

# 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

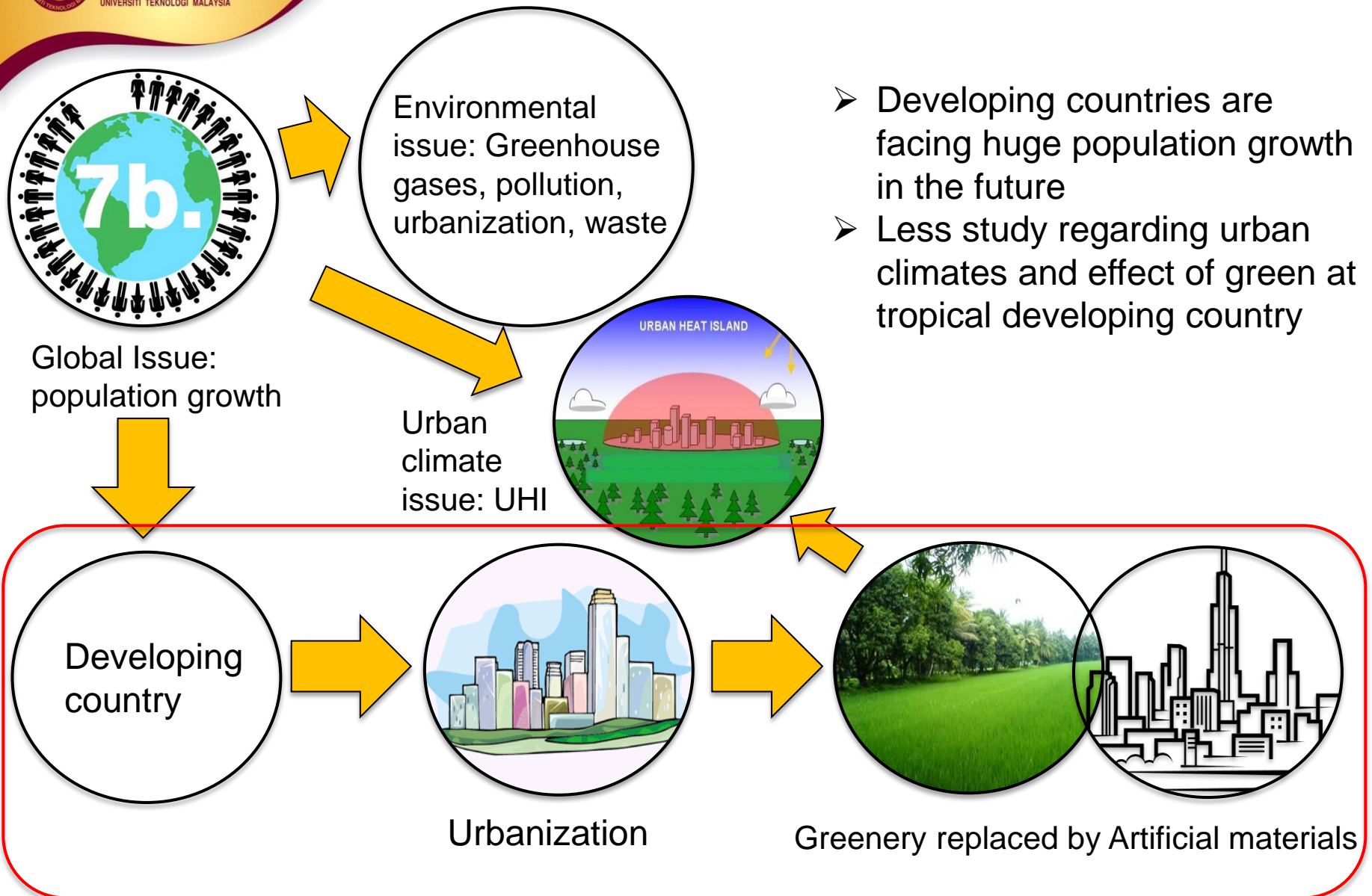
relatively drier weather

Northeast Monsoon

November-March

heavy rainfall

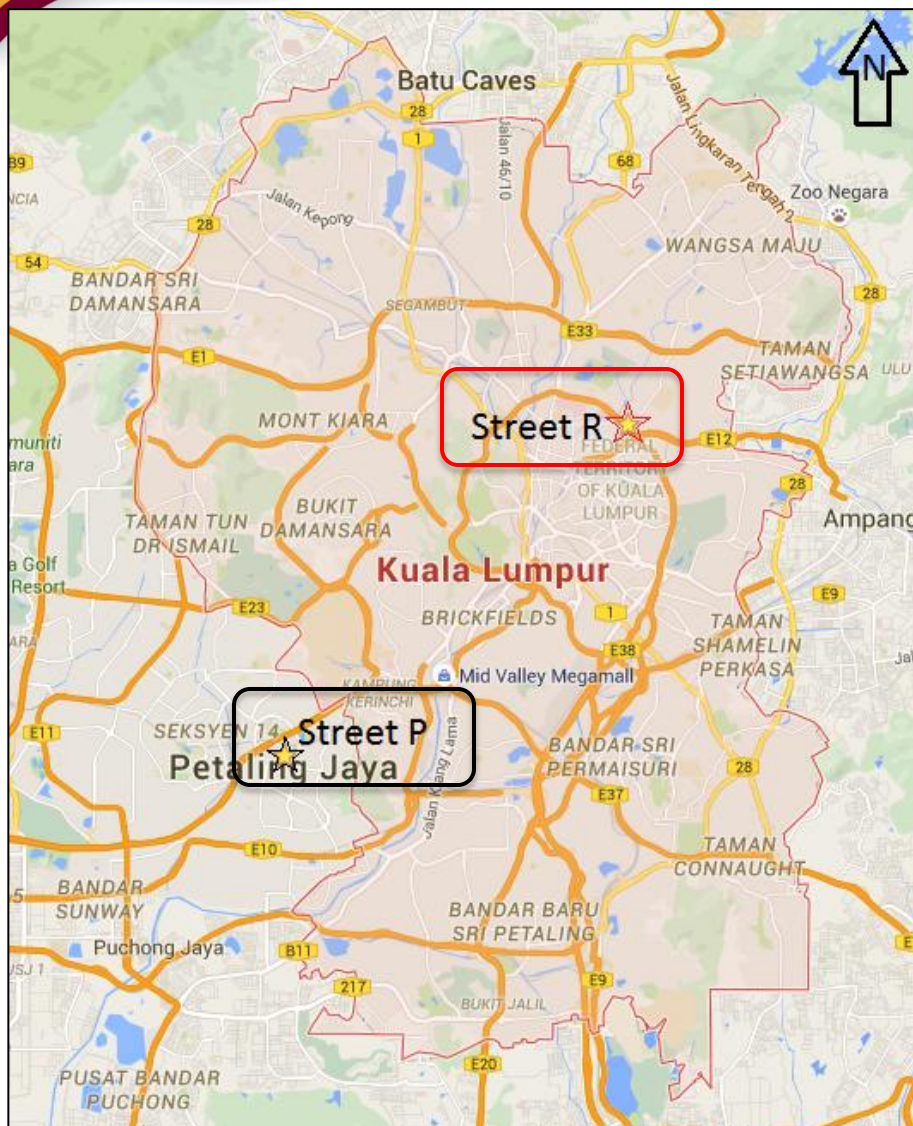
# RESEARCH MOTIVATION



- ❖ 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

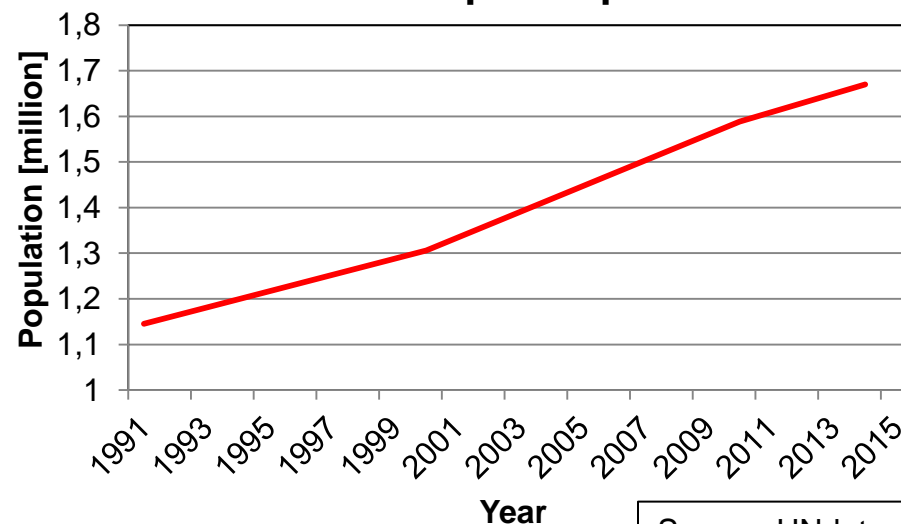
## 2. METHODOLOGY





Source: Google Maps

## Kuala Lumpur Population

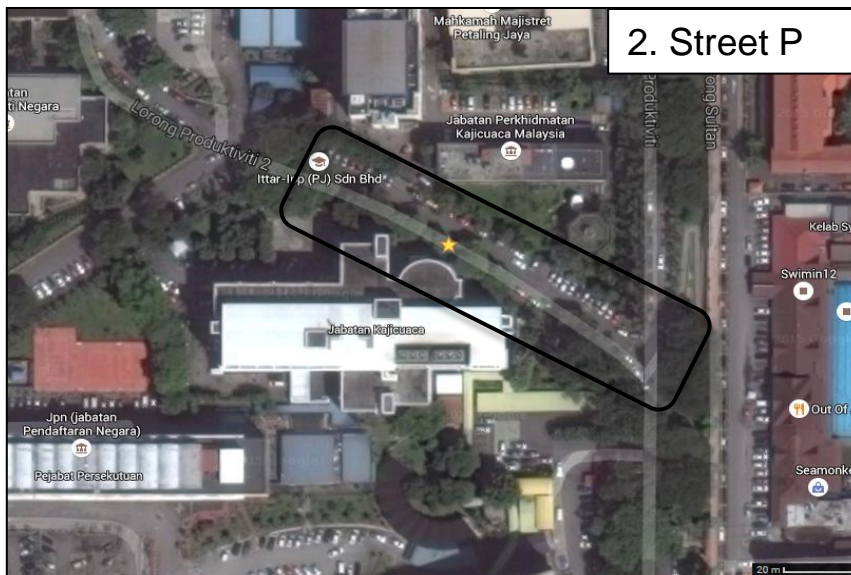


Average temperature	28.2° C
