The Impact of Urban Green Spaces on Urban Climate during Heat Events:

A Case Study on Urban Green Spaces in Melbourne

Asieh Motazedian, Andrew Coutts, Nigel Tapper

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Melbourne Sky View. Ref: https://www.flickr.com/photos/al-binali/5287520242/in/photostream/

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Introduction- Why is it important?

Heatwaves can take life!

The health impacts of January 2014 heatwave in Victoria.
Ref: http://www.health.vic.gov.au/environment/heatwaves-publications.htm

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Introduction- what do we know?

Vegetation as urban heat mitigation strategies

Mitigating urban air temperatures and improving Human **T**hermal Comfort

Ref: http://www.international.swinburne.edu.au/resources/images

The value of park-induced coolness is referred to as the park cool island **(PCI) effect.**

Parameters influencing the PCI effect- Micro scale

1. Irrigation
2. Meteorological conditions
3. Characteristics of the green area

(i.e. its size, type and the amount of existing vegetation in the green space)

4. Topography of the surroundings
   - Geometry of the surrounding streets
   - Height of the buildings
5. Other factors affecting PCI that require further study
   - Spatial distribution of trees
   - various types of trees

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Introduction

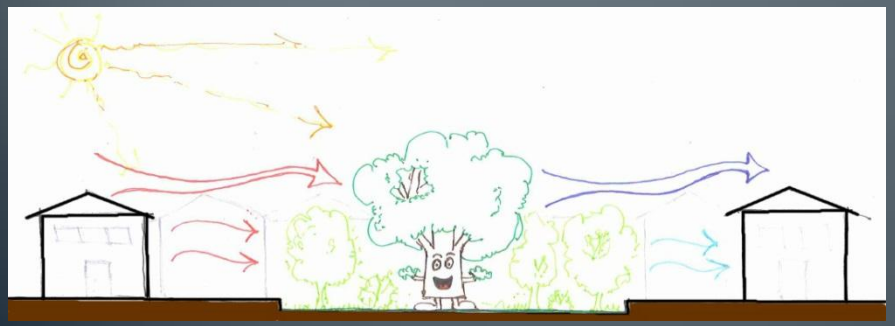
Research Objective

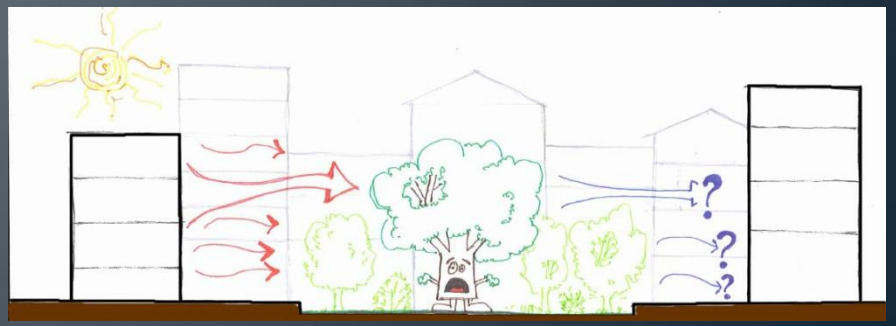
- **The aim** of this study is to investigate the interaction between a small urban park and its surrounding built environment in relation to the park characteristics and surrounding urban design with a particular focus on air temperature profile and human thermal comfort inside and outside of the park.

Research Question

1. What are the important parameters influencing the climatic and bio-climatic interactions between a park and its surrounding urban environment?

2. To what extent the park is able to modify the microclimate of its surroundings, according to the urban densities around it?





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Methodology

Site selection…

- **Step A** Long-term field measurement
- **Step B** Short-term field measurements

Study site- An expanded central city. Ref: Department of transport, planning and local

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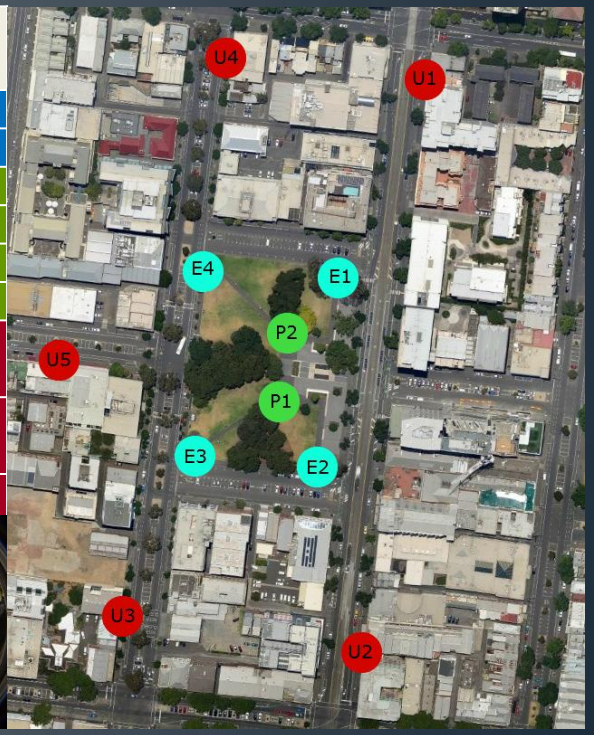
Methodology- weather stations

