LOW CARBON LIVING CRC

UCR Urban Climates Research

UniSA Zero Waste SA Research Centre for Sustainable Design and Behaviour

Thesis title:
An Exploration on the Impacts of Heat Stress on Vitality of Public Space and Outdoor Activity Patterns: A Case Study of Sydney, Melbourne and Adelaide

Thermal Resilience: A New Logic for Urban Greenery

Work in progress report
26 September 2014

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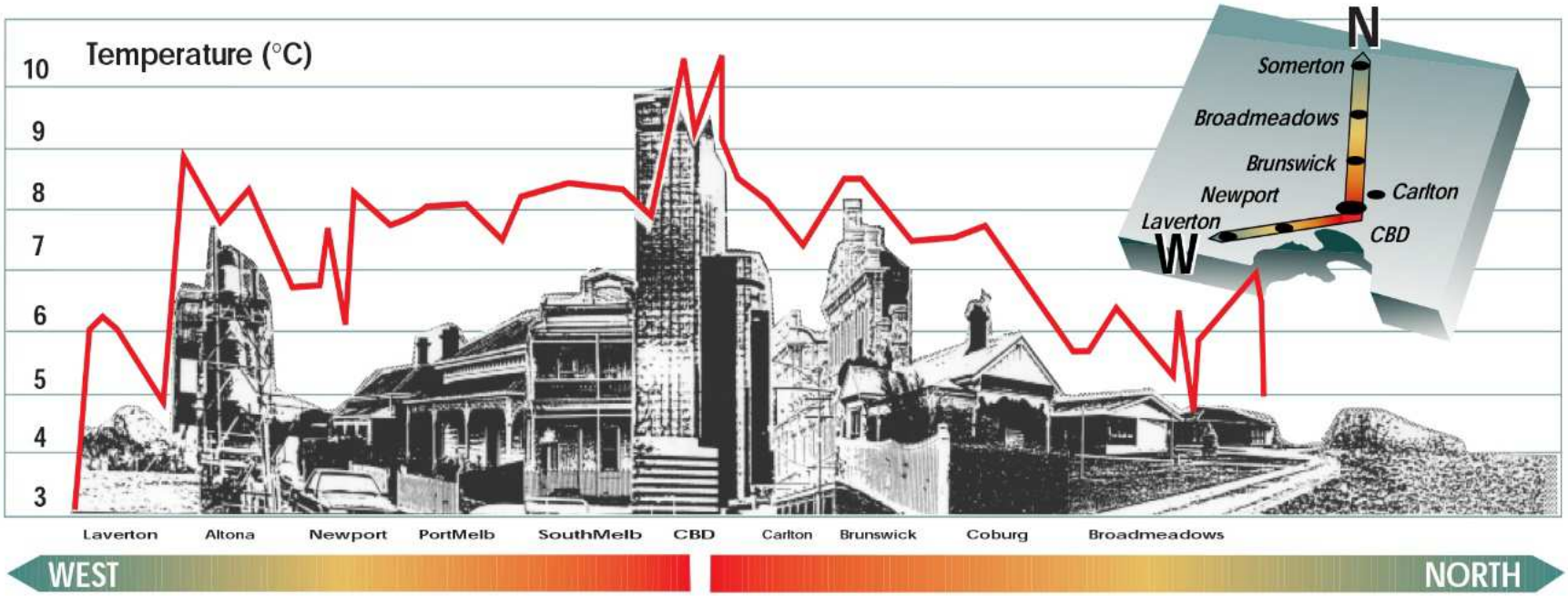
Ehsan Sharifi

Principal Supervisor:
Prof. John Boland
Co-Supervisor:
Dr Alpana Sivam

UHI behaviour in three Australian Cities



BoM 1997

Melbourne UHI winter

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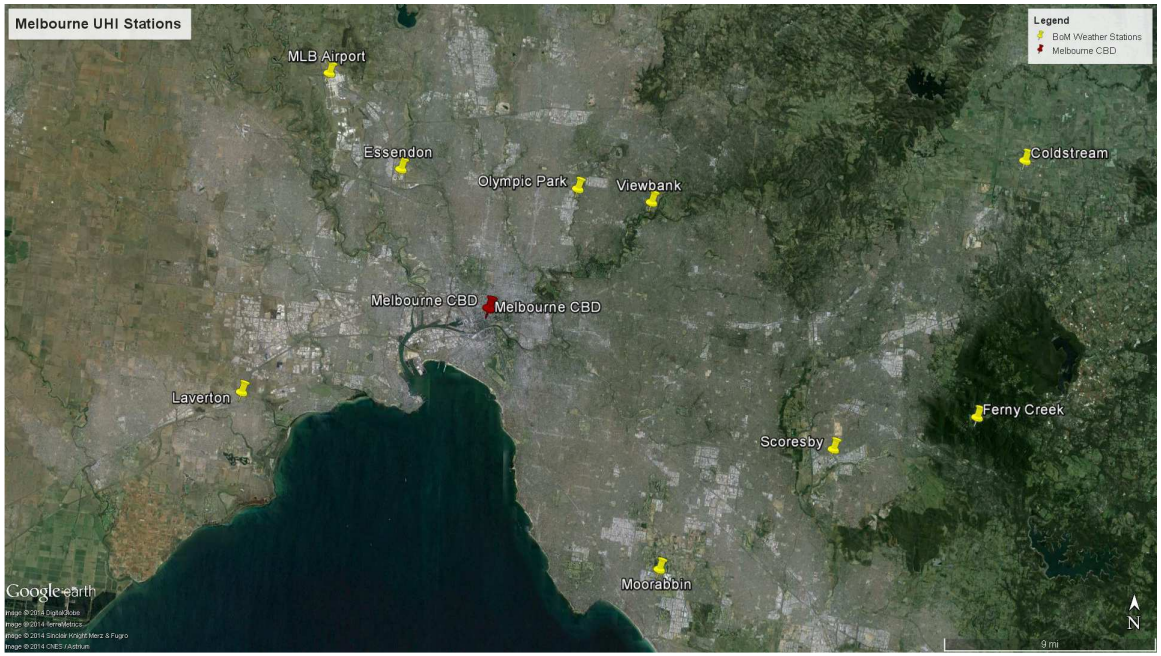