Average sunlight hours/day	6h 6'
Average monthly rainfall	219 mm
Average relative humidity	81%





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 – 8<sup>th</sup> April, 18<sup>th</sup> May, 0900 to 1330
  - Street P – 28<sup>th</sup> May, 3<sup>rd</sup> June, 0900 to 1330

Source: Google Maps

# FIELD MEASUREMENT PARAMETERS

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

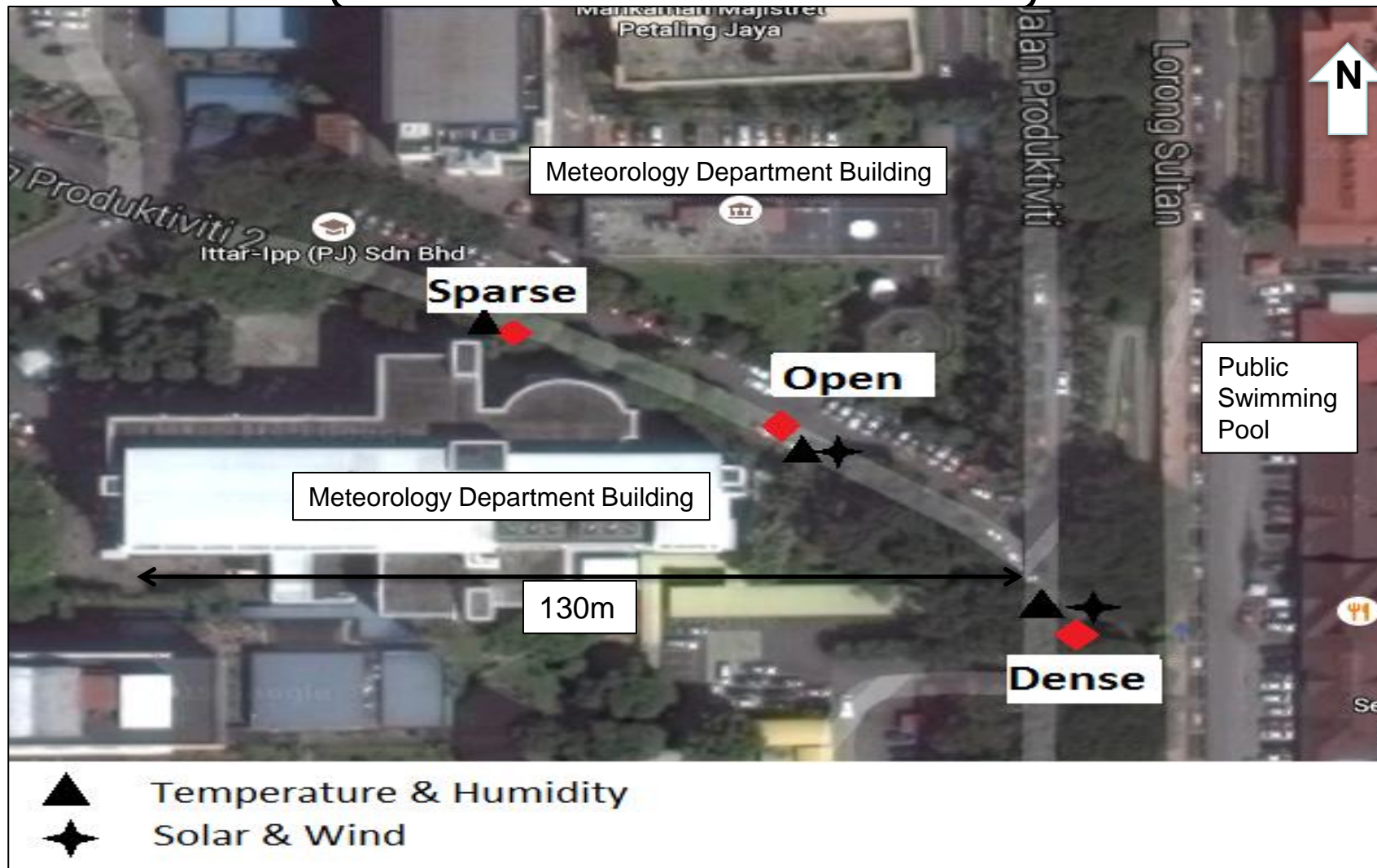
Jalan Raja Muda Abdul Aziz (Street R)