SVF is known to influence the microclimate

Station	Location	SVF	Sun exposure
P1	Middle of the park	0.425	Sunrise-1300h
P2	Middle of the park	0.507	All day
E1	North-East park edge	0.288	1000h-1200h
E2	South-East park edge	0.560	All day
E3	South-West park edge	0.756	All day
E4	North-West park edge	0.588	All day
U1	North-South street-left side	0.289	1200h-Sunset
U2	North-South street-left side	0.360	1100h-Sunset
U3	North-South street-right	0.338	Sunrise-1300h



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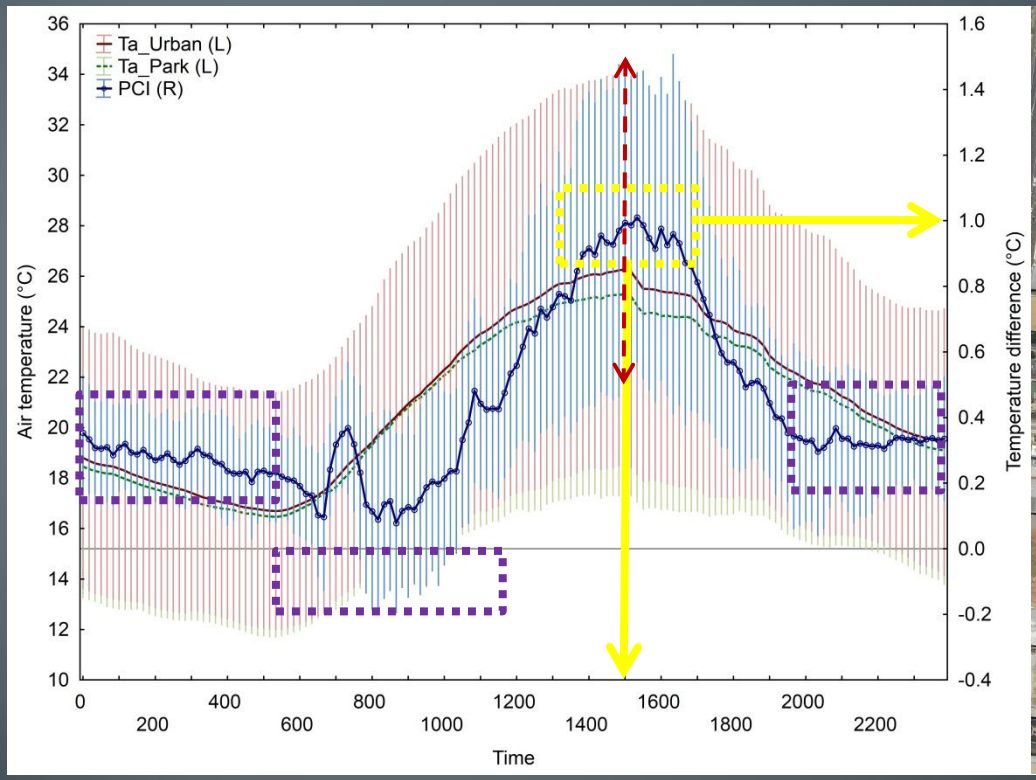
Step A- Results

The Park-built interaction during warm summer conditions- PCI



Monthly averaged air temperature in the park and the surrounding canyons.

Study site. Ref: nearmaps

The park was on average cooler than its surrounding urban environment with the maximum PCI reaching up to 1.0°C, during the peak daytime heating.

