HOW TREES SAVE LIVES. THE ROLE OF A WELL WATERED LANDSCAPE IN LIVEABLE CITIES

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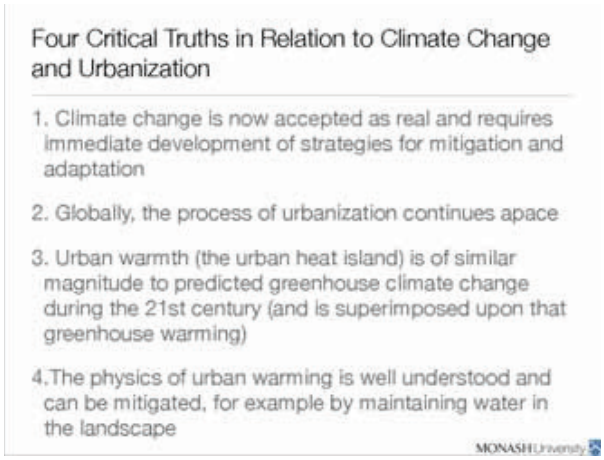

Australian Urbanisation

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Other realities

1. Increasing evidence that climate extremes may be shifting MORE than the climate averages
2. Globally, there is a push for cities to become denser (urban consolidation) therefore hotter
3. In many places around the world (e.g. in Australia) national and urban populations are ageing
4. Water scarcity is becoming a major issue for many cities around the globe, especially in "Mediterranean" climate regions

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Australian Projected Temperature Changes to 2100

IPCC 4AR, 2007

~0.5- 1degC change last century
~2.5- 4.5 degC change projected by 2100 under moderate emissions scenario

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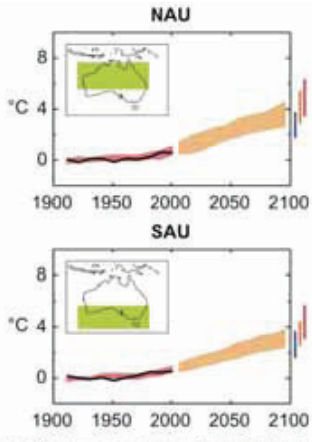
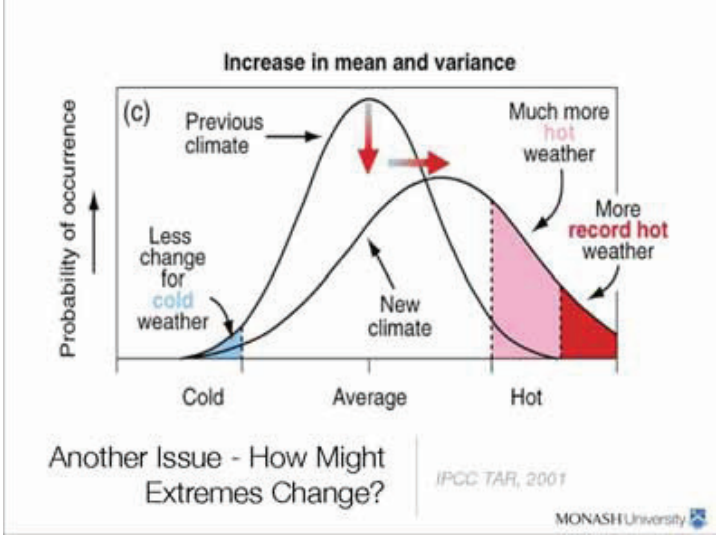


Figure 11.15. *Temperature anomalies with respect to 1901 to 1950 for two Australian land regions for 1906 to 2005 (black line) and as simulated (red envelope) by MMD models incorporating known forcings; and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue), the A1B scenario (orange) and the A2 scenario (red). More details on the construction of these figures are given in Box 11.1 and Section 11.1.2.*