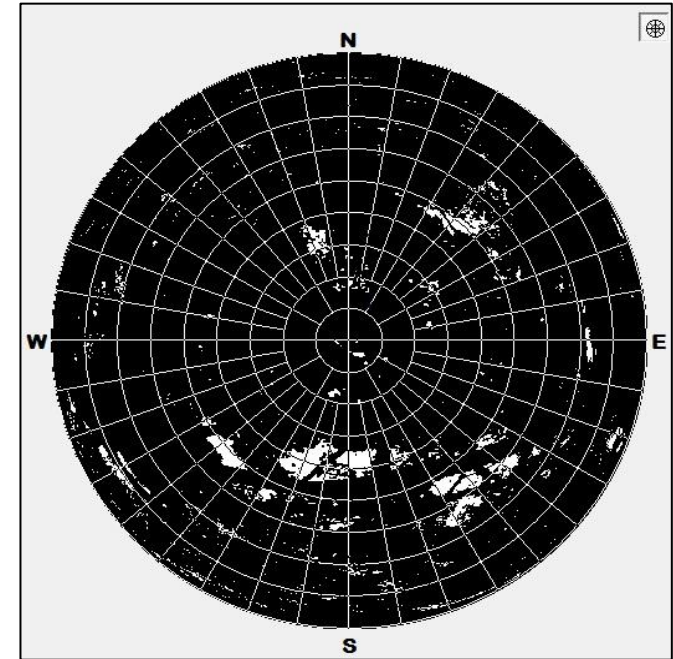
*Fig. Aerial view and measurement points of Street R*



## Jalan Produktiviti (Street P)



*Fig. Aerial view and measurement points of Street P*

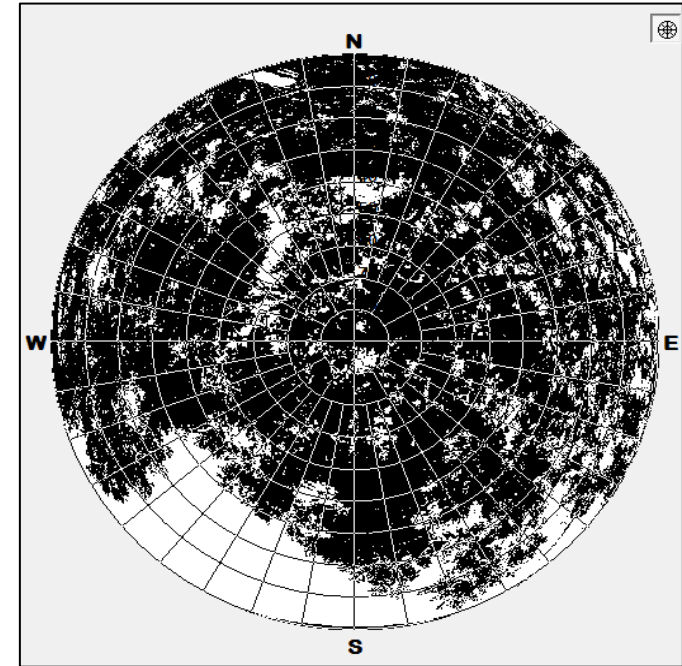


SVF = 0.043

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

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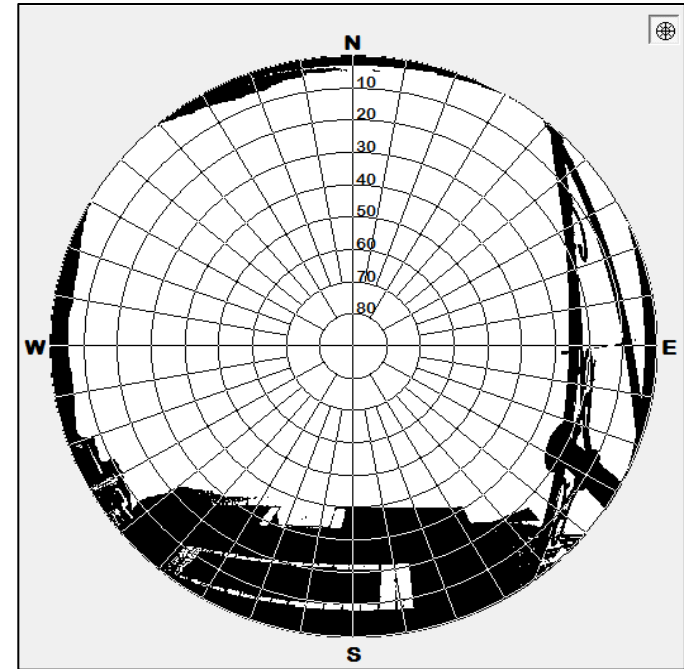