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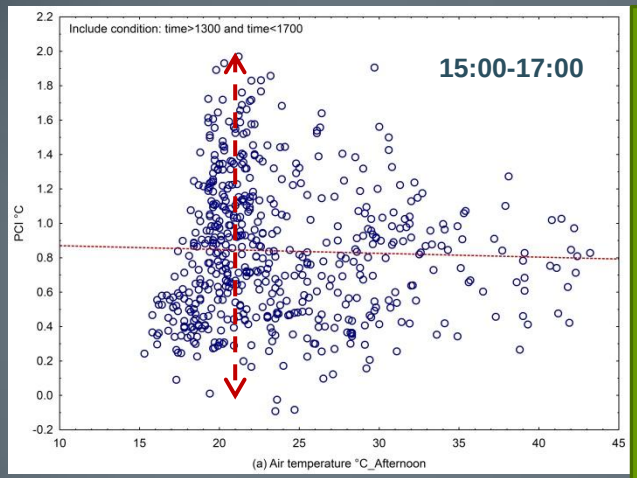
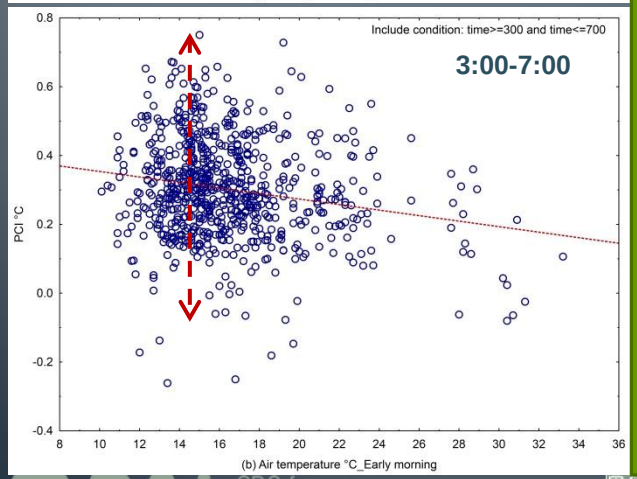
Step A- Results

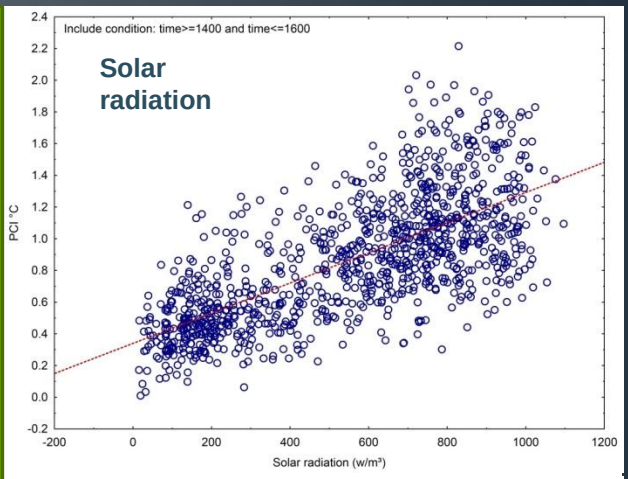
Drivers of variability in the intensity of the PCI

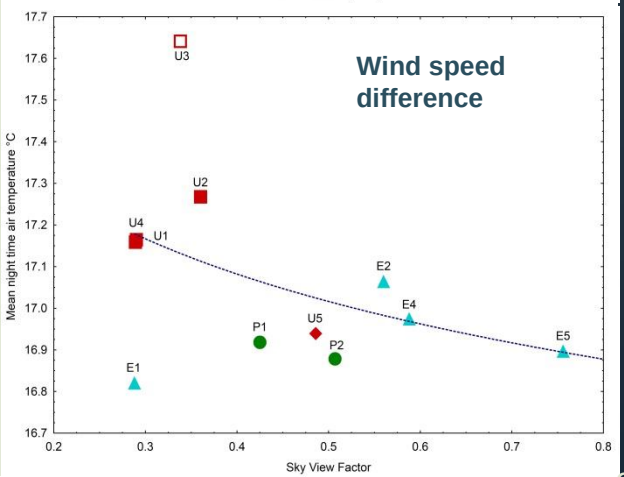




The diurnal variability in PCI depends on both meteorological conditions and the characteristics of the surrounding urban environment.

The nocturnal PCI variability is caused mainly by the land surface features.