Increase in mean and variance
(c)
Previous climate
Much more hot weather
More record hot weather
Less change for cold weather
New climate
Probability of occurrence
Cold
Average
Hot
Another Issue - How Might Extremes Change?
IPCC TAR, 2001
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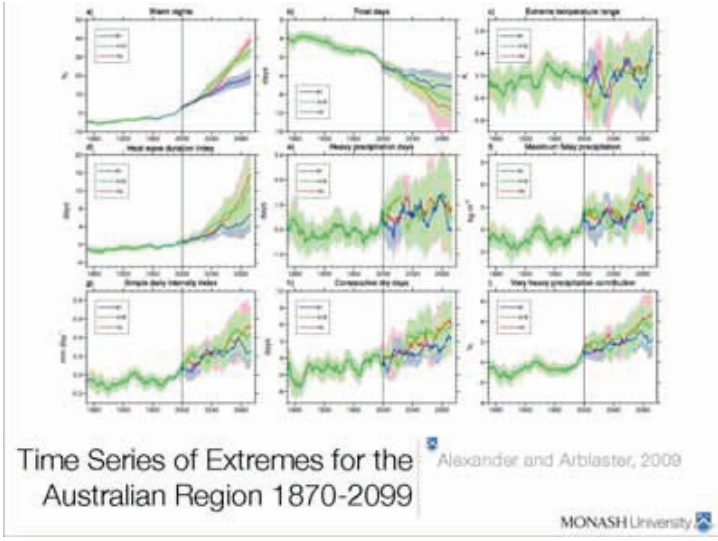
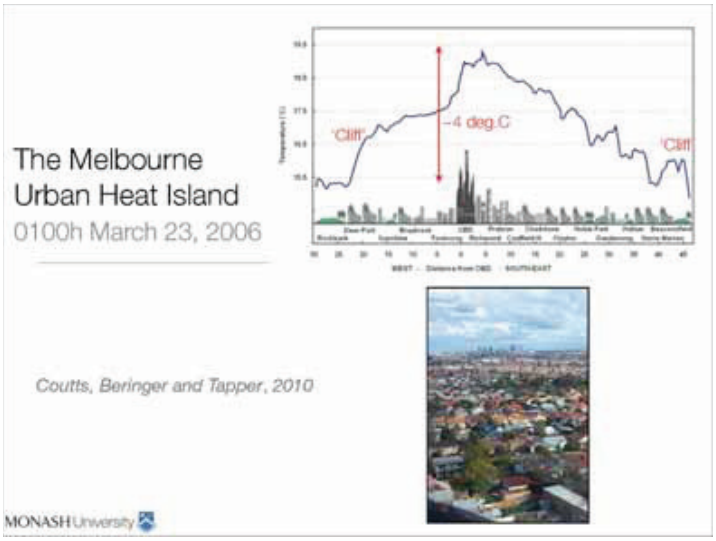
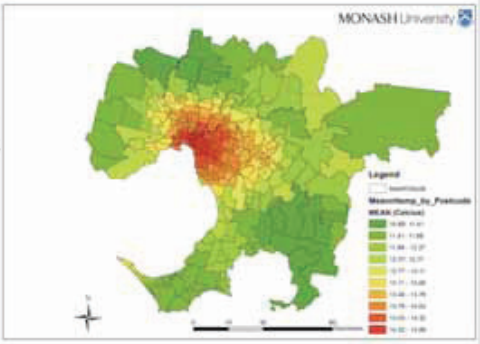

Time Series of Extremes for the Australian Region 1870-2099
Alexander and Arblaster, 2009
MONASH University


The Melbourne Urban Heat Island
0100h March 23, 2006
'Cliff'
~4 deg.C
'Cliff'
Coutts, Beringer and Tapper, 2010
MONASH University

The Melbourne Nocturnal Urban Heat Island - MODIS Monthly Data 2000-2006

Loughnan, Nicholls and Tapper, 2009a



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Urban Radiation and Energy Budget Simply Explained

Radiative energy available at the surface (Q*) + artificially produced energy (F) = energy used in heating the air (QH) + energy used in heating materials (QG) + energy used in evaporating moisture (QE)

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Causes of Urban Warmth

- The nature of surface materials (i.e. thermal characteristics and colour (albedo) of surfaces)
- Surface shapes and structures (the complex nature of urban geometry)
- Alterations in urban air quality
- The presence of heat sources (cars, industry, space heating, metabolic heat, etc)
- Surface waterproofing and especially removal of urban storm water