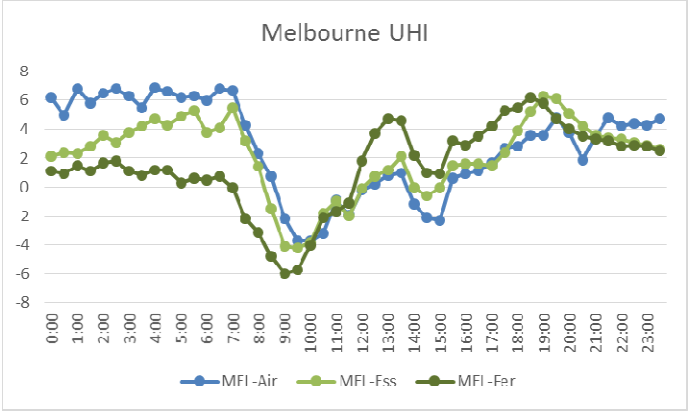

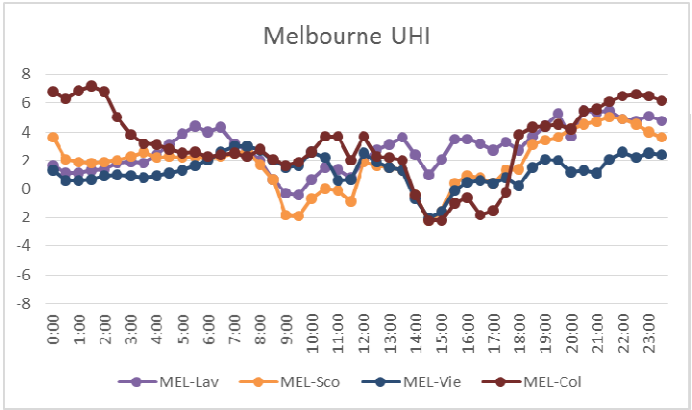

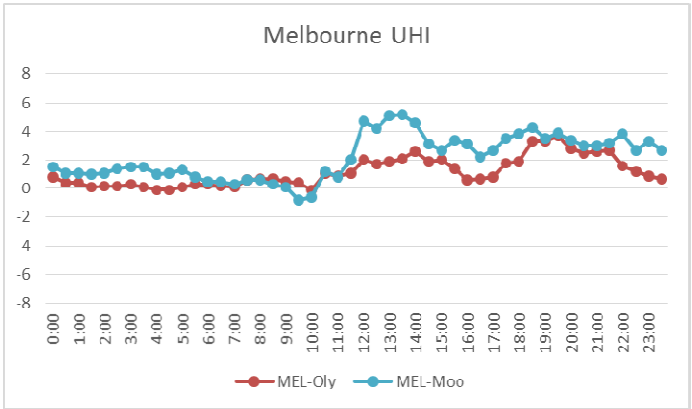

Sydney UHI winter

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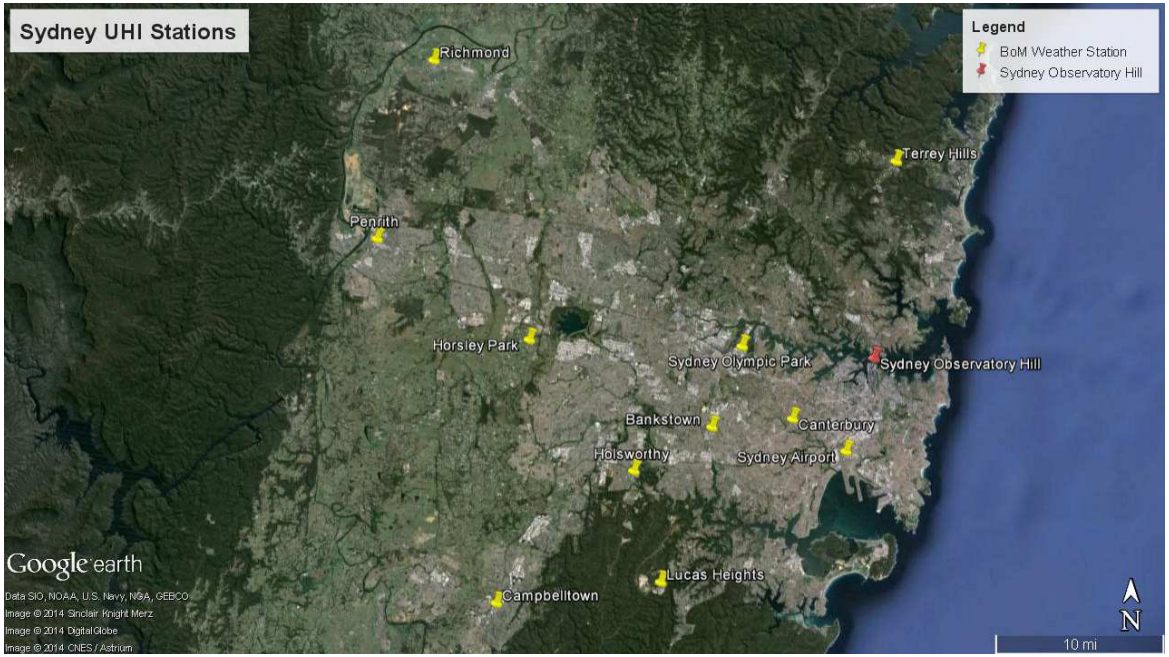