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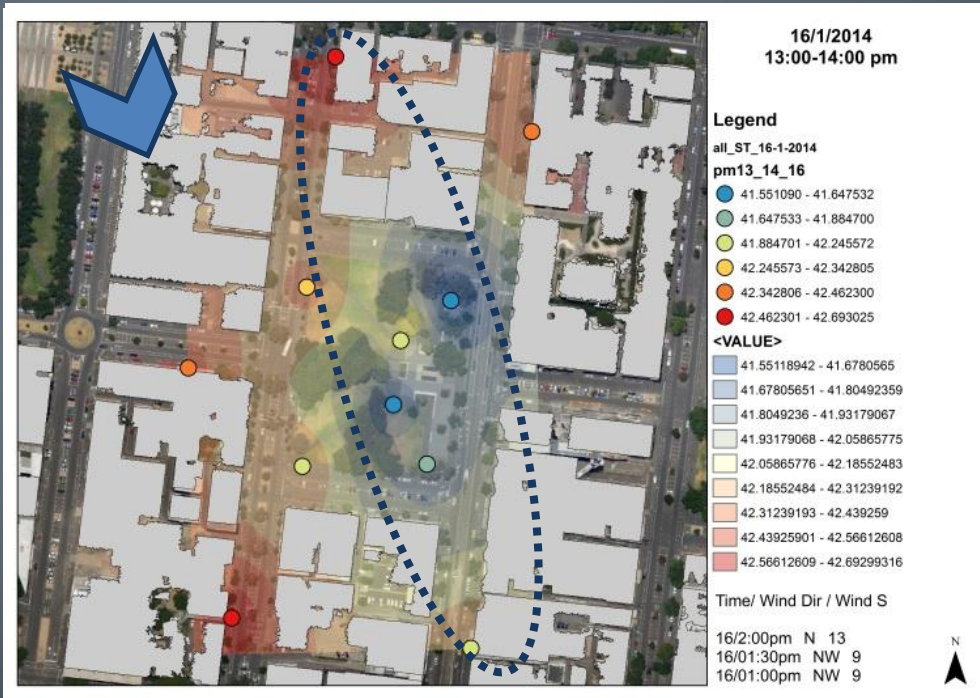
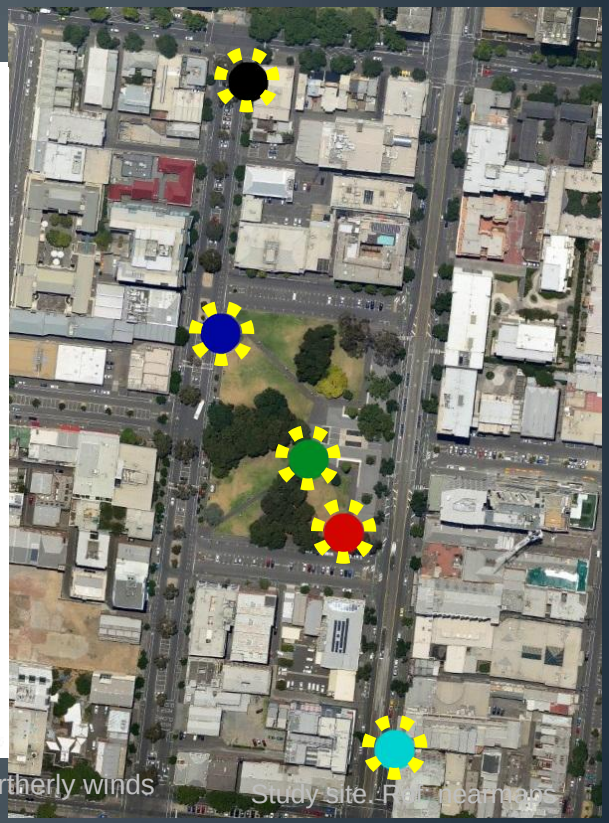
Step A- Results

PCI extension; various wind speeds and directions



The downwind cooling effects of the park showing the extension of PCI with northerly winds
Air temperature at stations with dominant northerly winds.



Development of PCI, was influenced by soil moisture availability, SVF and wind speed
Extension of PCI, was influenced by the dominant wind direction and exceeded half park-width away from the park