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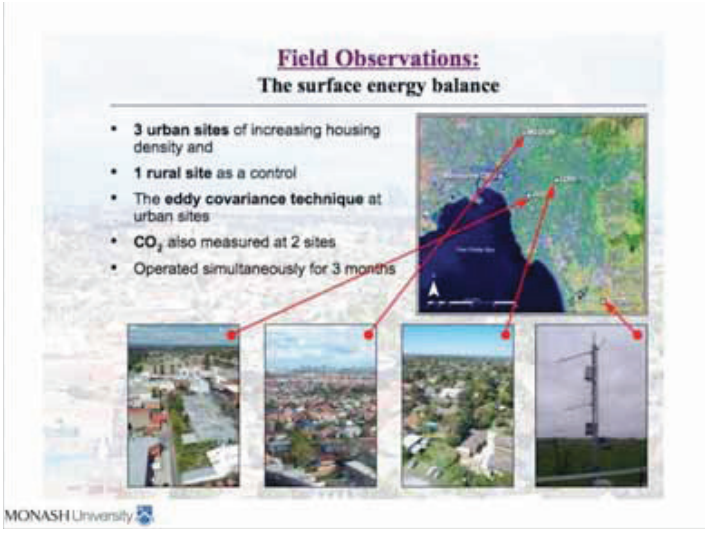
Field Observations:
The surface energy balance
3 urban sites of increasing housing density and
1 rural site as a control
The eddy covariance technique at urban sites
CO_2 also measured at 2 sites
Operated simultaneously for 3 months
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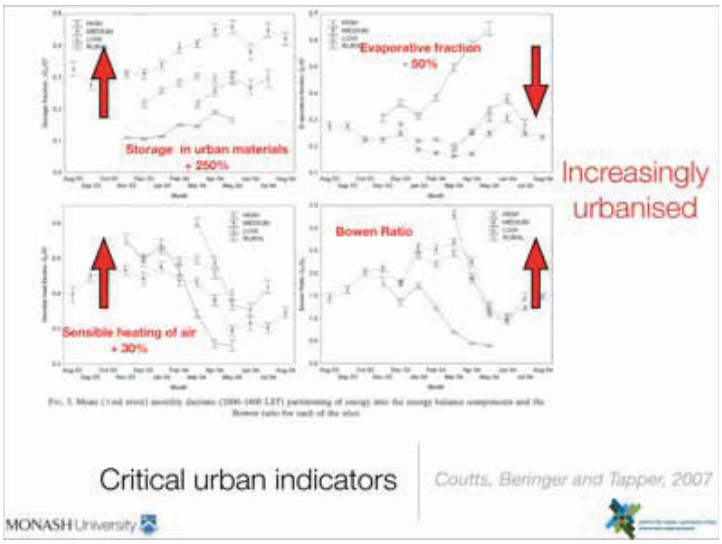
Evaporative fraction
- 50%
Storage in urban materials
+ 250%
Bowen Ratio
Sensible heating of air
+ 30%
Increasingly urbanised
Critical urban indicators
Coutts, Beringer and Tapper, 2007
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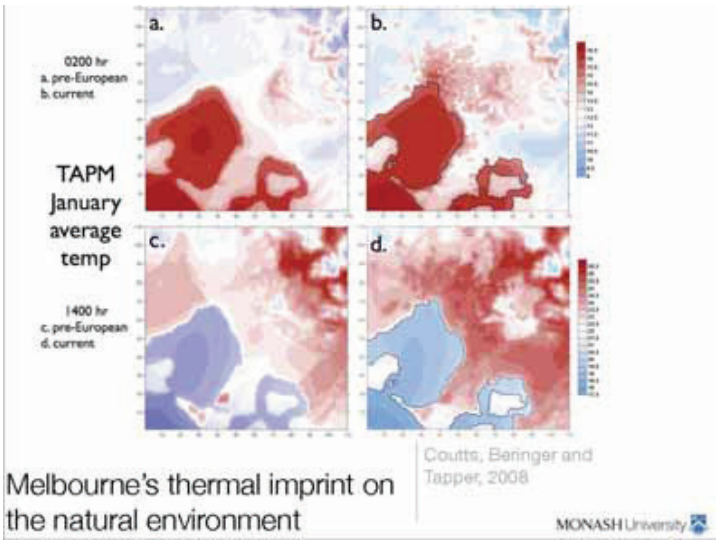
a.
b.
c.
d.
0200 hr
a. pre-European
b. current
TAPM
January
average
temp
1400 hr
c. pre-European
d. current
Coutts, Beringer and Tapper, 2008
Melbourne's thermal imprint on the natural environment
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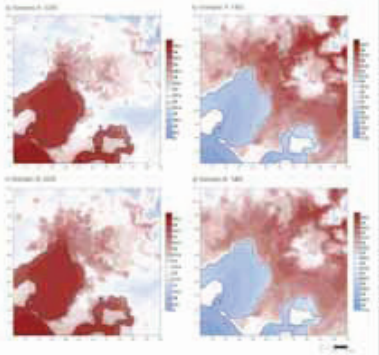
Modelling the Impact of Urban Consolidation on the Melbourne Heat Island - Melbourne 2030 Plan



