

Field Observation on Thermal Environment of an Urban Street with Roadside Trees in a Tropical Climate

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1. INTRODUCTION



- ❑ Equator, hot and humid climate
- ❑ Abundant sunshine & solar radiation
- ❑ Wind: generally light
- ❑ 4 wind change season: southwest monsoon, northeast monsoon, and two shorter inter-monsoon season
- ❑ High relative humidity
- ❑ East coast, Sabah and Sarawak experienced heavy rain during November to January

Average temperature	27° C
Highest mean daily wind speed	3.8 m/s
Average annual rainfall	1,623 mm
Average relative humidity	80%

Source: Malaysian Meteorological Department

MONSOON SEASON IN MALAYSIA



Southwest Monsoon

late May-Sept

relatively drier weather

Northeast Monsoon

November-March

heavy rainfall

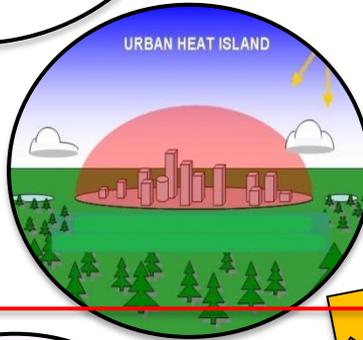
RESEARCH MOTIVATION



Global Issue:
population growth

Environmental
issue: Greenhouse
gases, pollution,
urbanization, waste

Urban
climate
issue: UHI



- Developing countries are facing huge population growth in the future
- Less study regarding urban climates and effect of green at tropical developing country

Developing
country



Urbanization



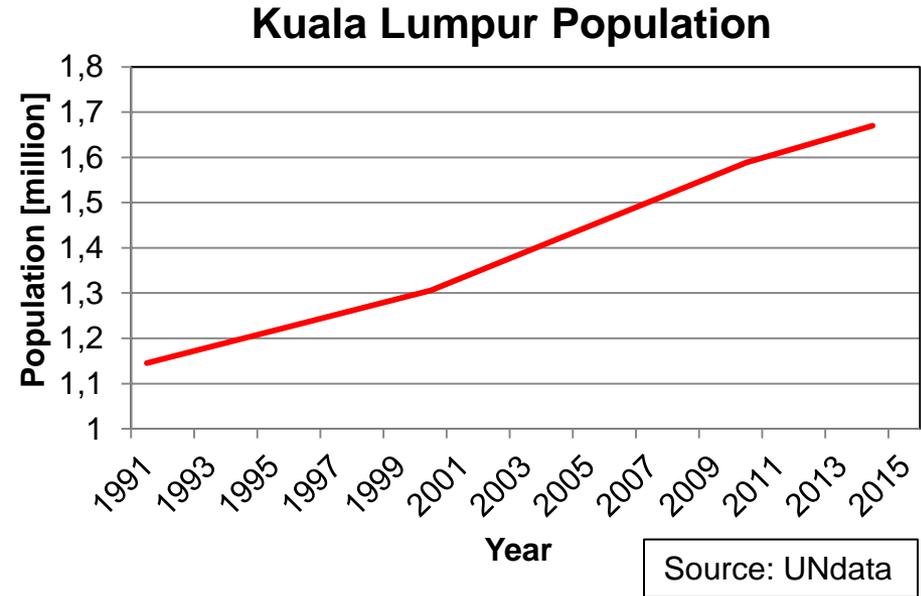
Greenery replaced by Artificial materials

- ❖ To clarify the quantitative mitigation effects of roadside trees on the thermal environment of an urban street canyon
- ❖ To investigate the effects of the density of roadside trees to thermal environment

2. METHODOLOGY



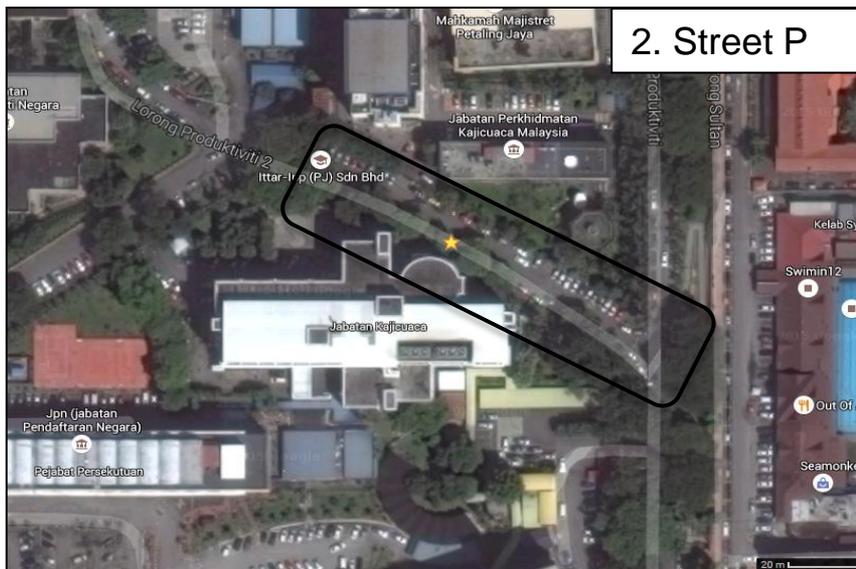
Source: Google Maps



Average temperature	28.2° C
Average sunlight hours/day	6h 6'
Average monthly rainfall	219 mm
Average relative humidity	81%



1. Street R



2. Street P

- ❑ Field measurement at two different street
 1. Jalan Raja Muda Aziz (Street R), and
 2. Jalan Produktiviti (Street P)
- ❑ Street R is located in the capital city of Malaysia, Kuala Lumpur.
- ❑ Street P is located in Petaling Jaya, about 15.5km southwest from Kuala Lumpur
- ❑ Measurement period:
 - Street R – 8th April, 18th May, 0900 to 1330
 - Street P – 28th May, 3rd June, 0900 to 1330

Source: Google Maps

Parameters	Instruments / Measurement Interval
Air Temperature & Relative Humidity	Thermistor thermometer/ capacitive hygrometer sensor (Hobo U12-013) / 1 min
Globe Temperature	Thermistor thermometer (T&D TR-52i) / 1 min
Surface Temperature	IR thermal camera (InfRec) / 1 hour
Solar Radiation	Pyranometer (Kipp&Zonen CMP11) / 1 min
Wind Speed	2-D ultrasonic anemometer (R.M. Young 86000) / 1 min

Jalan Raja Muda Abdul Aziz (Street R)



Fig. Aerial view and measurement points of Street R

Jalan Produktiviti (Street P)