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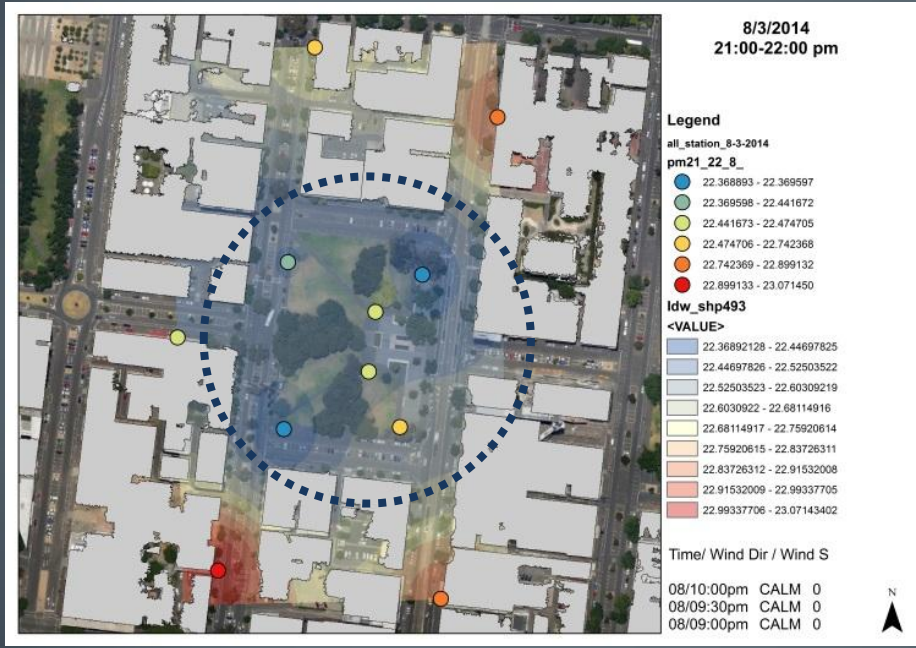
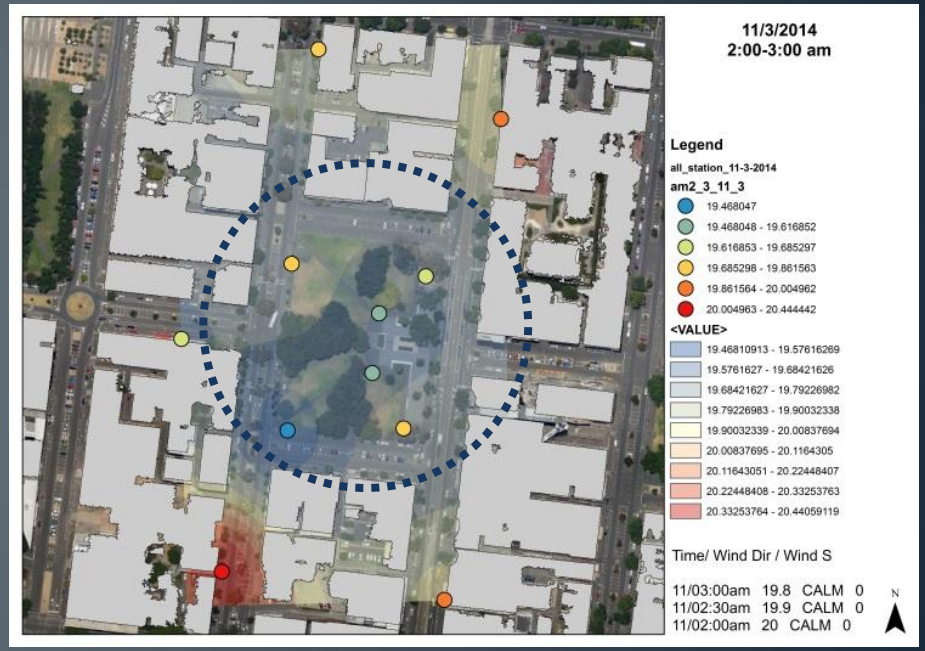
Step A- Results

PCI extension





The propagation of cooling effects of the park under calm conditions.

Under calm conditions (WS=0), the extension of the PCI was circular instead, benefiting all the canyons equally.

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Step B- Results

Transects data To extend the spatial resolution and at a lower height

Traverses crossing the park in three directions at1530h-1630h

Traverses crossing the park in three directions at 2130h-2300h

Traverses crossing the park in three directions with northerly winds

Peak daytime heating; open asphalt ---------- highest temperature

The data from the traverses also illustrated a distinct cool island in the park and extended away from the park boundary, under the trees ---------- lowest temperature