Coutts, Beringer and Tapper, 2008

Mean surface temperature fields for 0200 and 1400, with current urban fabric (A) and projected urban fabric (B)

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Heat and human mortality

- **Definition** (no formal definition of heatwave)
  - BoM "prolonged period of excessive heat"
  - Largest cause of mortality natural hazard (BoM, Borden & Cutter 2009)
  - Passive threat - unlike floods/cyclones *and underreported*
- **Examples**
  - Most famous heatwave-mortality event Europe 2003
  - As many as 35,000 excess deaths were associated with the 2003 event
  - Beniston, 2004 *Geophys. Res. Letters* "..shape of things to come"
  - Australia smaller numbers (374 excess deaths in Jan09 heat wave event).
- **Place Specific**
  - Features of the natural and built environments affect heat loads
  - Demography, socio-economics and underlying health status important

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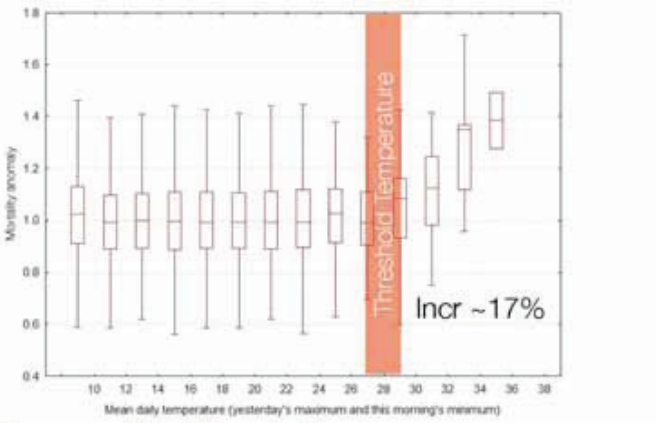

Melbourne - Heat Threshold for Excess Deaths in >64 y.o.

Nicholls, Skinner, Loughnan and Tapper, 2008

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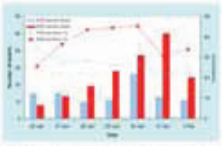
DHS Report Released April 6th, 2009

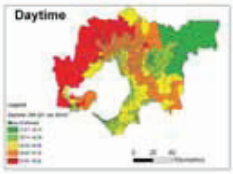
374 excess deaths Jan. 26 - Feb. 1 (62% jump over previous year)

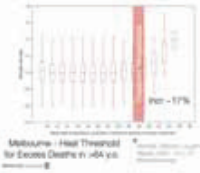
66% of excess deaths were in 75+ age group



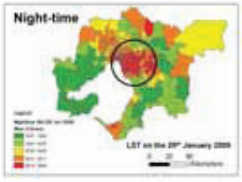
DHS 2009

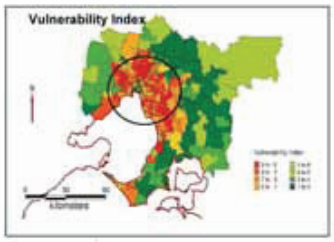
The Age, April 6, 2009





Melbourne - Heat Threshold for Excess Deaths in >64 y.o.





Heat and Vulnerability

Loughnan, Nicholls and Tapper, 2009a

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Heat thresholds for other Victorian centres

Loughnan, Nicholls and Tapper, 2009b

Major centre (SD)	Threshold temperature					
	Tmax		Tmin		MeanT	
Bendigo (Loddon)	40 (14)	8%	22 (18)	5%	32 (23)	18%
Wodonga (Hume)	40 (16)	20%	28 (4)	3%	30 (28)	None identified
Latrobe Valley (Gippsland)	36 (41)	16%	22 (8)	22%	30 (23)	18%
Horsham (Grampians)	38 (103)	10%	None identified	None identified	32 (33)	10%
Hamilton (Western District)	42 (6)	5%	24 (10)	7%	34 (2)	7%
Lakes Entrance (East Gippsland)	36 (21)	15%	23 (24)	7%	30 (10)	7%
Geelong (Barwon)	40 (19) 1 day lag	10%	26 (11)	4%	28 (39)	15%
Shepparton (Goulburn)	43 (3)	36%	26 (8)	13%	30 (23)	13%
Ballarat (Central highlands)	32 (13)	5%	18 (65)	10%	24 (16)	18%
Mildura (Mallee)	44 (7)	18%	27 (16)	10%	35 (20)	10%