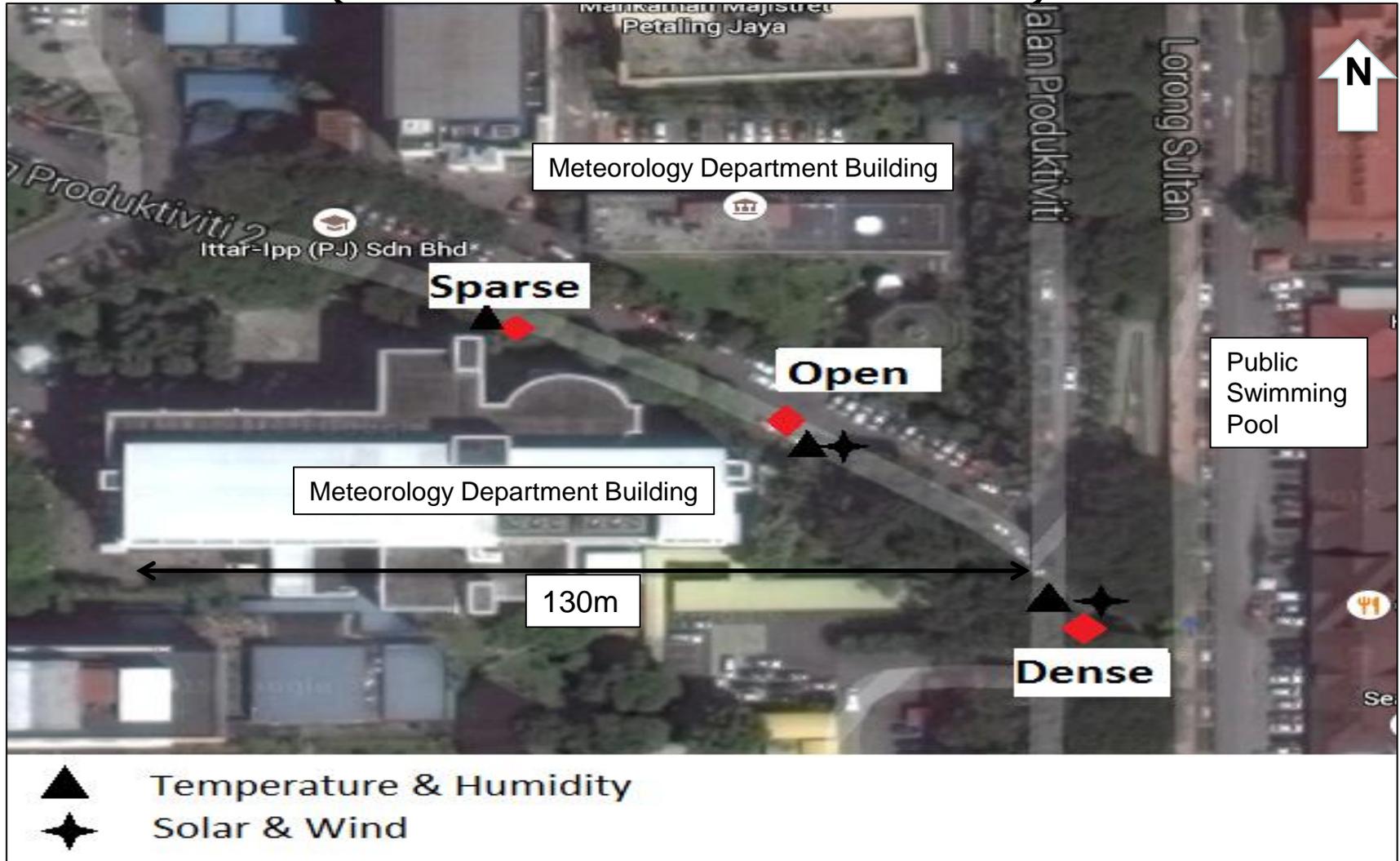
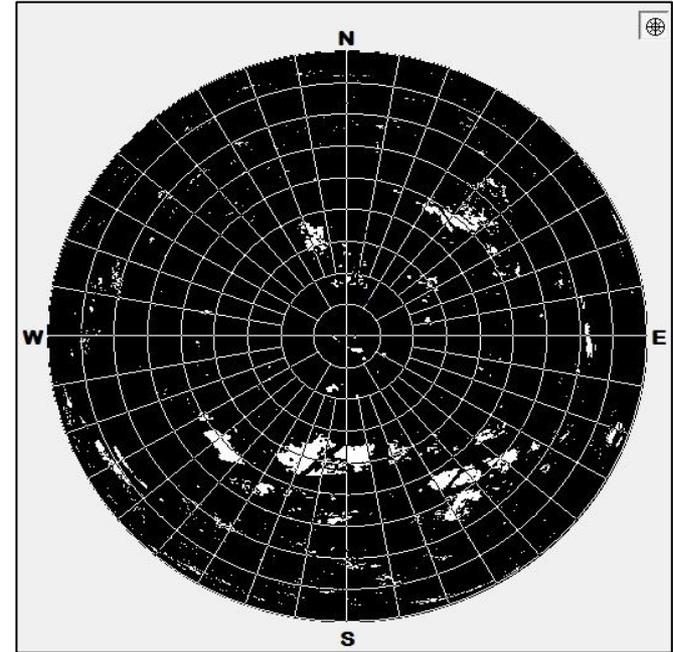
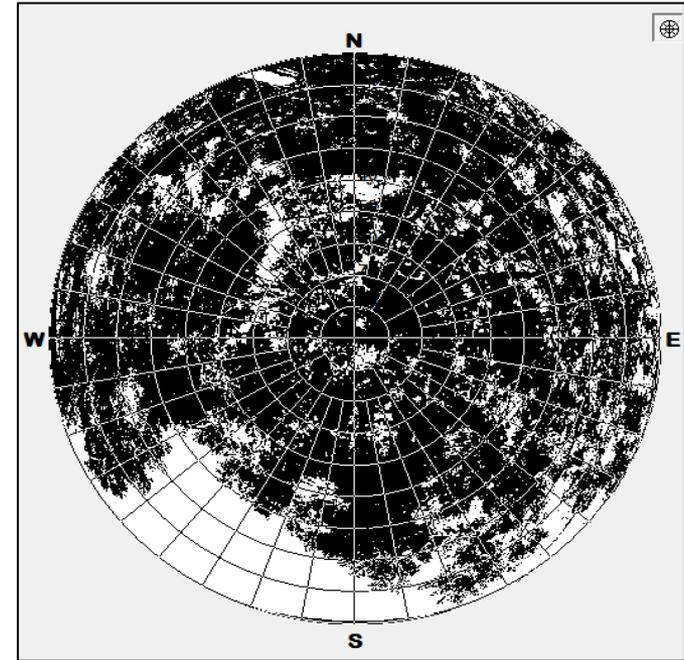