[illegible] ---------- highest temperature

open irrigated grass ---------- lowest temperature

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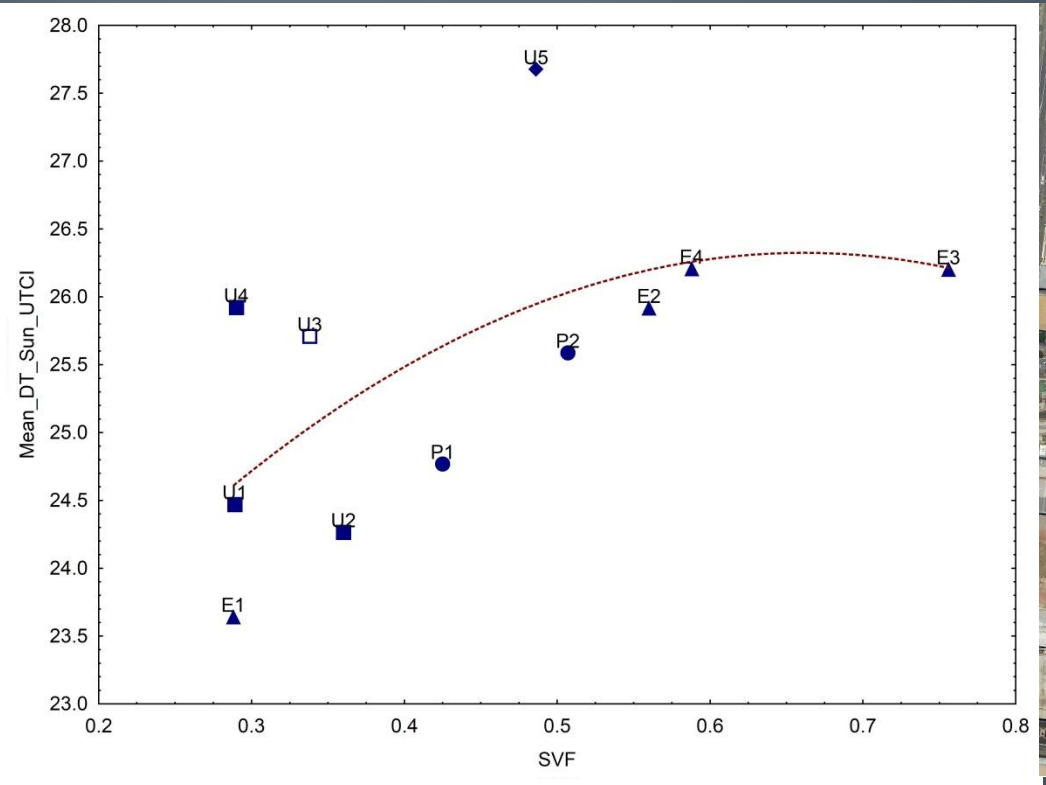
Step A- Results

The UTCI An index to evaluate Human Thermal Comfort



UTCI averaged over summer 2013-14 for the stations inside the park and the surrounding canyons with different solar access

During summer conditions and in peak daytime heating, trees' shading and evapotranspiration in the park could reduce the level of heat stress from strong in the nearby streets to comfortable in the park.

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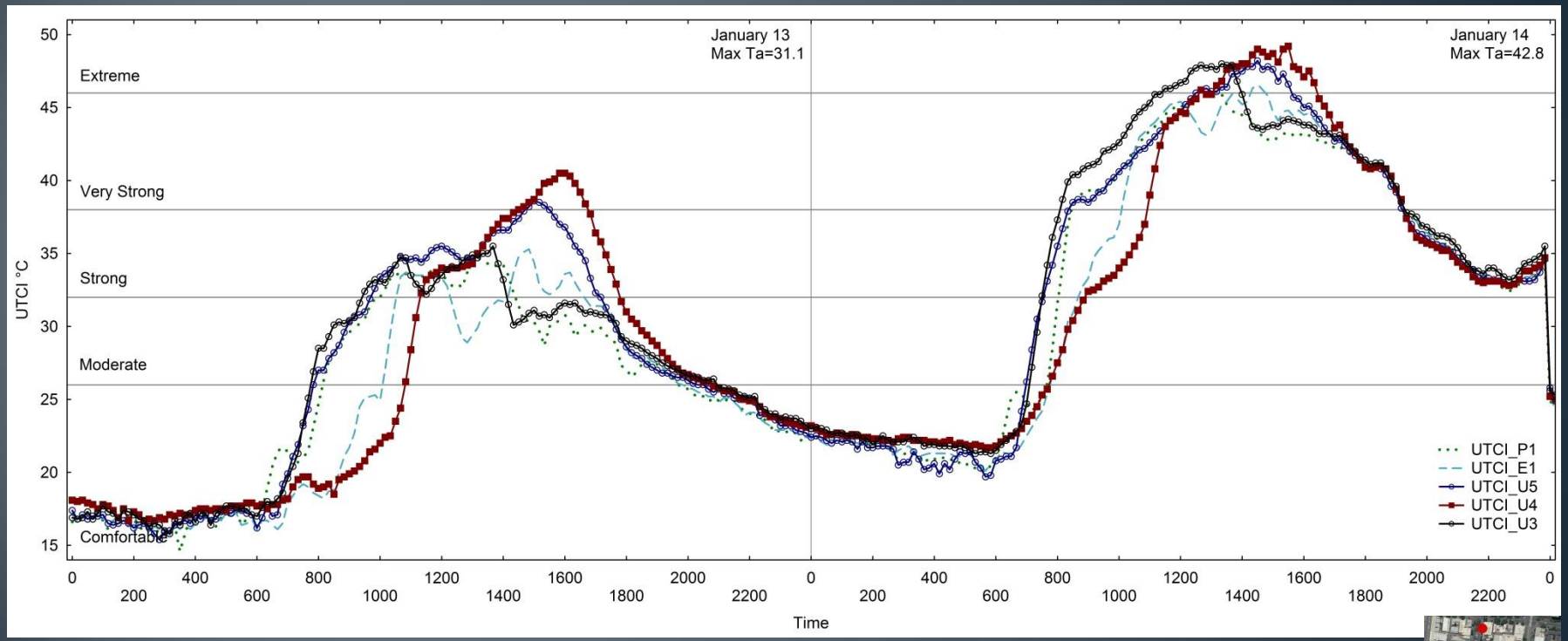
Step A- Results