SVF = 0.279

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

14

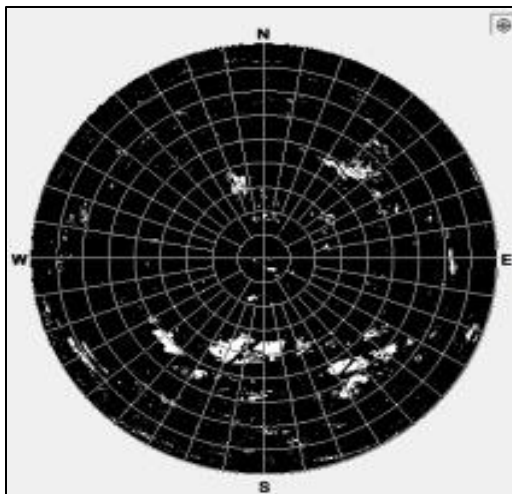


SVF = 0.795

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

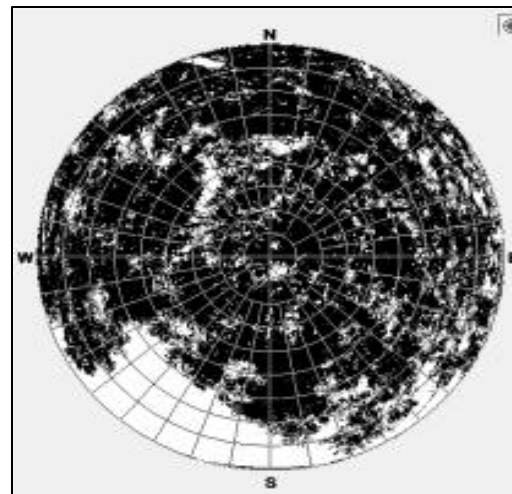


**Dense**



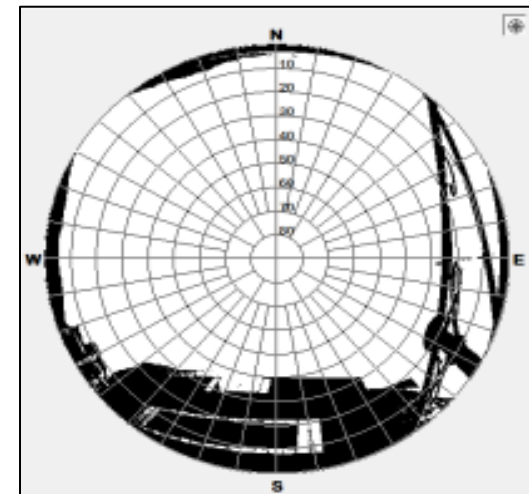
SVF= 0.043

**Sparse**



SVF= 0.279

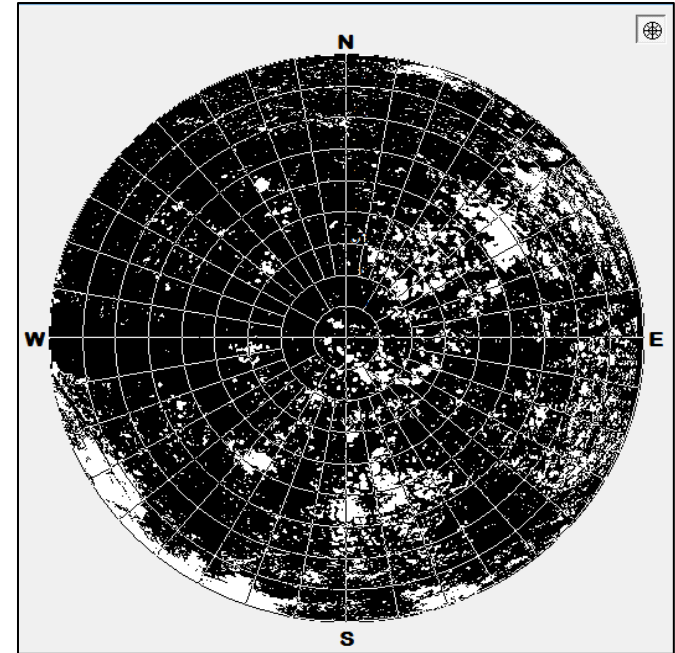
**Open**



SVF= 0.795

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

16

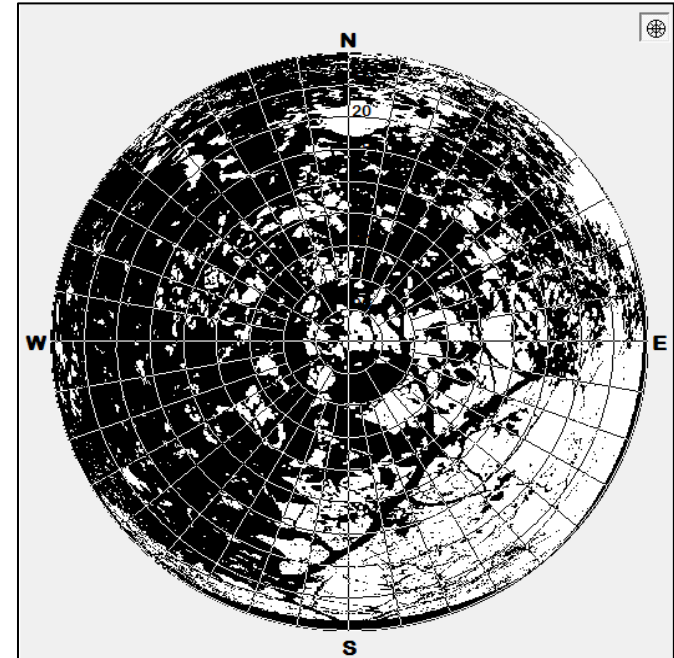


SVF = 0.077

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

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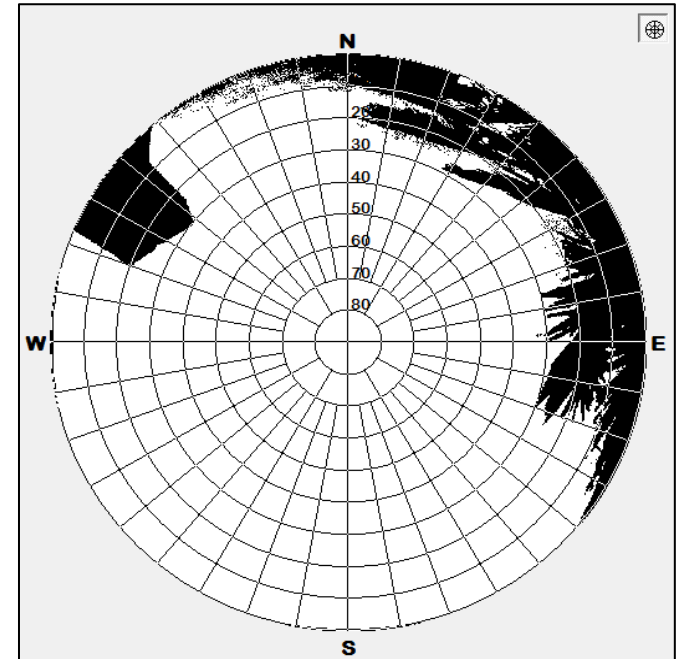