Fig. Aerial view and measurement points of Street P



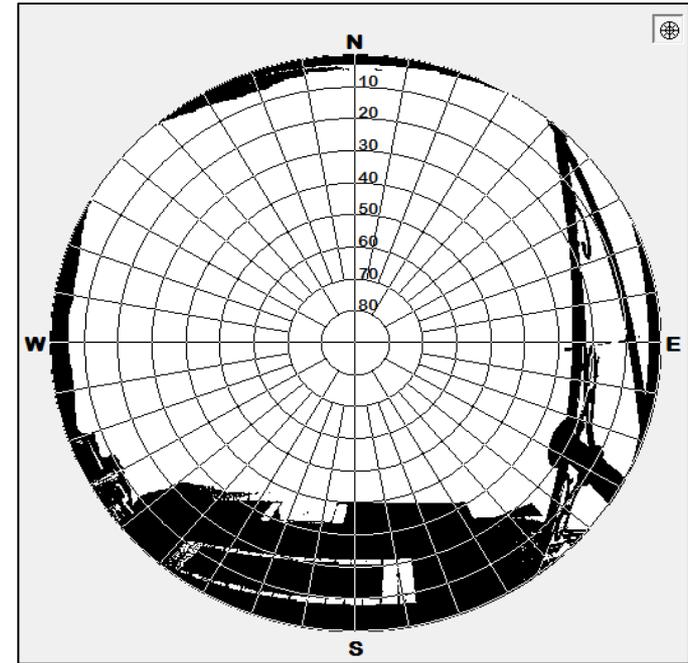
SVF = 0.043

Photo of environment, monochrome fisheye photo, SVF for Street R, dense



SVF = 0.279

Photo of environment, monochrome fisheye photo, SVF for Street R, sparse



SVF = 0.795

Photo of environment, monochrome fisheye photo, SVF for Street R, open

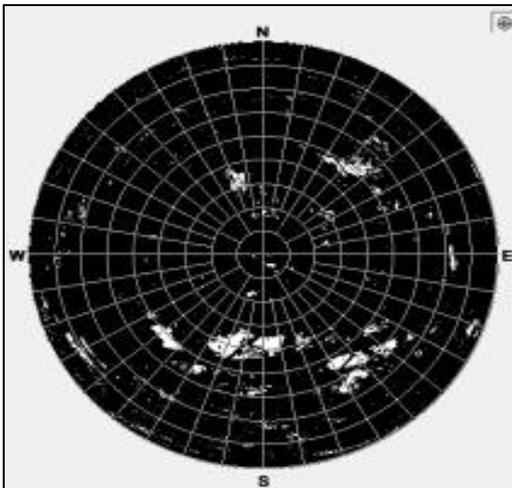
Dense



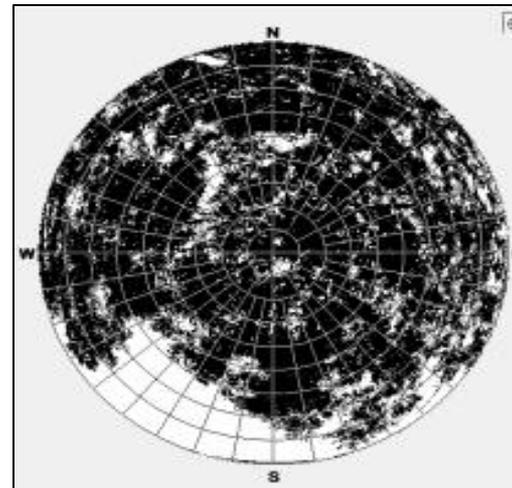
Sparse



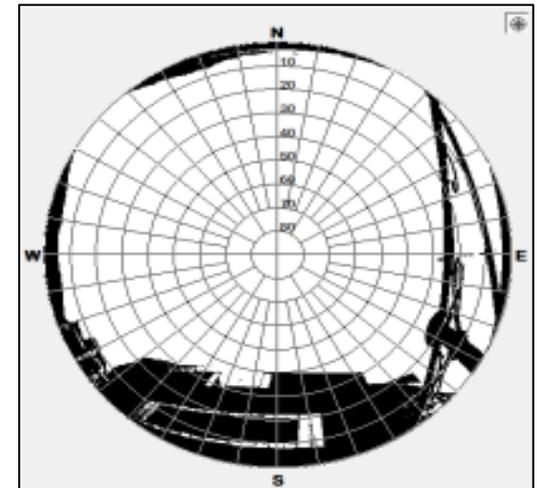
Open



SVF= 0.043

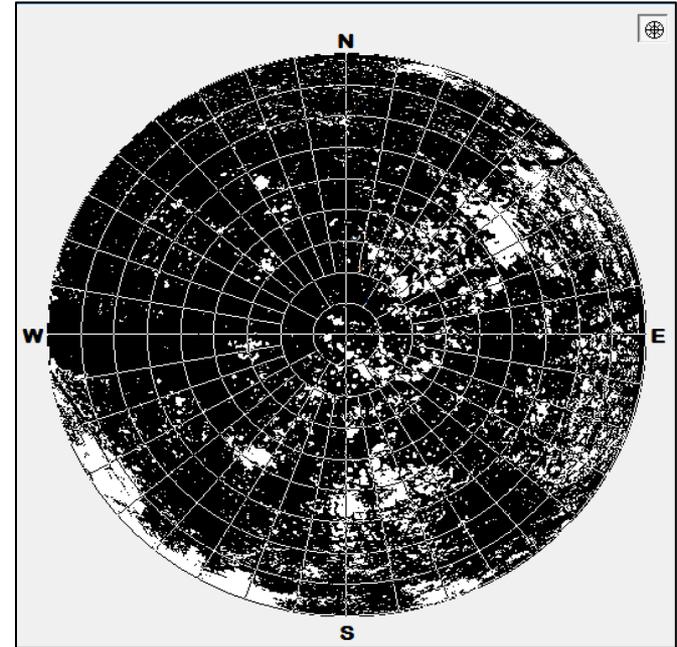