The UTCI



UTCI for two individual days when *Ta* ≥30°C, (a) 13th, and (b) a representative day when *Ta* ≥ 35°C.

Inside the park the heat stress can be reduced one level in very hot summer days.

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Step A and B

Conclusions

- Results from this study confirm the importance of small urban parks in mitigating high air temperatures and improving human health especially during hot summer conditions.
- The diurnal magnitude of park induced coolness depends on the local meteorological conditions and surface features.
- The nocturnal variability within PCI was less and dominantly influenced by the characteristics of the site.
- The findings of this study also confirmed that since the PCI is largely dependent on the characteristics of the park and its urban surrounding, thereby parks design become of great importance.

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What's next?

- Modelling with CAT (Erell et al., 2009) and SOLWEIG (Lindberg et al., 2014) to simulate *Ta* and *MRT*

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- The CRC for Water Sensitive Cities
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- CityPower for permission to install the equipment on the power poles.

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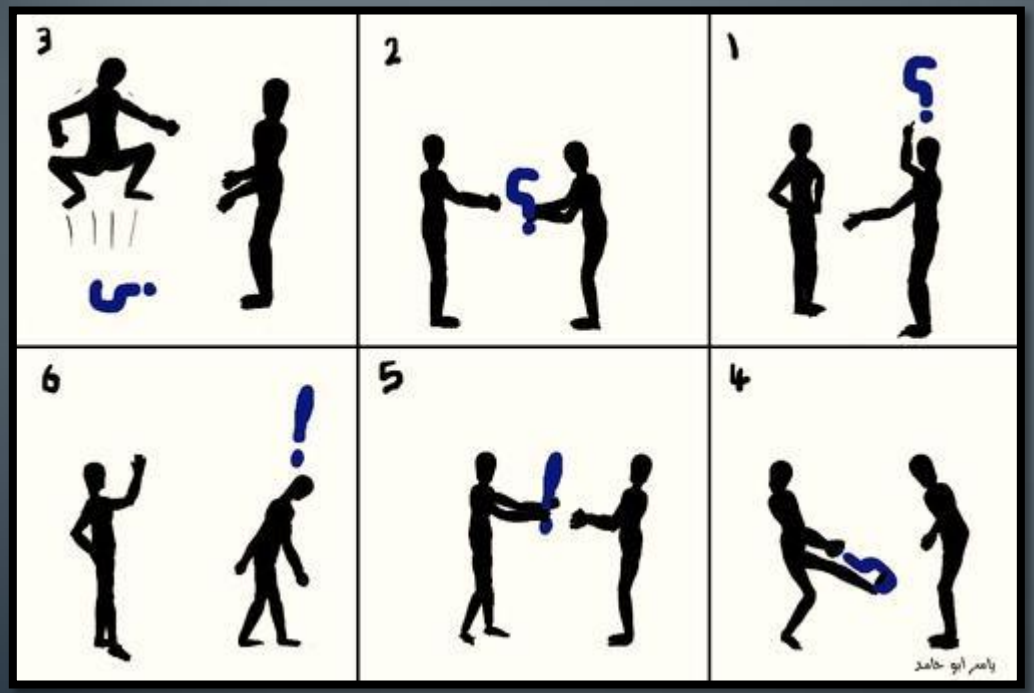
Questions?!