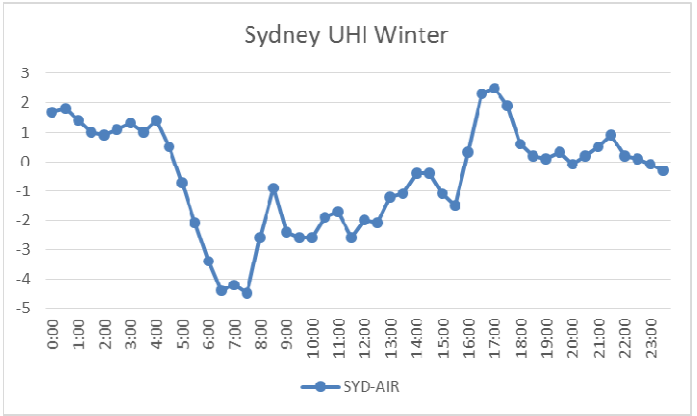

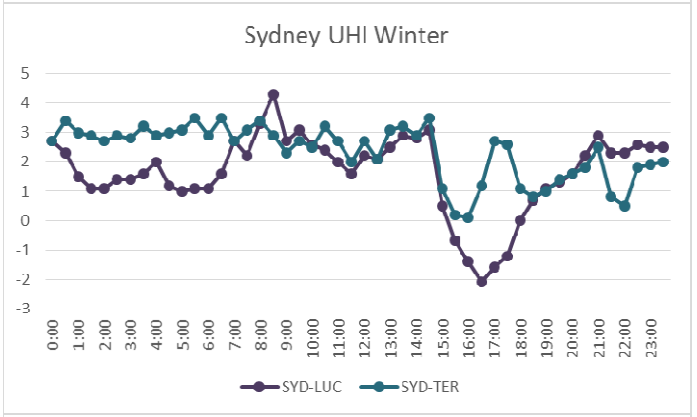

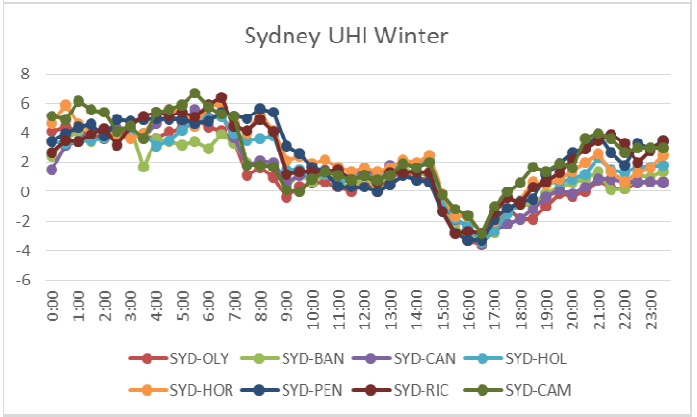

Adelaide UHI winter

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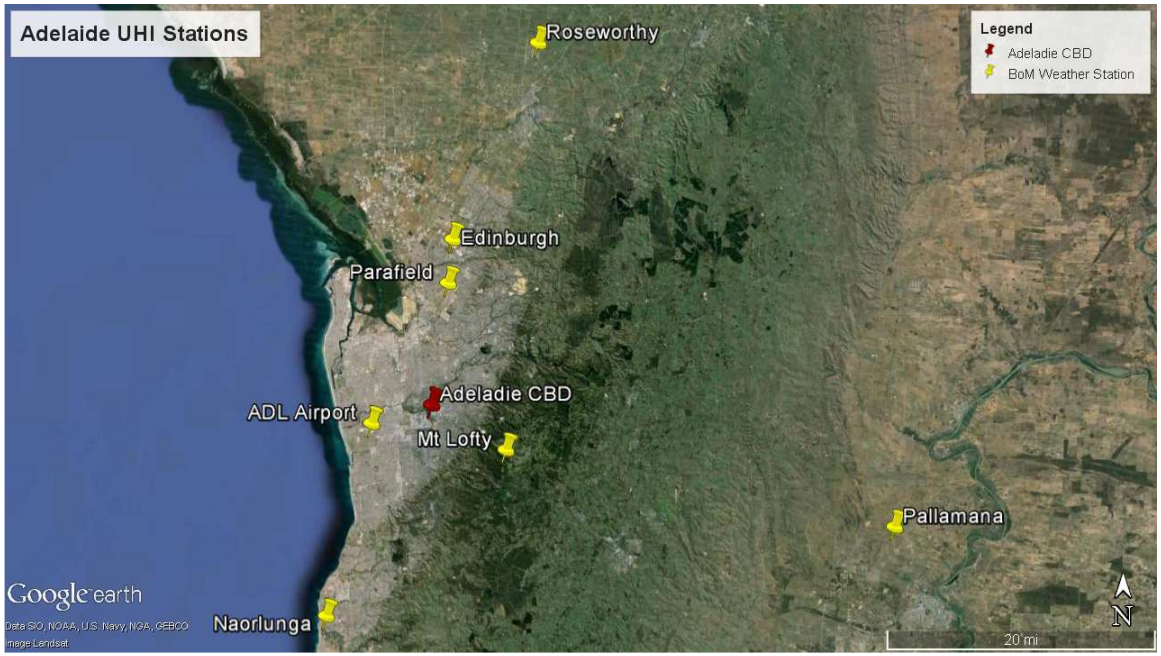