SVF= 0.279



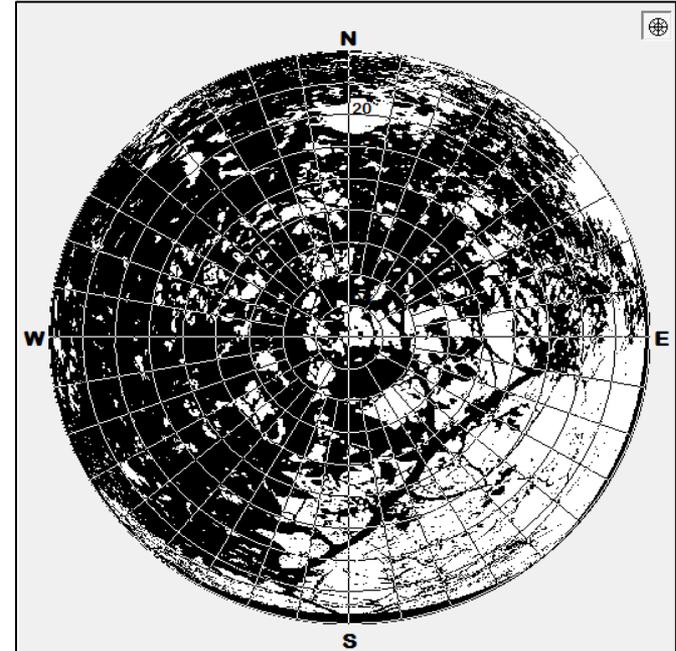
SVF= 0.795

Table : Photo of environment, monochrome fisheye photo, SVF for Street R



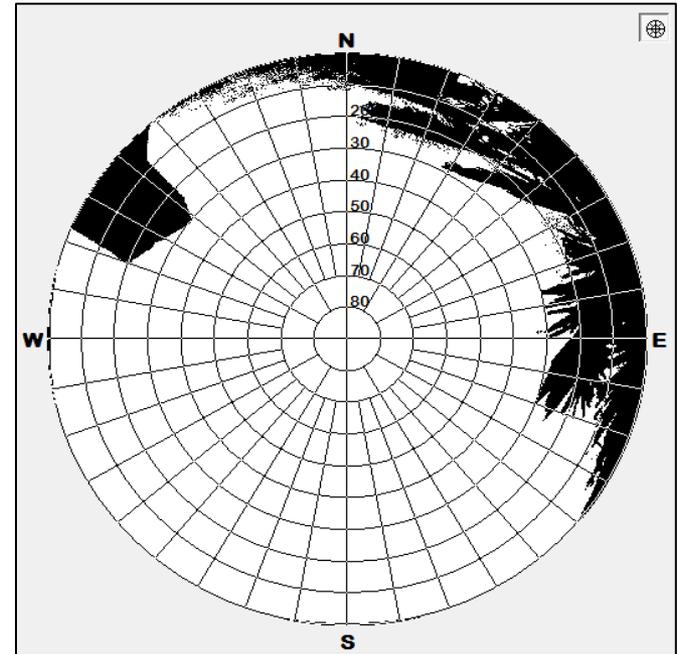
SVF = 0.077

Photo of environment, monochrome fisheye photo, SVF for Street P, dense



SVF = 0.352

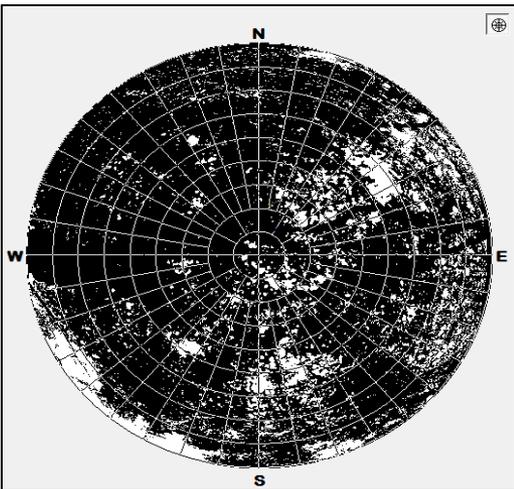
Photo of environment, monochrome fisheye photo, SVF for Street P, sparse



SVF = 0.848

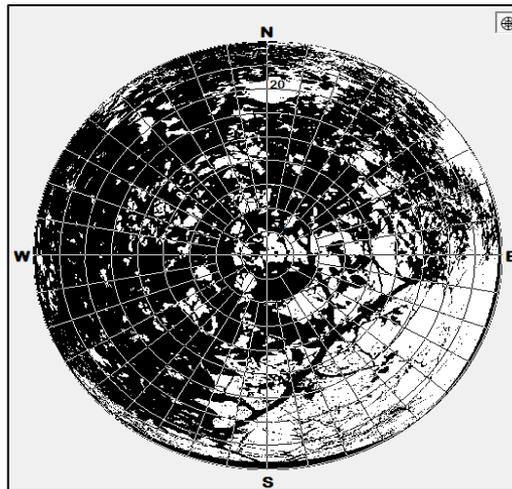
Photo of environment, monochrome fisheye photo, SVF for Street P, open

