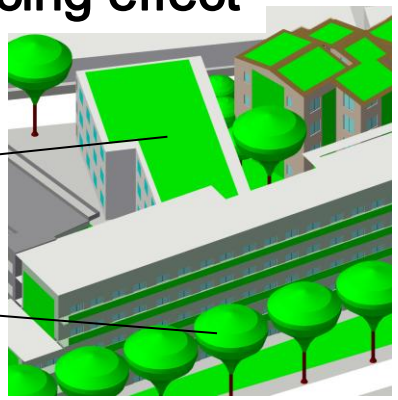
4. Thermo Environmental Analysis

➢ *Housing areas conditions for the analysis of the thermal environment*

Greening the surface temperature of the reducing effect

- By the effect of reduced surface temperature on the surface of the green coverage

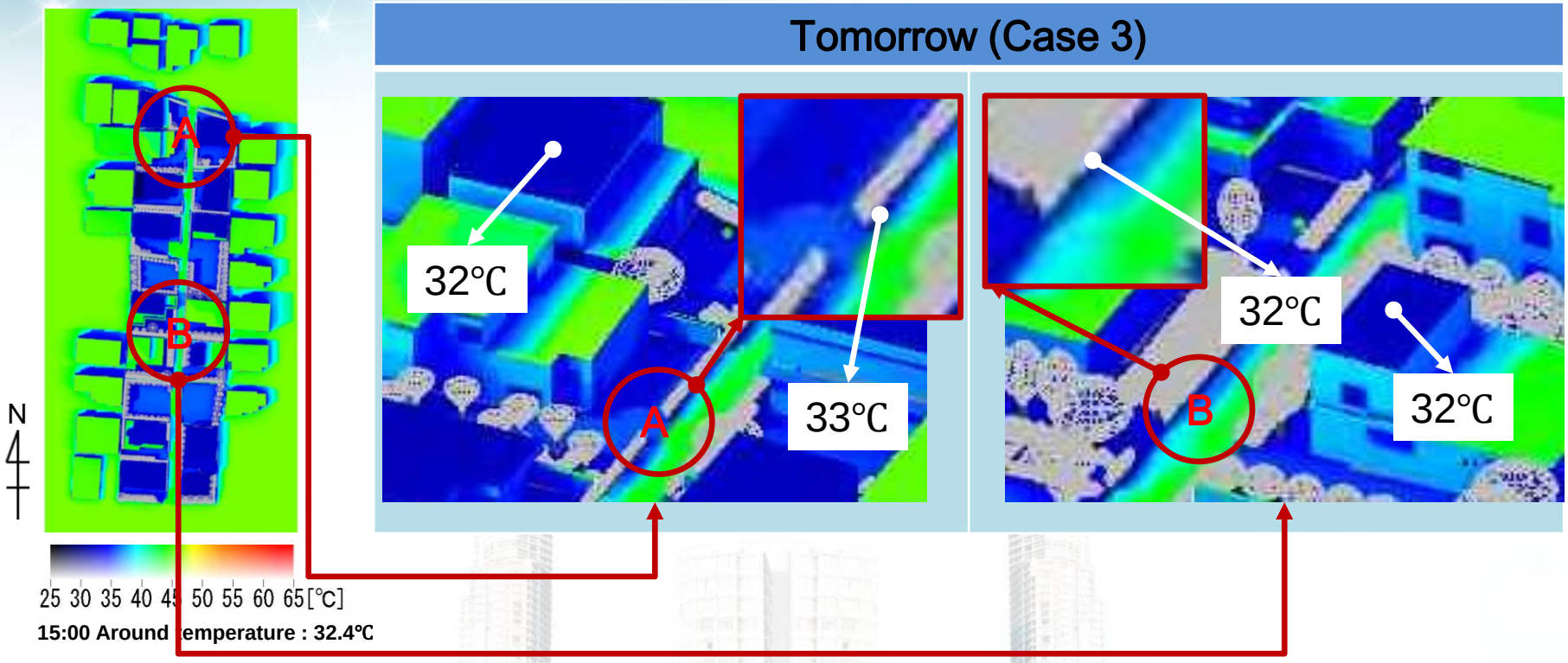
- Shielding effect of solar radiation by trees