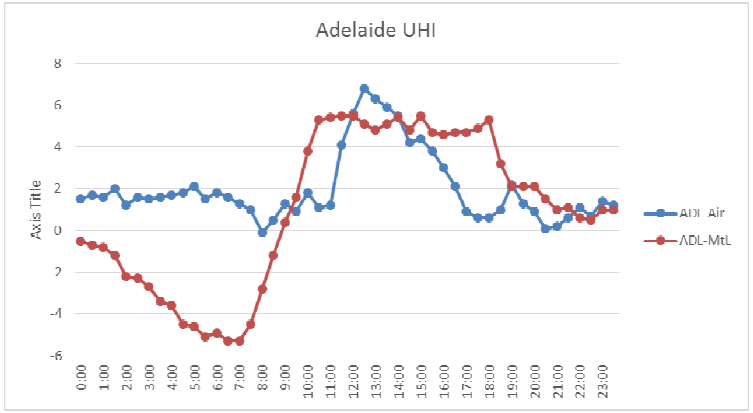

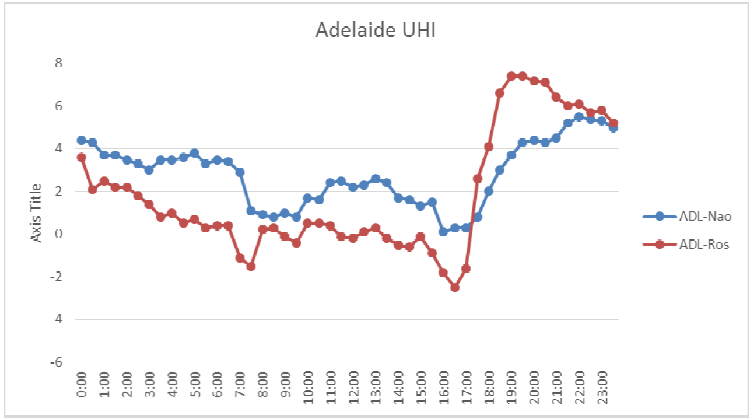

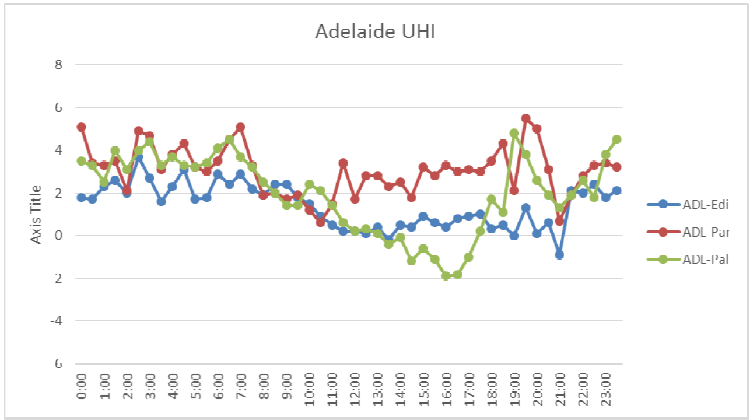

UHI Study in Human Scale

Research Focus

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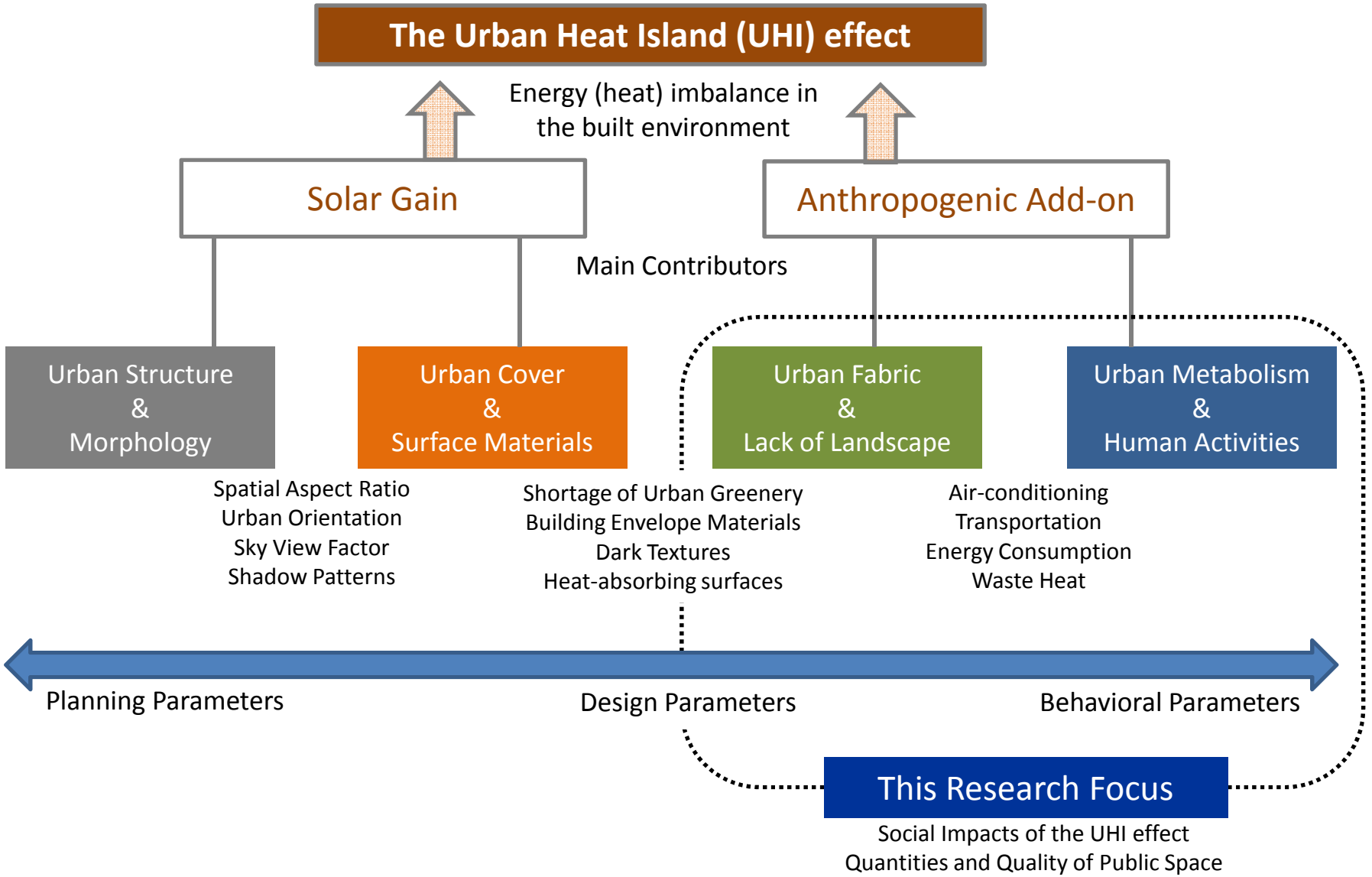

Research Questions

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RQ1 What outdoor behavioural patterns are sensitive to heat stress in public space and to what extent do they correlate with spatial thermal variables?

RQ2 What physical attributes make public space resilient to heat stress and to what extent do heat-sensitive outdoor behavioural patterns (subject of RQ1) alter with these variables?

RQ3 What adaptation strategies can enhance thermal resilience in public space?

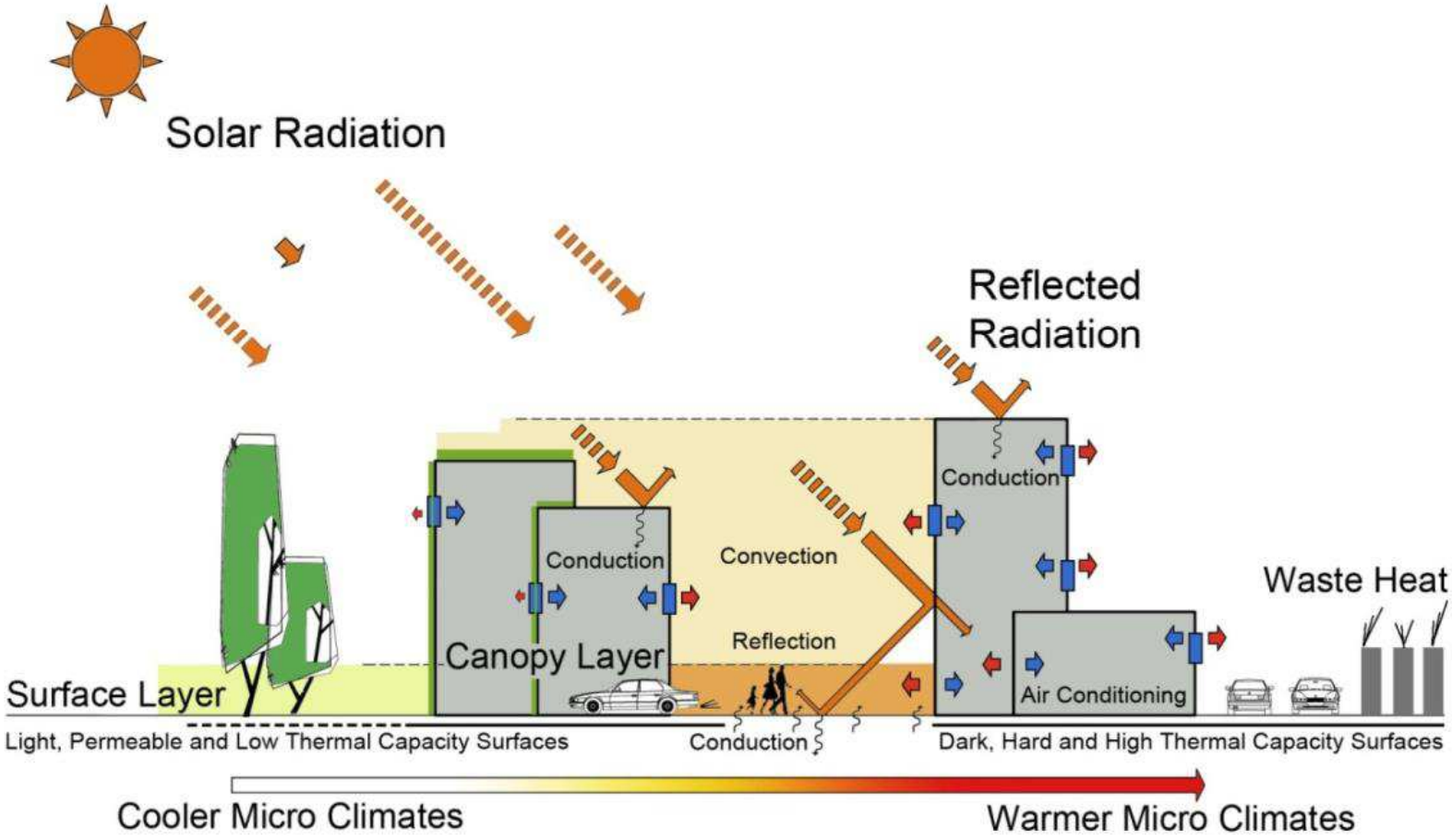
Heat sensitive behavioural patterns

Heat-resilient public spaces

Adaptation strategies

brandavenue.typepad.com

Heat Stress, Public Space and Public Life



Sharifi, E & Lehmann, S 2012a, 'Urban Heat Island Effect Mitigation in Rapidly Developing Cities', *6th International Conference and Workshop on the Built Environment in Developing Countries (ICBEDC)* The University of South Australia, pp. 982-1000.