Dense



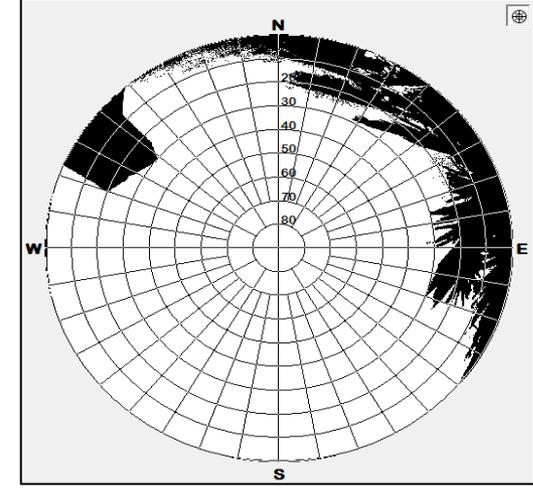
SVF= 0.077

Sparse



SVF= 0.352

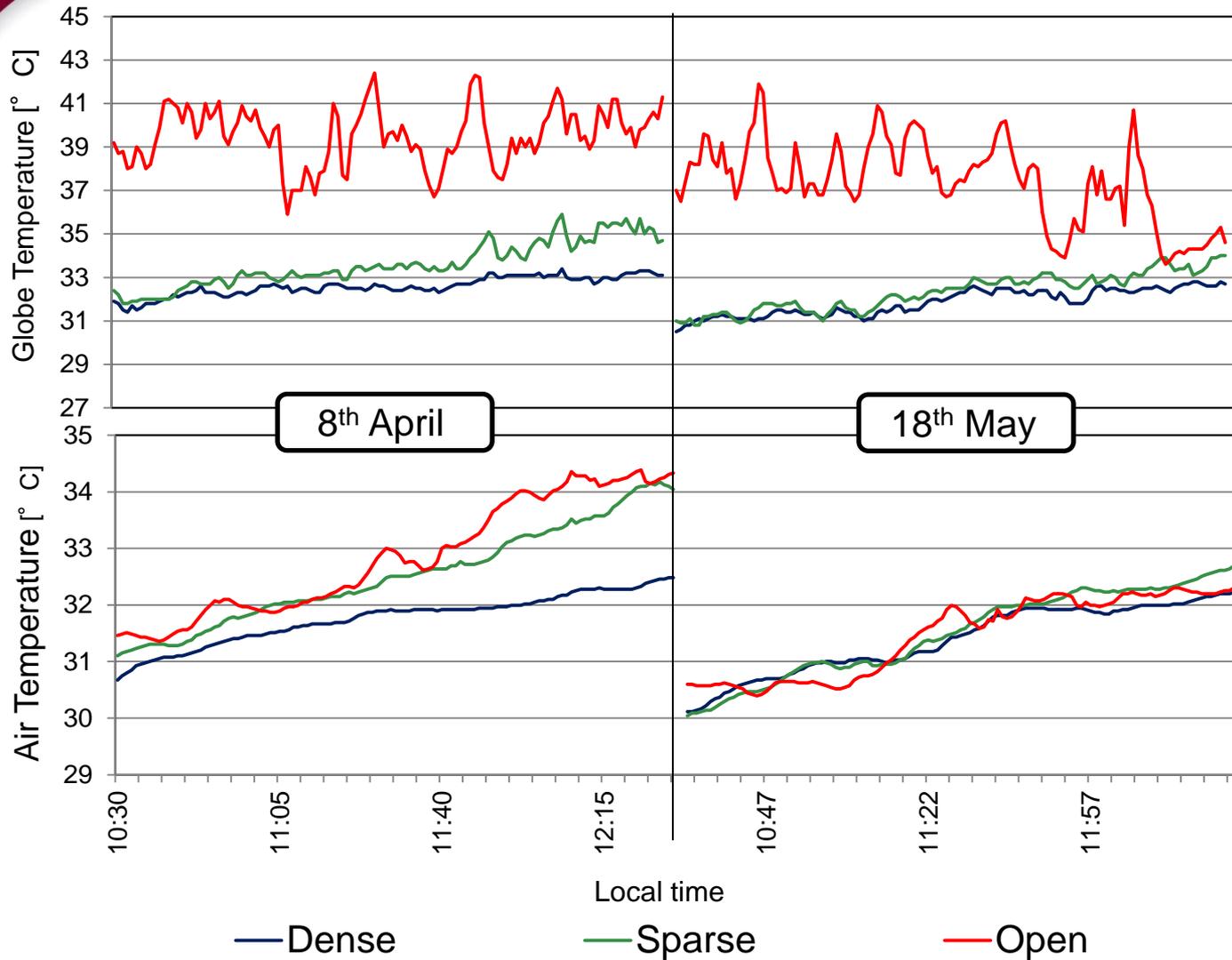
Open



SVF= 0.848

Table : Photo of environment, monochrome fisheye photo, SVF for Street P

3. RESULTS