Ref: http://www.toonpool.com/cartoons/simple%20answer_134925

Thank you for your attention

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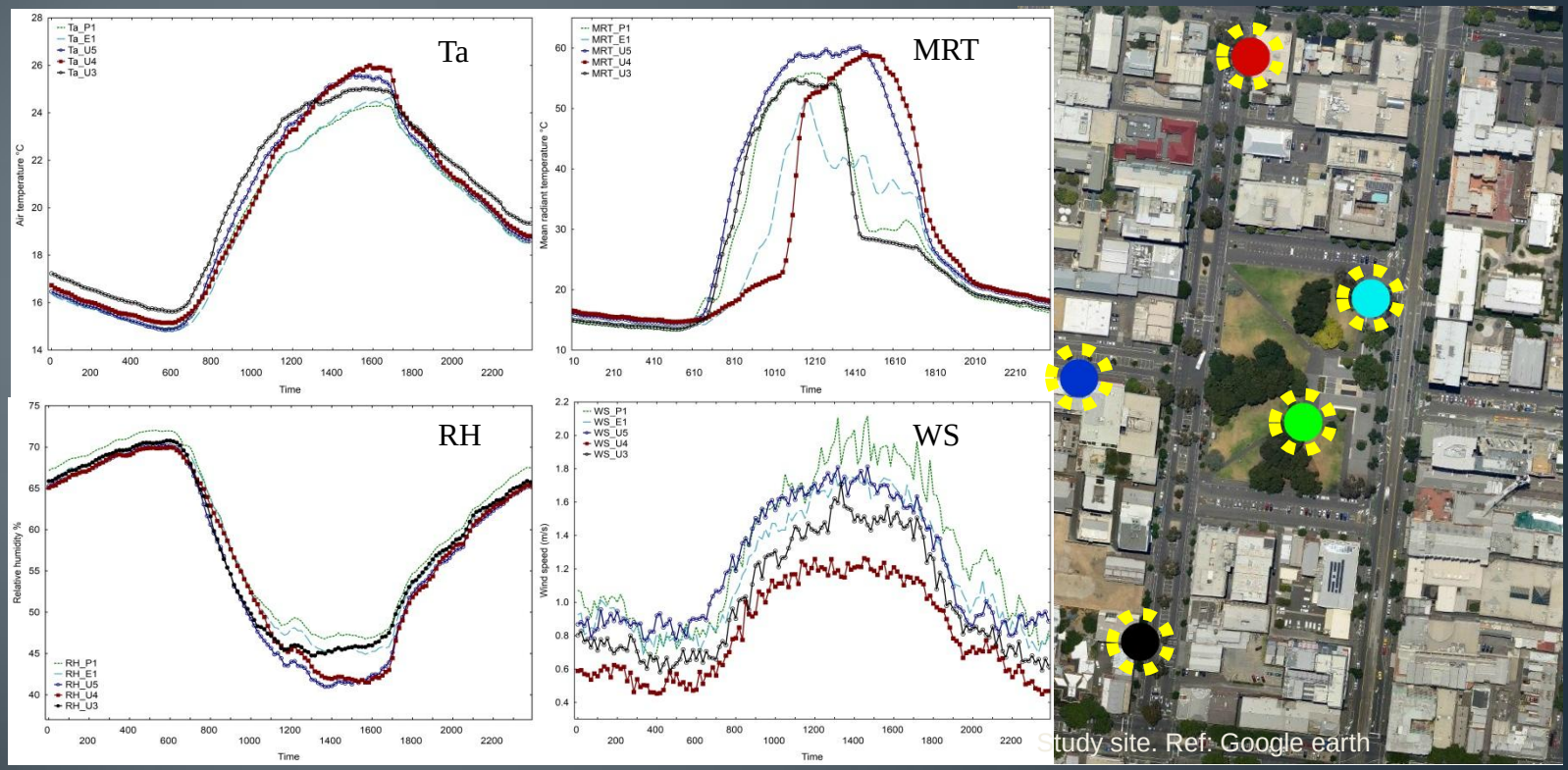
Step A- Results

The UTCI An index to evaluate Human Thermal Comfort



Individual environmental components influencing HTC, averaged over summer 2013-14

During summer conditions and in peak daytime heating, trees' shading and evapotranspiration in the park could reduce the level of heat stress from strong in the nearby streets to comfortable in the park.