Sharifi, E & Lehmann, S 2012b, 'Urban Heat Island Effect Mitigation in Precinct Scale: A Case Study of Sub-Tropical Sydney', *4th International Network for Tropical Architecture Conference (iNTA)*, National University of Singapore, pp. 1-9.

Sharifi, E, Boland, J & Lehmann, S 2014, 'Thermal Resilience of Activity Patterns and Urban Greenery in Public Space: Three Case Studies in Adelaide, South Australia', *7th Making Cities Liveable Conference: Book of Proceedings*, Healthycities, pp. 162-181.

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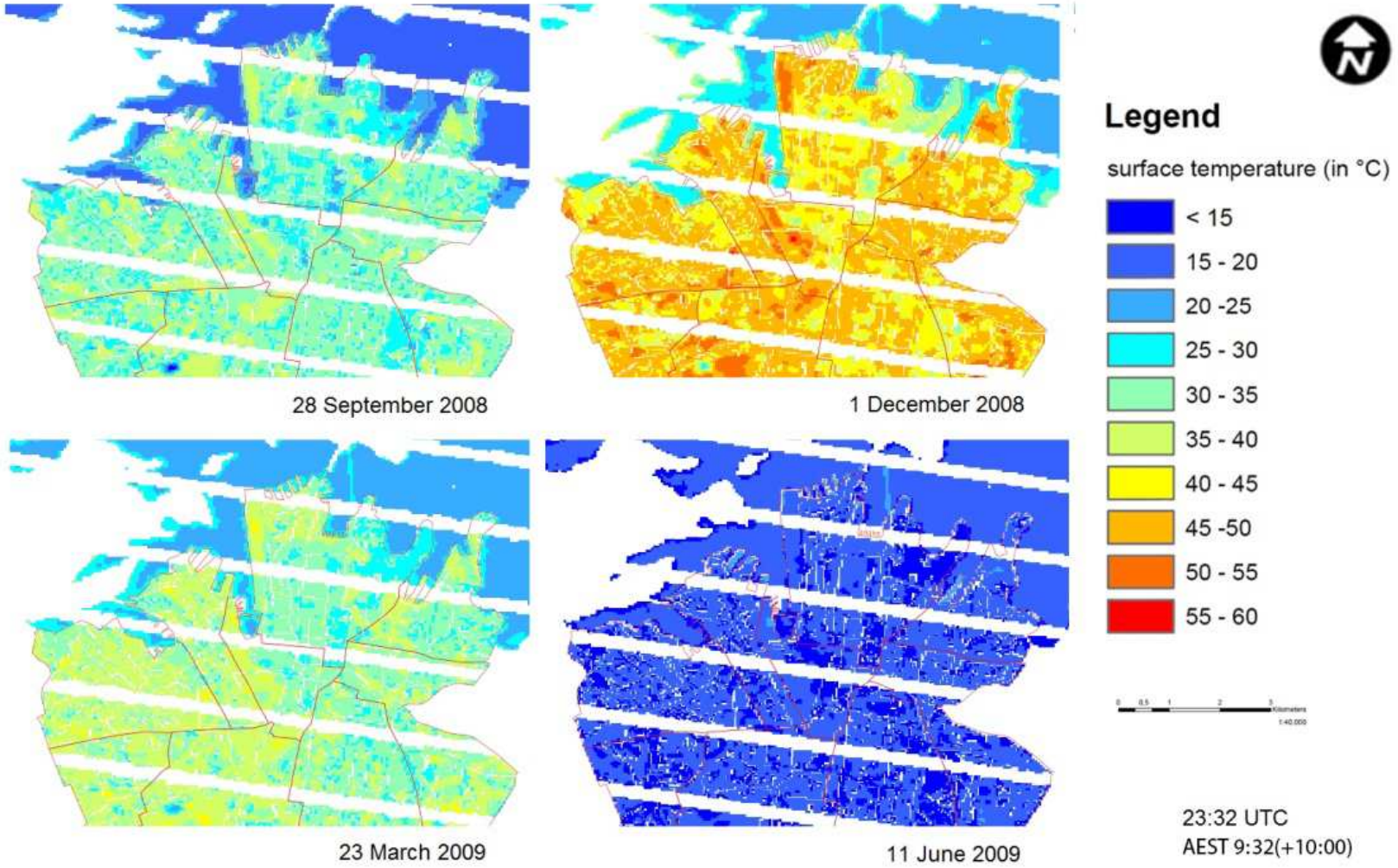
Sharifi, E, Philipp, C & Lehmann, S 2014a, 'Multi-scale analysis of the surface layer urban heat island effect in five higher density precincts of central Sydney', in Lehmann, S (ed), *Low Carbon Cities*, Springer.

Sharifi, E, Philipp, C & Lehmann, S 2014b, 'Correlational Analysis of Urban Greenery and Urban Heat Island Effect in Central Sydney', *7th Making Cities Liveable Conference: Book of Proceedings*, Healthycities, pp. 182-200.

Sharifi, E, Sivam, A, Boland, J, 2015, Thermal Resilience of Activities in Public Space: Case Study of Adelaide, South Australia ', *Sustainable Development,* under preparation

Spatial Thermal Resilience and Urban Greenery

Annual variation of surface temperature in five precincts of Sydney, Landsat 7– ETM+ (2008-2009)



Spatial Thermal Resilience

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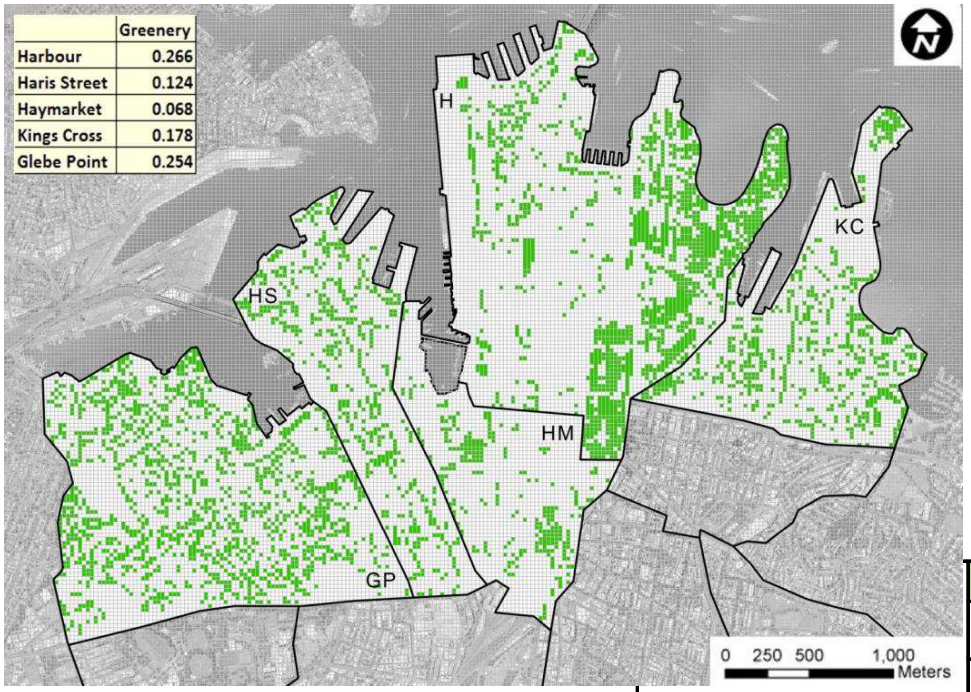