Dense



Sparse



Open

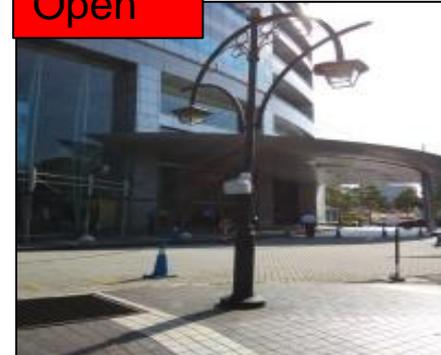


Fig. Globe and air temperature variation for 8th April and 18th May 2015 at Street R

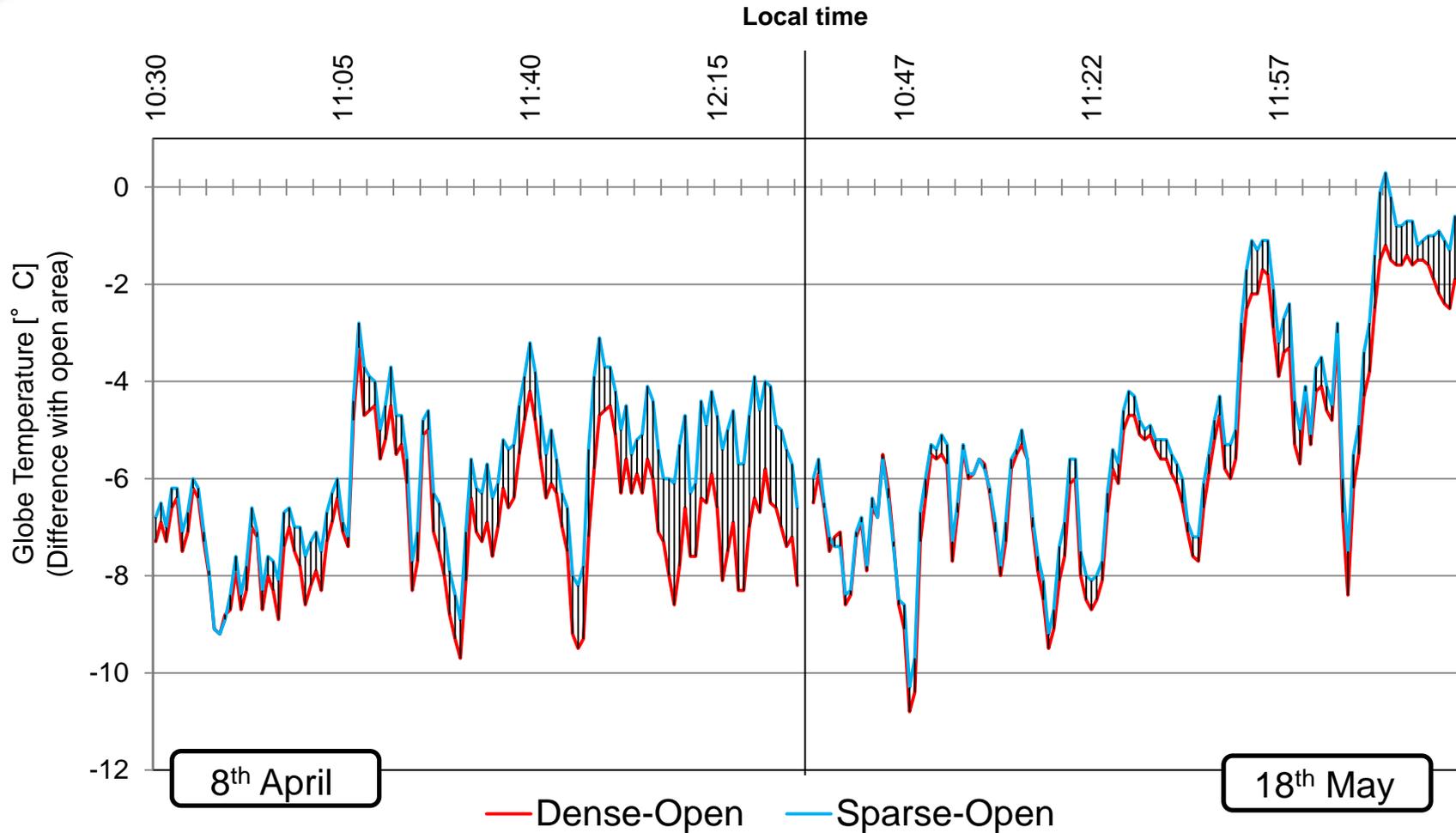
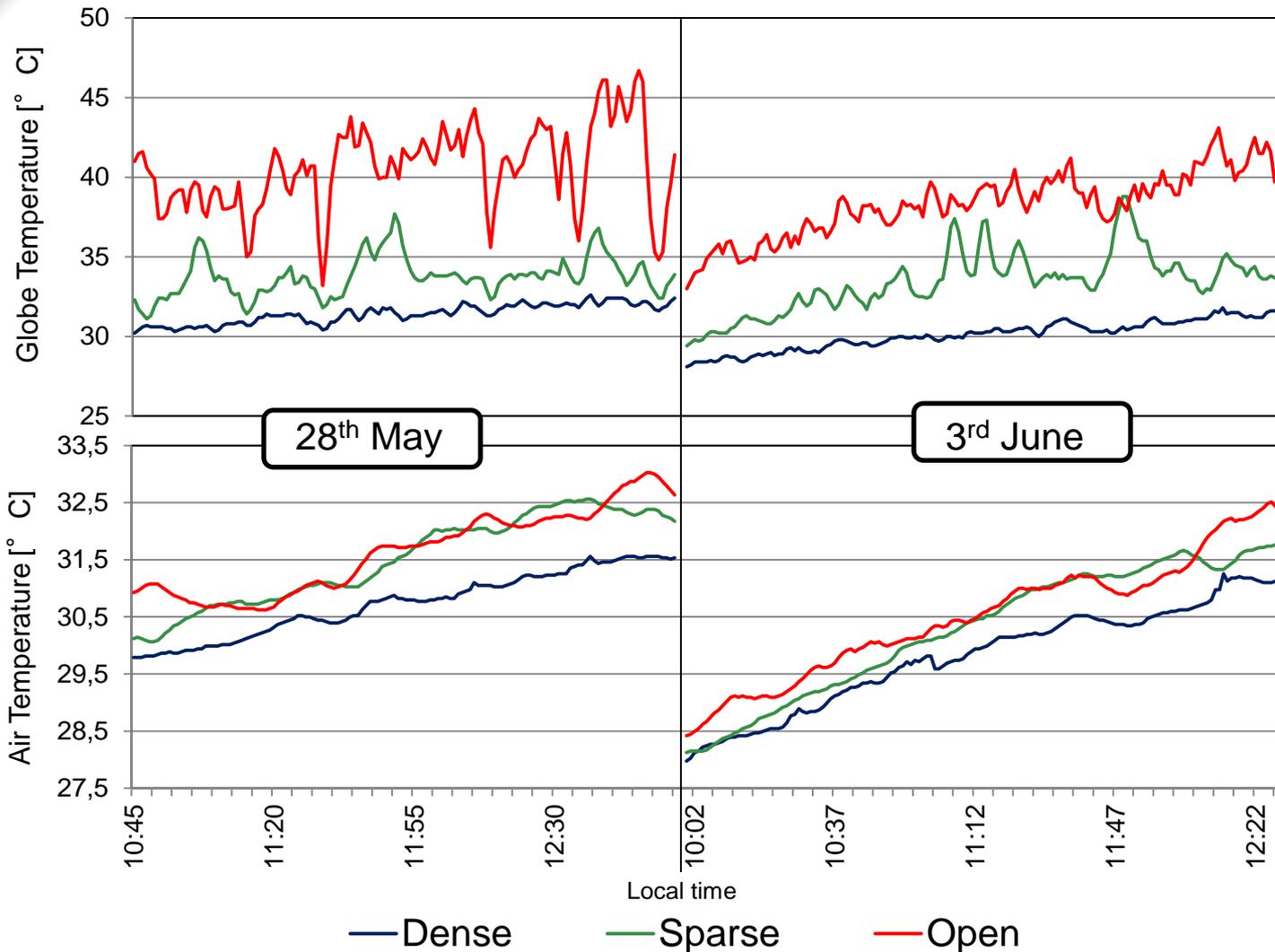