SVF = 0.352

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

18

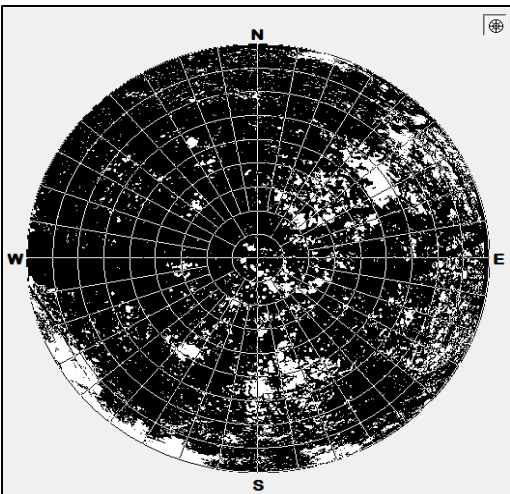




SVF = 0.848

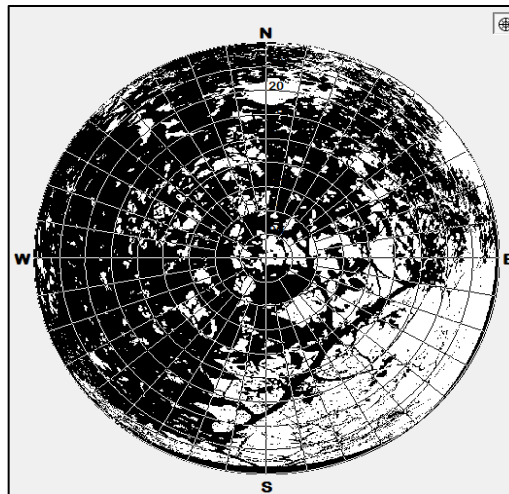
Photo of environment, monochrome fisheye photo, SVF for Street P, open