- ✓ Urban precincts with more greenery are more resilient to hotter temperatures (10-20 per cent more greenery can decrease the surface temperature up to 1.5 degrees centigrade in the precinct scale).

	28 September 2008			1 December 2008			23 March 2009			11 June 2009		
	Air Temp. 19-34°C			Air Temp. 18-32°C			Air Temp. 19-27°C			Air Temp. 5-16°C		
	Temp at 11:45=32°C			Temp at 11:45=30°C			Temp at 11:45=25°C			Temp at 11:45=14°C		
Precinct	**Tree Canopy (%)**	**Grass Cover (%)**	**sUHI (°C)**	**Tree Canopy (%)**	**Grass Cover (%)**	**sUHI (°C)**	**Tree Canopy (%)**	**Grass Cover (%)**	**sUHI (°C)**	**Tree Canopy (%)**	**Grass Cover (%)**	**sUHI (°C)**
Harbour	20.0	5.9	2.67	19.9	7.0	5.10	20.1	6.5	2.95	19.7	5.0	1.52
Harris Street	9.8	1.8	5.12	9.7	2.3	8.18	10.4	2.0	6.00	9.3	2.9	2.16
Haymarket	5.8	1.2	3.70	5.2	1.1	6.68	5.6	1.2	3.86	4.3	1.2	1.22
Kings Cross	11.7	6.7	4.11	11.9	7.1	5.89	10.9	6.9	3.53	9.9	8.3	2.68
Glebe Point	10.9	14.7	3.92	11.6	14.0	5.80	11.6	13.8	4.12	10.7	12.7	1.24
Botanic Garden (Benchmark)	42.2	33.9	-	41.3	35.8	-	41.4	34.9	-	42.2	32.1	-
Correlation Coefficient (R) Value	-0.62	-0.19	-	-0.64	-0.60	-	-0.42	-0.31	-	-0.002	-0.02	-

Activity Thermal Resilience and Urban Greenery

Activity Thermal Resilience

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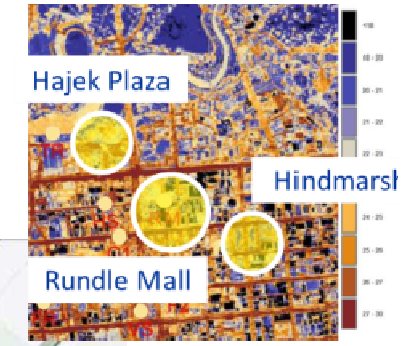
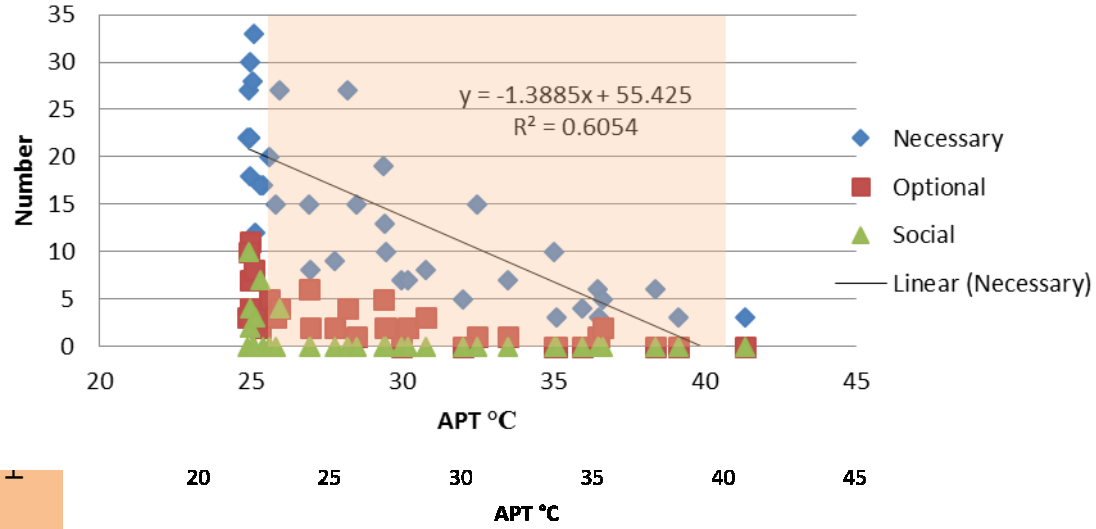
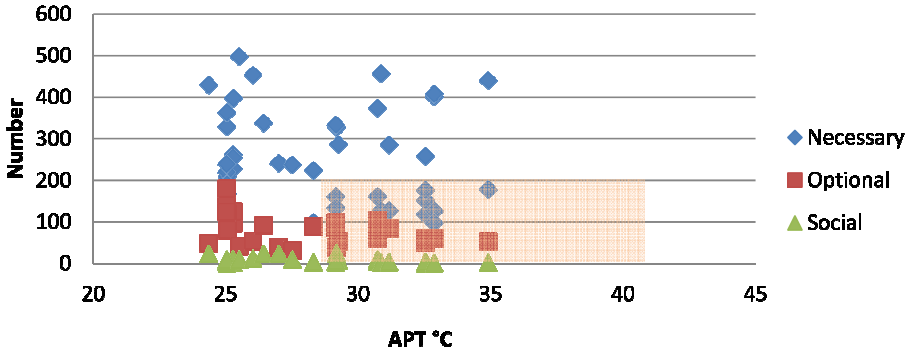
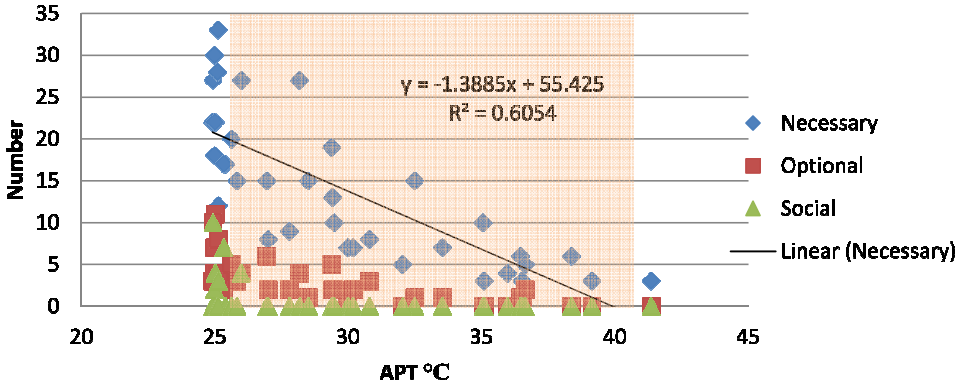