Fig. Globe temperature difference (compared to open area) at Street R on 8th April and 18th May 2015



Dense



Sparse



Open



Fig. Globe and air temperature variation for 28th May and 3rd June 2015 at Street P

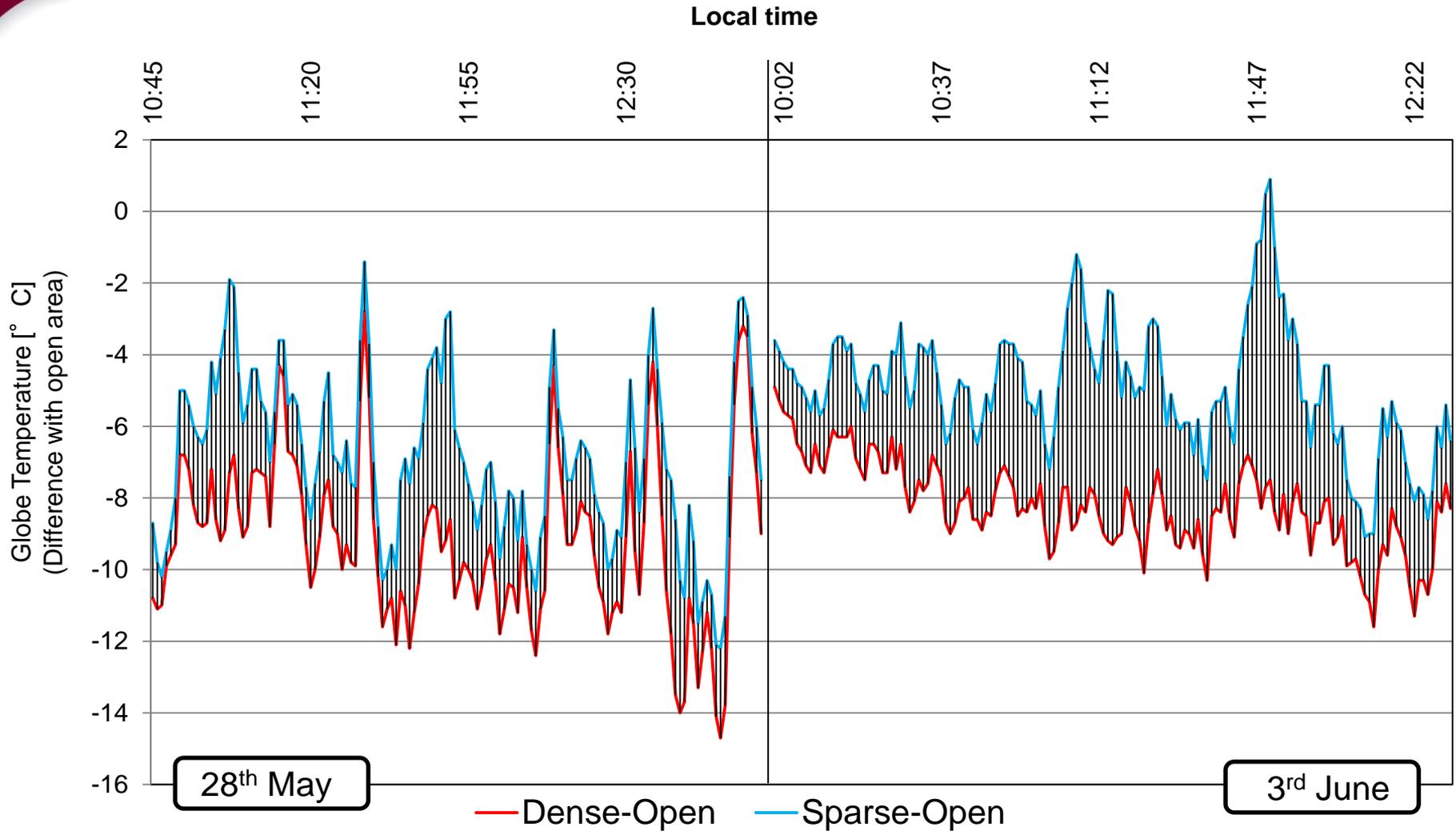
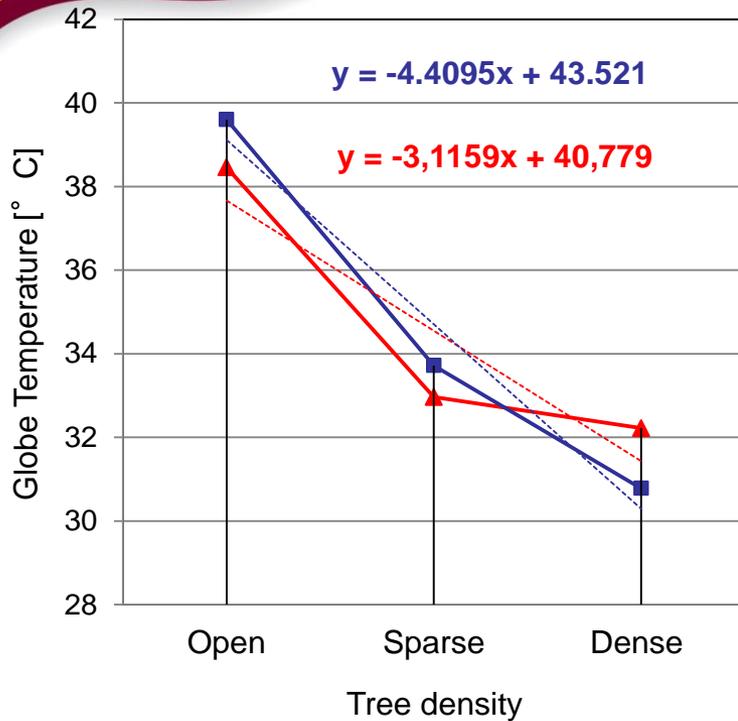
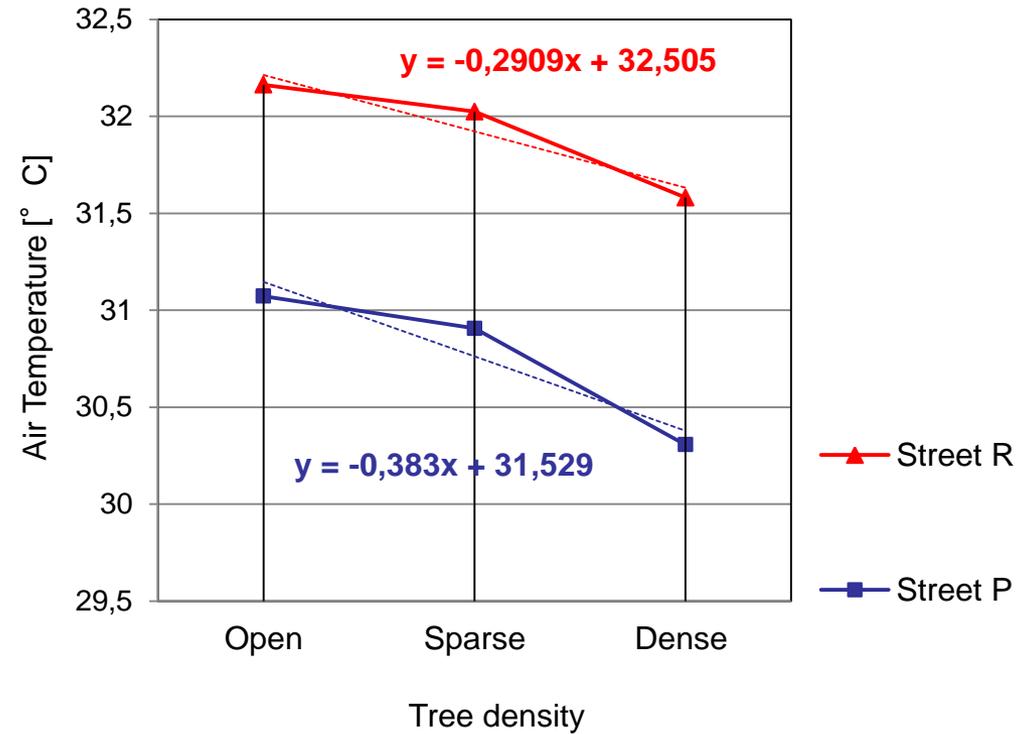


Fig. Globe temperature difference (compared to open area) at Street P on 28th May and 3rd June 2015



Reduction (%) Open-Dense
 Street R: 16.2
 Street P: 22.3



Reduction (%) Open-Dense
 Street R: 1.8
 Street P: 2.5

Fig. Average of globe (left) and air temperature (right) of Street R and Street P at daytime (4 days, 10:30am to 12:30pm)