**Dense**



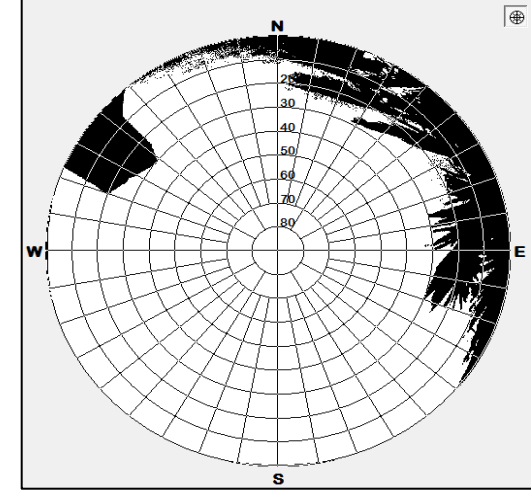
SVF= 0.077

**Sparse**



SVF= 0.352

**Open**



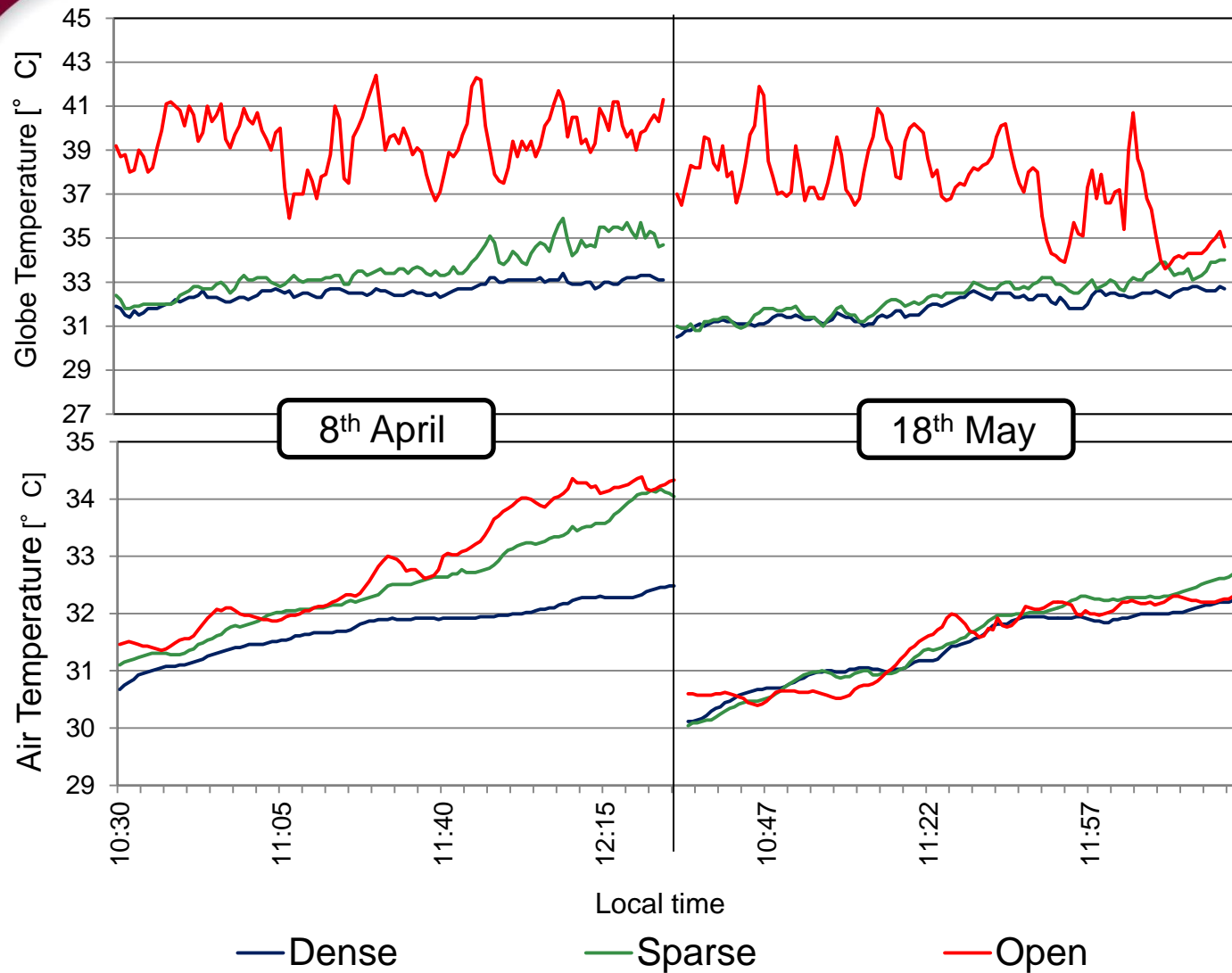
SVF= 0.848

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

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## 3. RESULTS





Dense



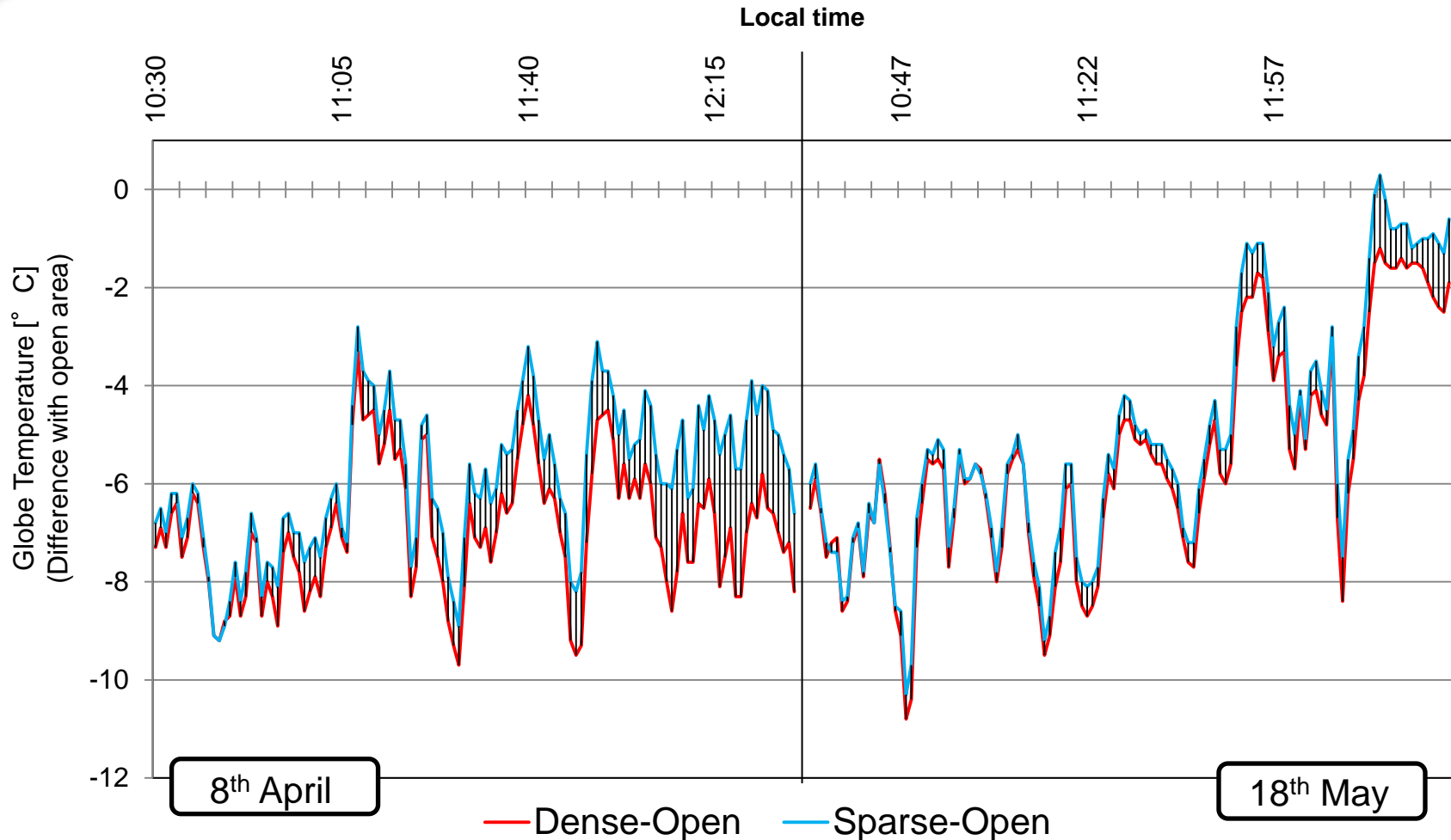
Sparse



Open

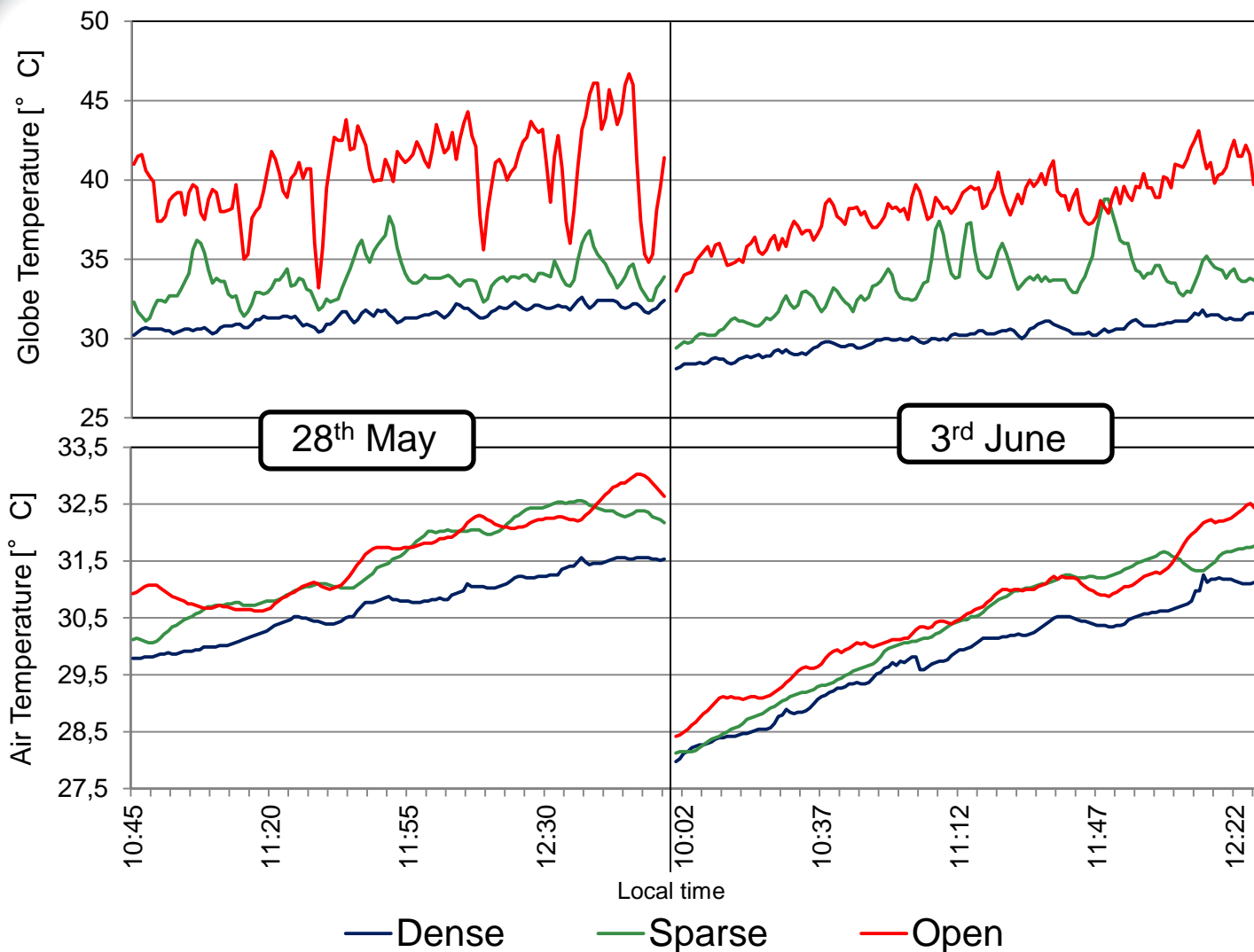


Fig. Globe and air temperature variation for 8<sup>th</sup> April and 18<sup>th</sup> May 2015 at Street R