Rundle Mall



Hajek Plaza



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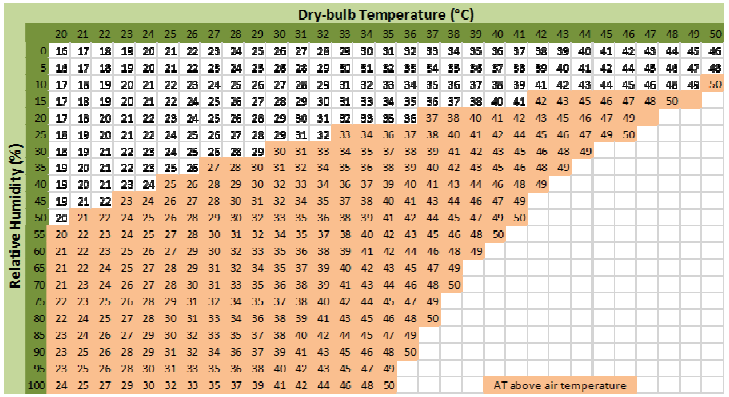

Apparent temperature chart (Steadman 1994)

Activity Thermal Resilience

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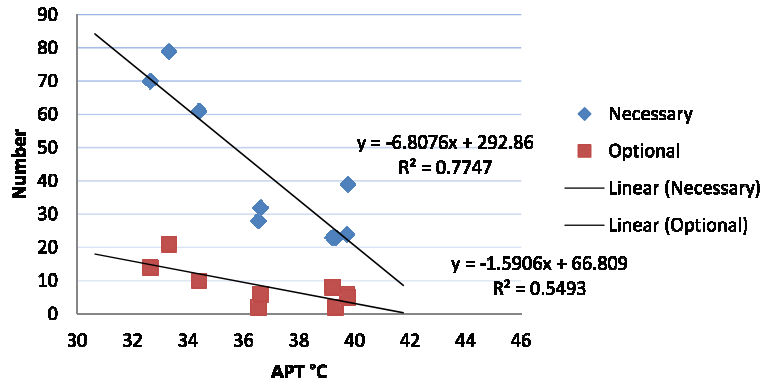
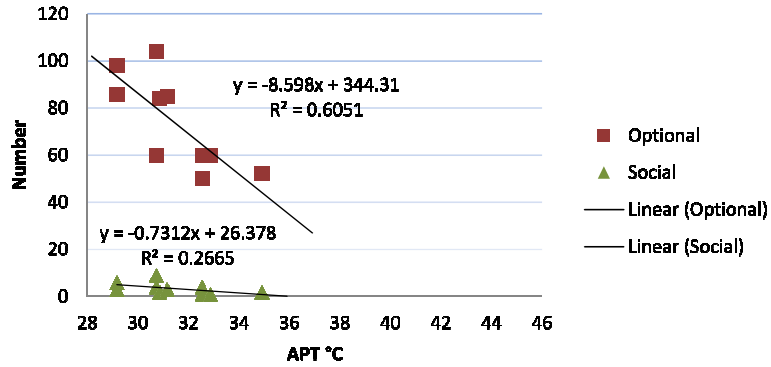
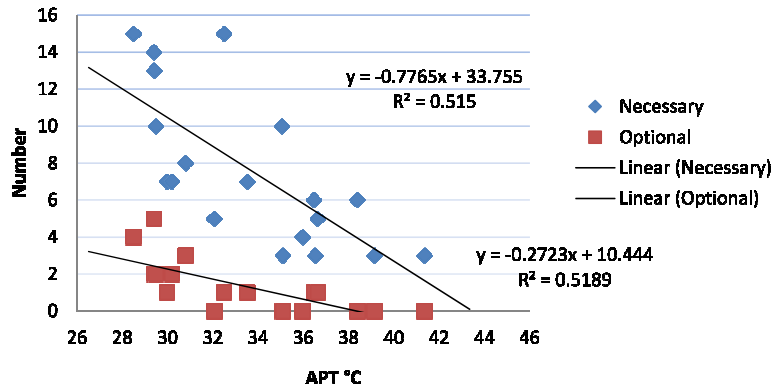
Hindmarsh Square



Rundle Mall



Hajek Plaza



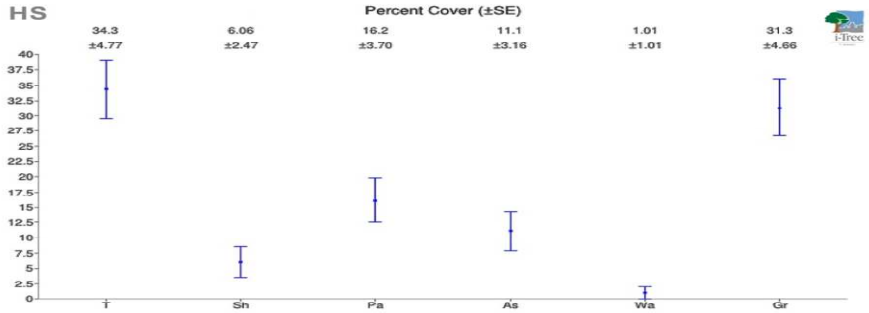
R value (correlational analysis) P value (regression analysis)	Necessary Activities above Critical Thermal Threshold (CTT)	Optional Activities above Critical Thermal Threshold (CTT)	Social Activities above Critical Thermal Threshold (CTT)
APT in Hindmarsh Square, CTT = 32°C	R = -0.88	R = -0.74	R = -0.17
	P = 0.002	P = 0.02	P = 0.66
APT in Rundle Mall, CTT = 30°C	R = 0.22	R = -0.77	R = -0.51
	P = 0.31	P < 0.001	P = 0.01
APT in Hajek Plaza, CTT = 28°C	R = -0.71	R = -0.72	R = N/A (div/0)
	P < 0.001	P < 0.001	P = N/A