Cases		Conditions
 Greening after the fence demolition	Tomorrow (Case 3)	- 16 houses fence demolition - Green coverage: 25% - Surface: grass and water retaining pavement - Tree planting and a green roof

4. Thermo Environmental Analysis

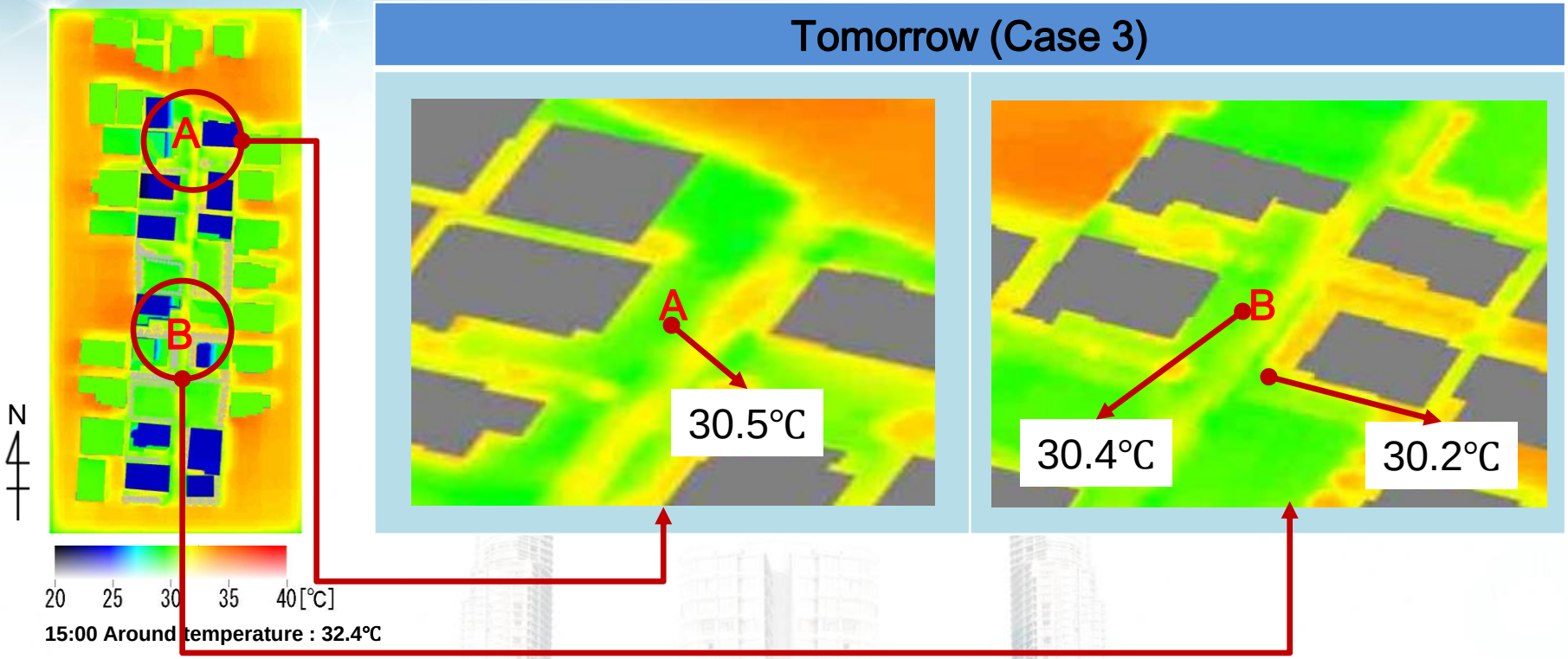
➢ *Surface temperature distribution(15:00)*