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





Dense



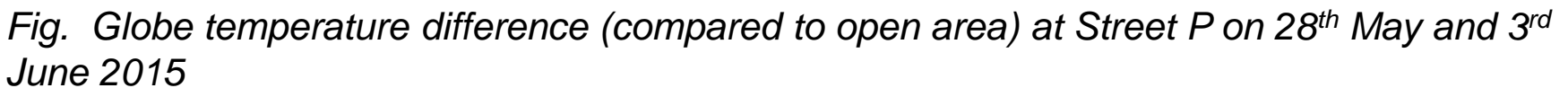
Sparse

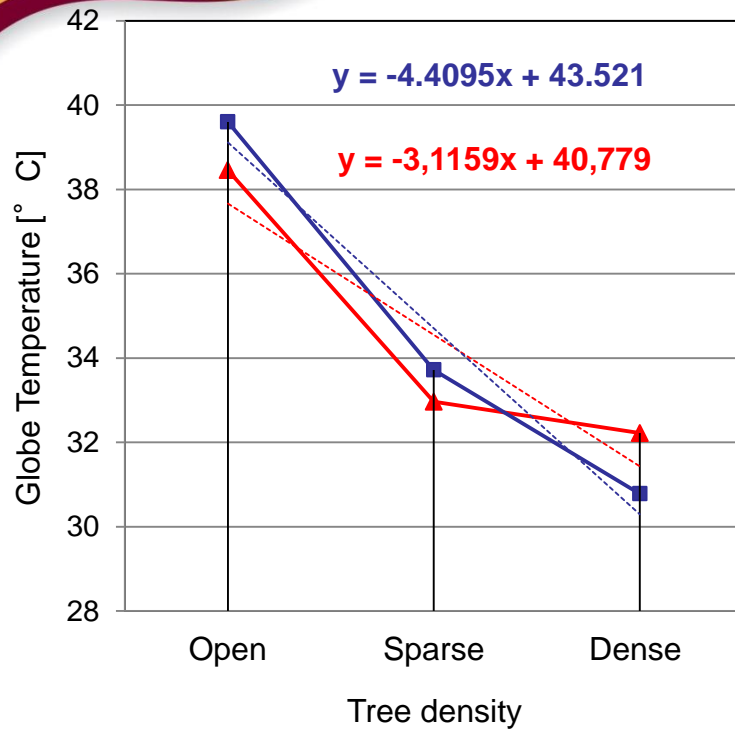


Open

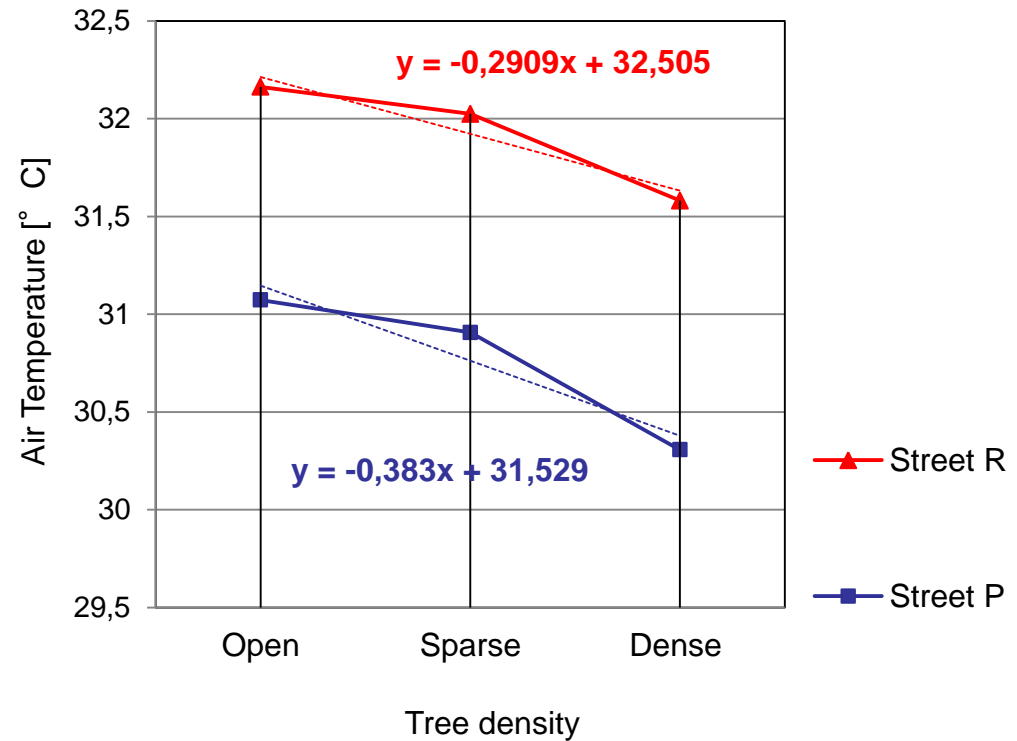


Fig. Globe and air temperature variation for 28<sup>th</sup> May and 3<sup>rd</sup> June 2015 at Street P