Hindmarsh Square

Rundle Mall

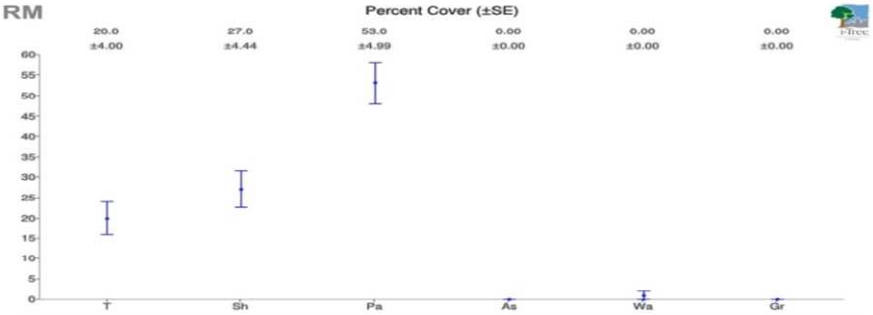
Hajek Plaza

HS



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, shrub	T	34	34.3 ±4.77
Shade	Temporary or permanent shade	Sh	6	6.06 ±2.47
Paving	Concrete, paving	Pa	16	16.2 ±3.70
Asphalt	Asphalt and bitumen	As	11	11.1 ±3.16
Water	Surface water	Wa	1	1.01 ±1.01
Grass	Grass or ground	Gr	31	31.3 ±4.66

RM



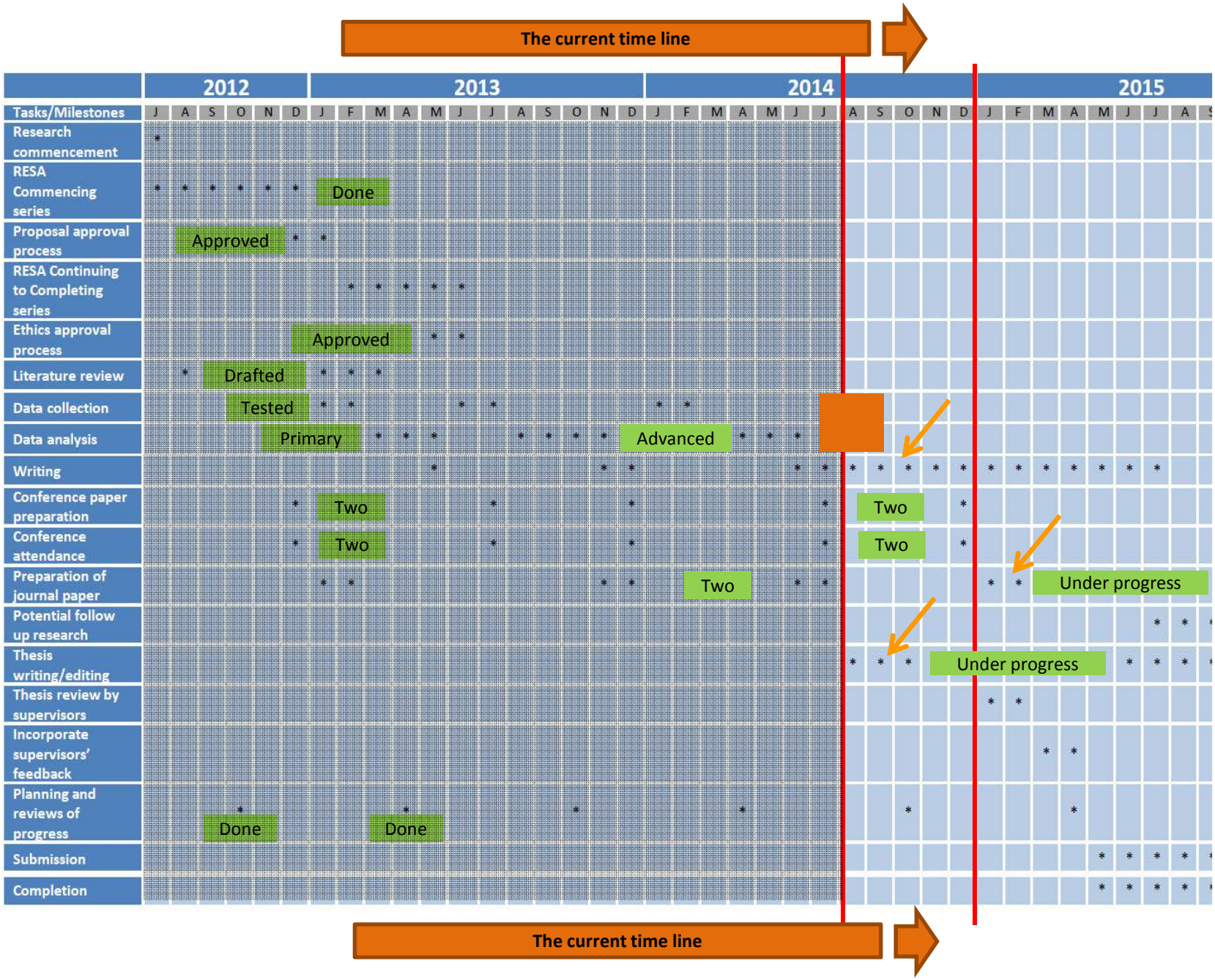
Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, shrub	T	20	20.0 ±4.00
Shade	Temporary or permanent shade	Sh	27	27.0 ±4.44
Paving	Concrete, paving	Pa	52	52.0 ±4.99
Asphalt	Asphalt and bitumen	As	0	0.00 ±0.00
Water	Surface water	Wa	1	1.01 ±1.01
Grass	Grass or ground	Gr	0	0.00 ±0.00

HP

Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, shrub	T	1	1.00 ±1.00
Shade	Temporary or permanent shade	Sh	9	9.00 ±3.00
Paving	Concrete, paving	Pa	62	62.0 ±4.85
Asphalt	Asphalt and bitumen	As	0	0.00 ±0.00
Water	Surface water	Wa	0	0.00 ±0.00
Bark	Sand or bark chips	Gr	28	28.0 ±4.49

Activity Thermal Resilience

- There are Critical Thermal Thresholds for heat-sensitivity in public spaces. These CTTs vary from 28°C to 32°C in different public spaces.
- Optional activities (sitting, standing, eating, playing and sport) are highly sensitive to heat stress in public space and start to fade after the public space reached its thermal threshold.
- Necessary activities (walking between home and work or for daily shopping) have more resilience to heat stress and have a higher thermal sensitivity threshold than optional activities in public spaces with a diversity of supportive land uses
- Necessary and optional activity patterns are shifting towards shadowed places in higher temperatures.
- Social activities (group activities, cultural activities such as music playing) are more sensitive to time and organisational adjustments than heat stress, nevertheless, still follow necessary activities thresholds.


The current time line
2012
2013
2014
2015
Tasks/Milestones
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Research commencement
RESA Commencing series
Done
Proposal approval process
Approved
RESA Continuing to Completing series
Ethics approval process
Approved
Literature review
Drafted
Data collection
Tested
Data analysis
Primary
Advanced
Writing
Conference paper preparation
Two
Two
Conference attendance
Two
Two
Preparation of journal paper
Two
Under progress
Potential follow up research
Thesis writing/editing
Under progress
Thesis review by supervisors
Incorporate supervisors' feedback
Planning and reviews of progress
Done
Done
Submission
Completion
The current time line

Next stages

Urban Climates Research

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- Validating findings and further data analysis at Federation Square, Darling Quarter and Hajek Plaza

- Data analysis of public surveys

- Micro-climate and simulation and thermal-resilience prediction for three scenarios in 2070

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THANK YOU

for your comments