Surface temperature	Case 1	Case 2	Case 3
A point	35℃	44℃	33℃
B point	34℃	44℃	32℃

4. Thermo Environmental Analysis

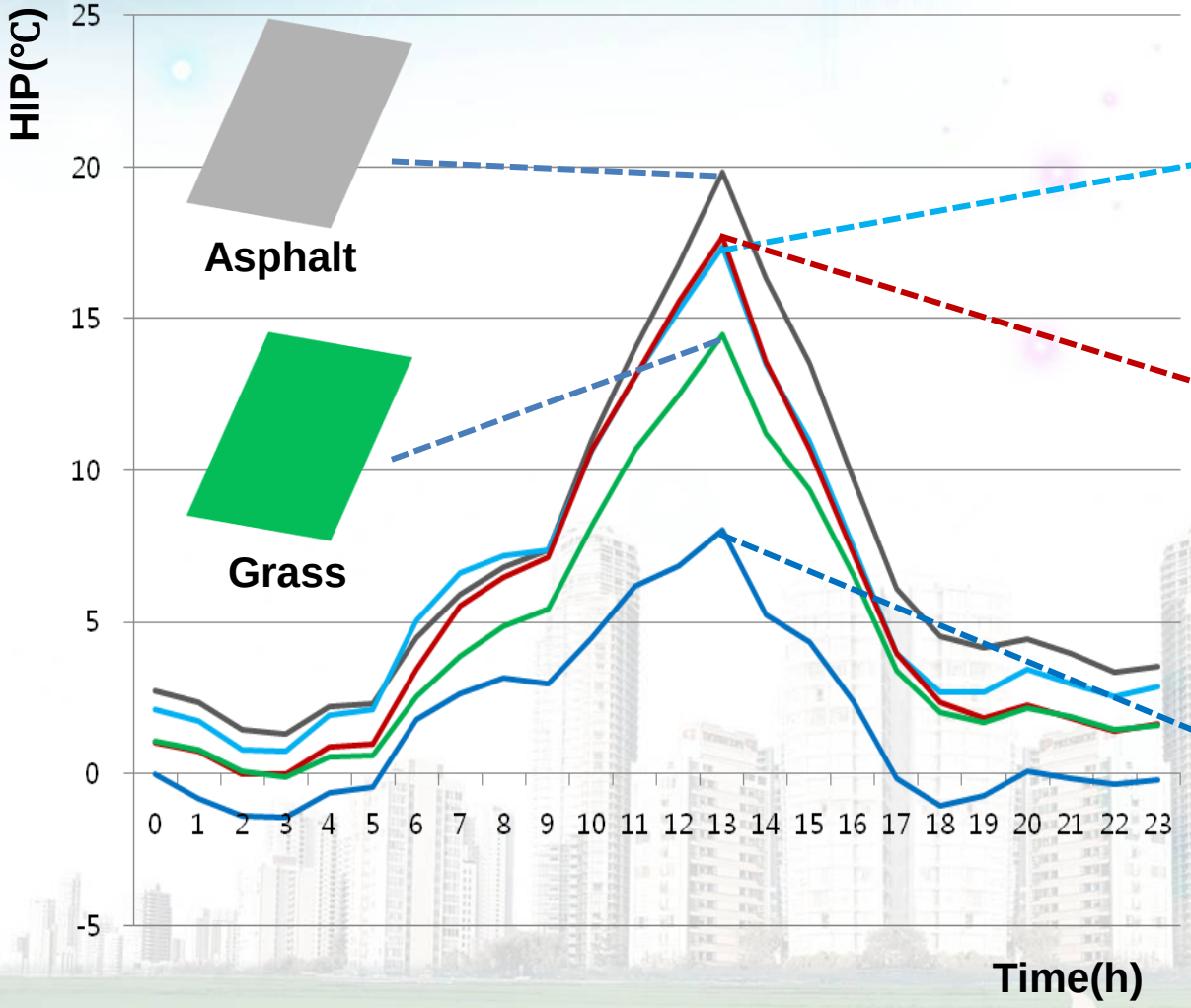
➢ *MRT distribution(15:00)*

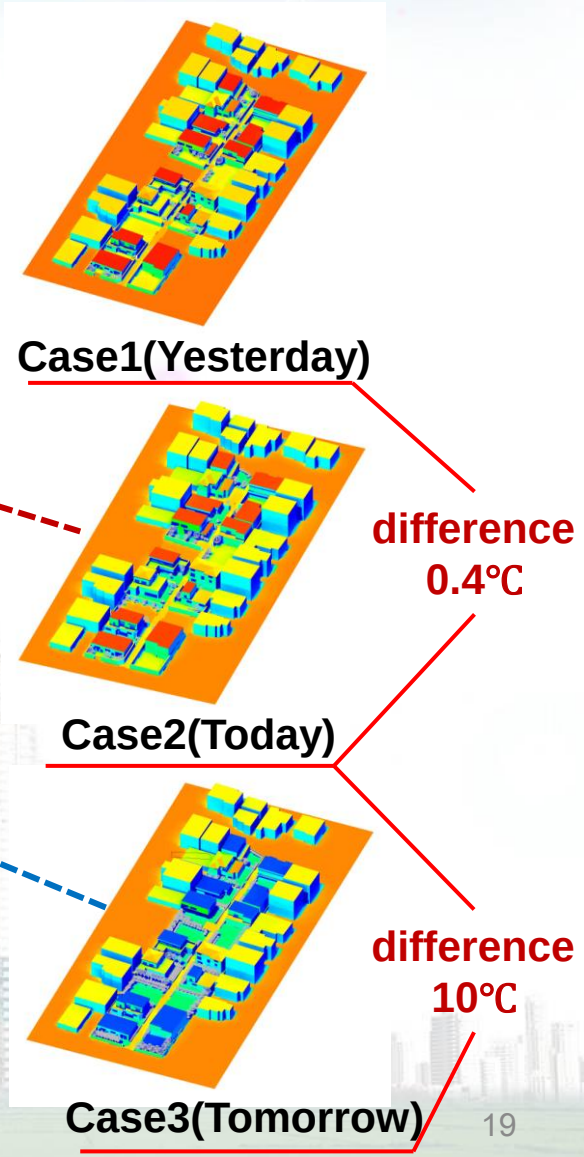


MRT	Case 1	Case 2	Case 3
A point	31.1℃	33.6℃	30.5℃
B point	31.5℃	32.1℃	30.4℃

4. Thermo Environmental Analysis

➢ *HIP graph(13:00)*





5. Conclusion

➢ *Create a comfortable urban environment with less impact to the environment !*

Yesterday (Case 1)	Today (Case 2)	Tomorrow (Case 3)
		

➢ **Buildings and grounds are covered with greenery**

- Planting tall trees with large crown along the road
- Vegetative screens, rooftop, wall and veranda planting

5. Conclusion

➢ *Significance of the study*

1. Thermal environment can be evaluated in the stage of design

2. Thermal environment can be quantitatively predicted and evaluated

3. Visible output for the thermal environment is easily evaluated by designers and clients

5. Conclusion

➢ *Creating comfortable urban households from urban heat environmemt*

Regionality	Make a good use of natural potential in the building site — Climate, site conditions, microclimate in the surroundings —
Spaces	Space design in which various environmental factors such as heat and wind flow are also considered, not only from th e traditional viewpoints of design and spatial structure
Materials	Surface materials should be selected from the viewpoint of the thermal environment Various thermal environment improving measures such a s rooftop planting are utilized

Realization of environmentally conscious design, comfortable living spaces, new lifestyle

Thank you for attention

(jiwon97@kmu.ac.kr)