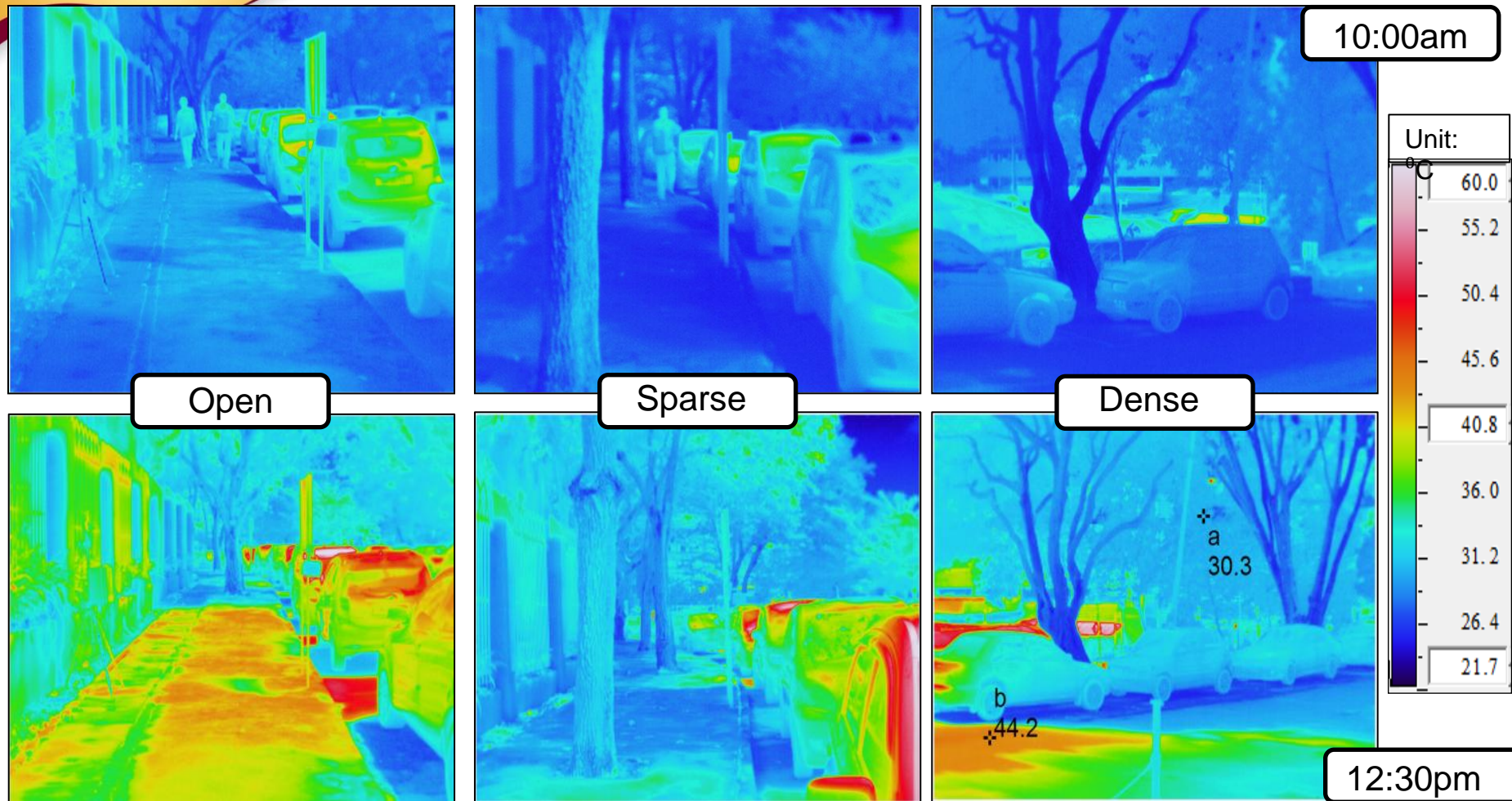


Reduction (%) Open-Dense  
 Street R: 16.2  
 Street P: 22.3



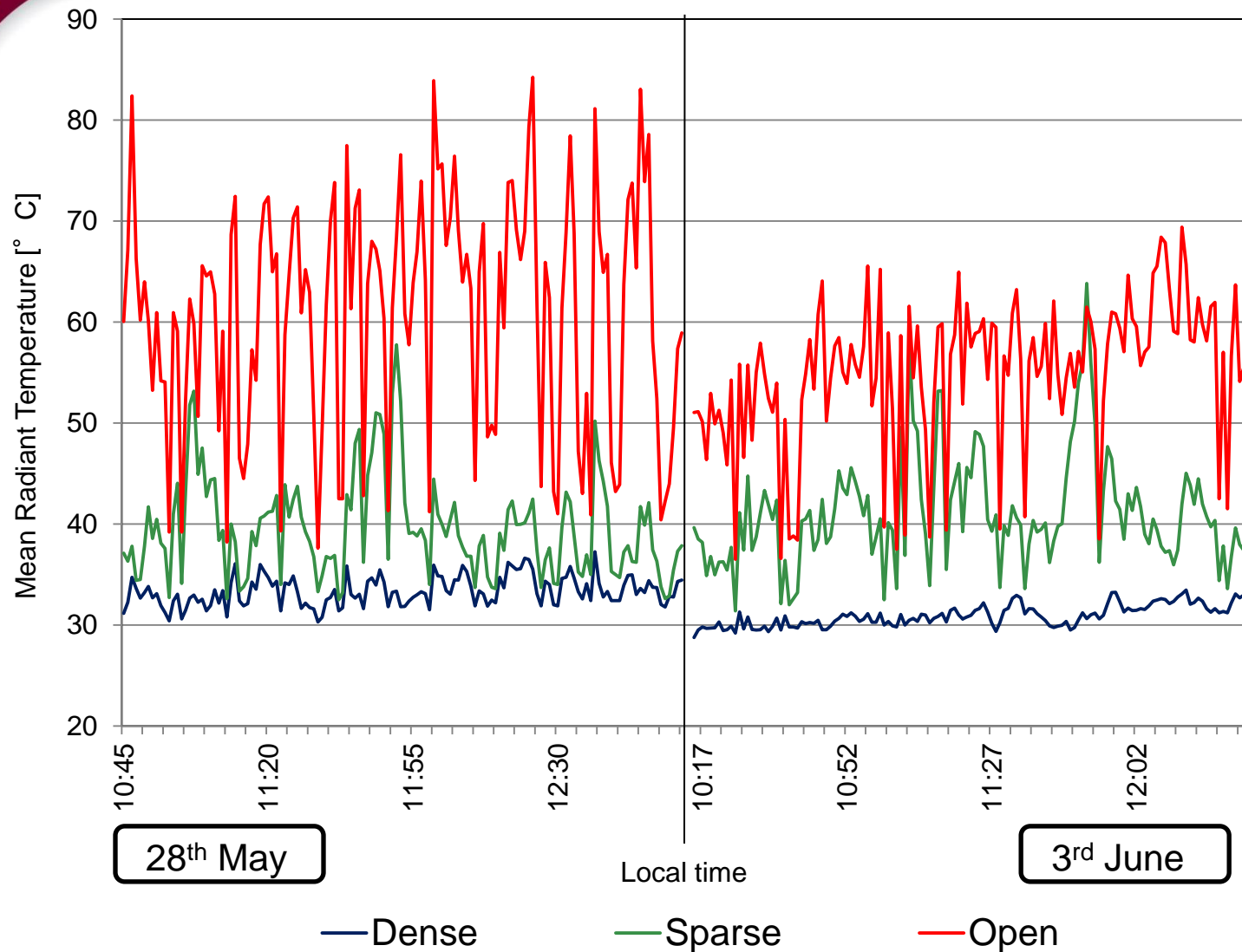
Reduction (%) Open-Dense  
 Street R: 1.8  
 Street P: 2.5

*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 3<sup>rd</sup> 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 28<sup>th</sup> May and 3<sup>rd</sup> June 2015 at Street P



1. The mitigation effects of roadside trees are revealed on the decrease of globe temperature (up to  $14.7^{\circ}\text{C}$ ) 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  $1.5^{\circ}\text{C}$  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  $14^{\circ}\text{C}$  lower than that of ground (b), similar with the air temperature (within  $\pm 2^{\circ}\text{C}$ ).

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