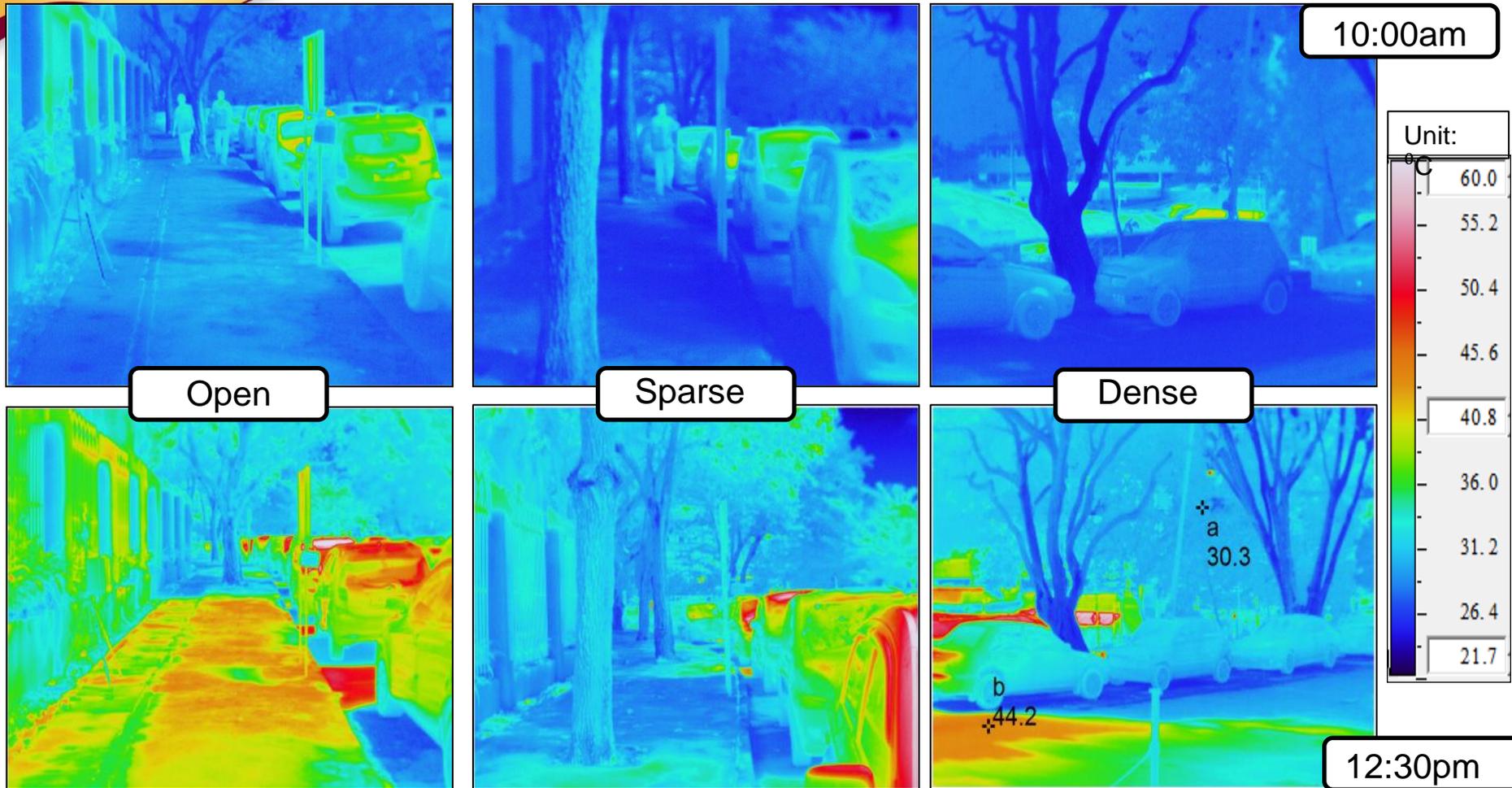
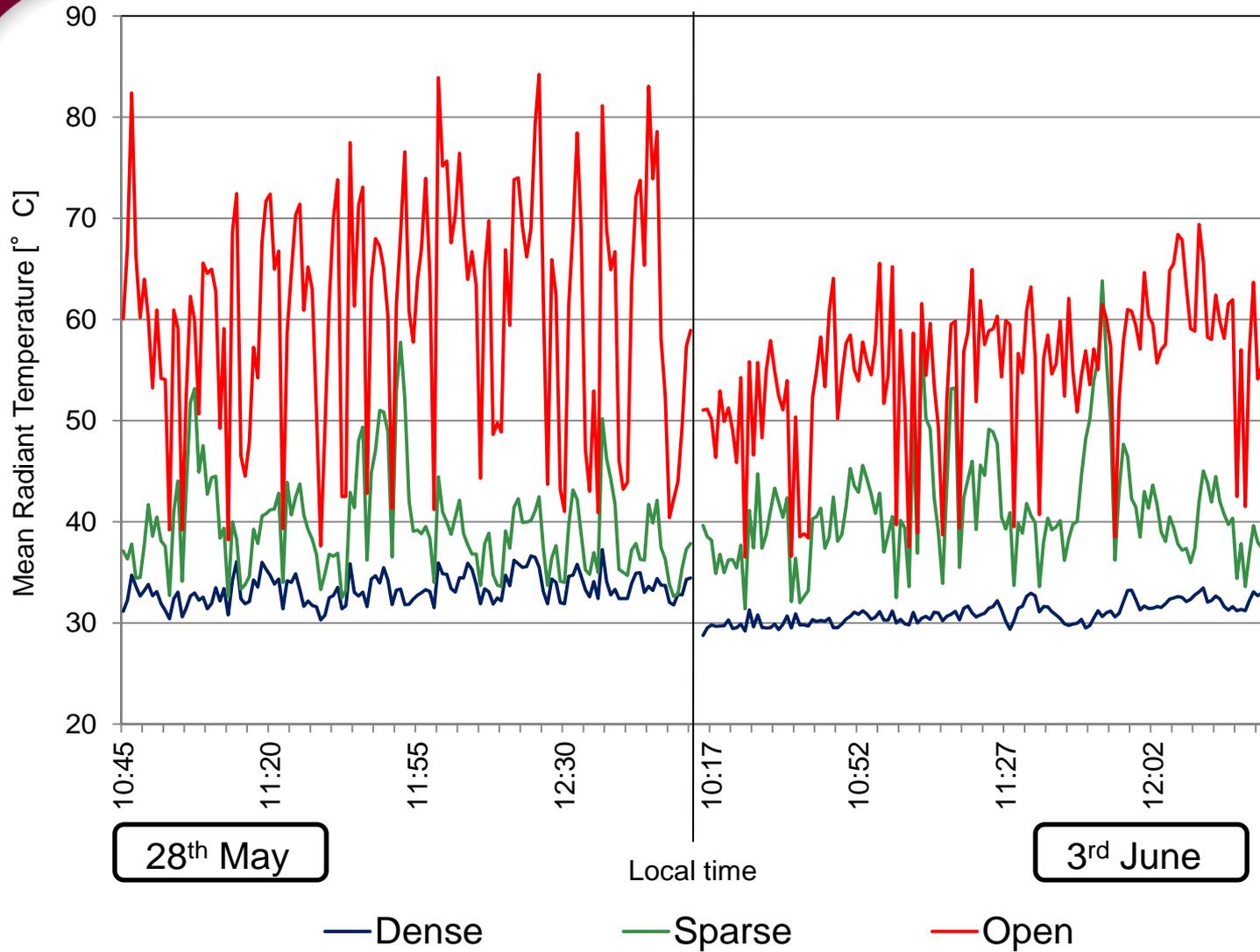


Fig. : Thermal images of Street P at 10:00am (top row) and 12:30pm (bottom row) on 3rd June (point (a) refers to tree crown surface temperature, (b) refers to road surface temperature [°C])



Dense



Sparse



Open



Fig. Mean radiant temperature variation for 28th May and 3rd June 2015 at Street P

1. The mitigation effects of roadside trees are revealed on the decrease of globe temperature (up to 14.7⁰C) and MRT over three different tree density when compared in this study. However, the effects of trees on air temperature are lower (difference <3.8% or 1.5⁰C even at peak hour).
2. The cooling effects (reduction of globe temperature of 22.3% at Street P) of roadside trees are mainly contributed from the shading and transpiration of trees.
3. Effect of transpiration was indirectly shown by thermal images taken at 12:30am at street P. Under dense tree condition, the surface temperature of the tree crown (a) was about 14⁰ C lower than that of ground (b), similar with the air temperature (within $\pm 2^{\circ}$ C).

Southwest monsoon	May	June	July	August	September
Northeast monsoon	November	December	January	February	March

- ❖ Next field measurement target:
 - August/September- field measurement at residential area
 - November/December- field measurement in different monsoon season (rainy weather)
- ❖ Wind speed reduction under tree canopy, comparing to different tree density.



Fig: Cheras, KL

Thank you for listening... 30