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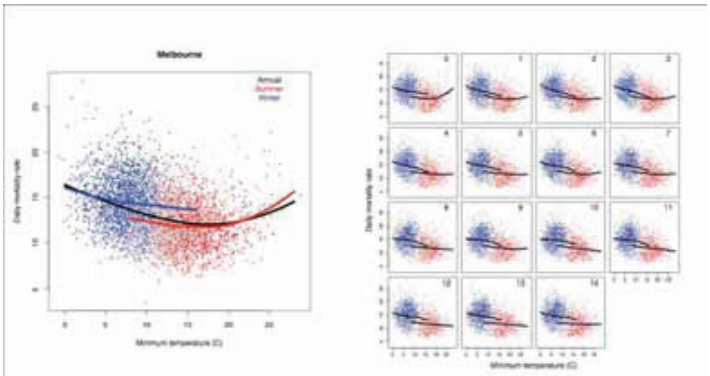

Seasonal and Synoptic Controls on Mortality in Melbourne

Nicholls, Loughnan and Tapper, 2010. Int J. of Health Geographics (in review)

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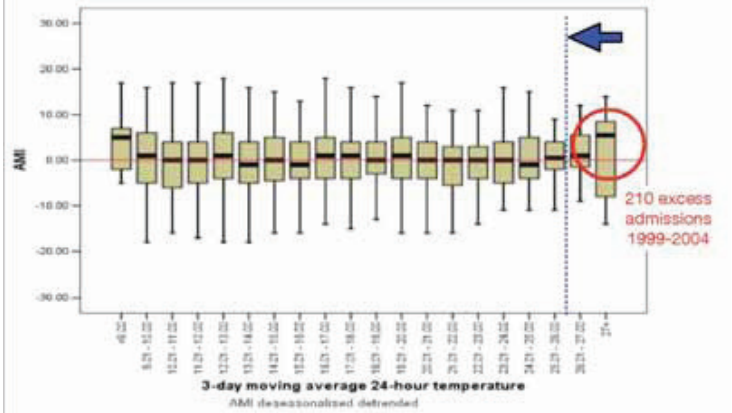

Melbourne Temperature and Excess AMI in >64 y.o.

Loughnan, Nicholls and Tapper, 2009c. Applied Geography

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The Health Costs of Extreme Temperatures

- For AMI health costs ONLY for Melbourne (i.e. not including mortality costs, other climate sensitive diseases or the costs to the economy of lost productivity)
- 210 excess admissions over period of 1999-2004 @ $8K/day for a average of 5 days = $8.4 million
- Projected dramatically increased costs of treating climate sensitive diseases over the next 25 years; e.g. Cardiovascular Disease 142%
- Combined effects of climate change, increased health care costs, increased urbanisation and aging population = $$$$

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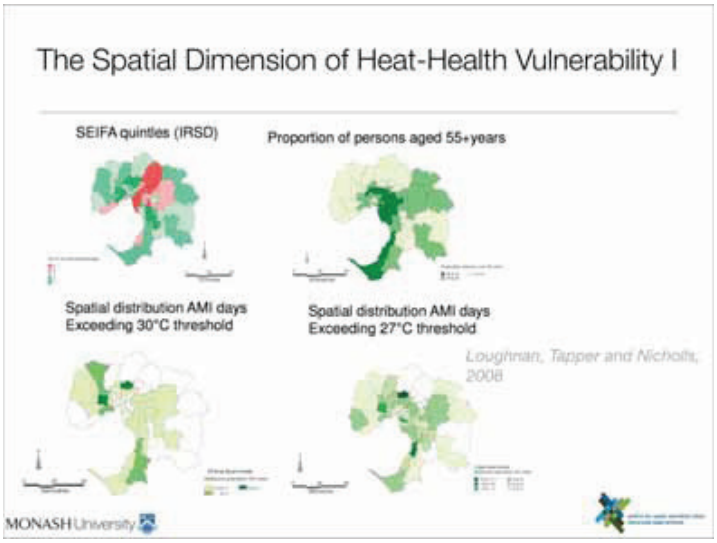
The Spatial Dimension of Heat-Health Vulnerability I
SEIFA quintiles (IRSD)
Proportion of persons aged 55+years
Spatial distribution AMI days Exceeding 30°C threshold
Spatial distribution AMI days Exceeding 27°C threshold
Loughnan, Tapper and Nicholls, 2008
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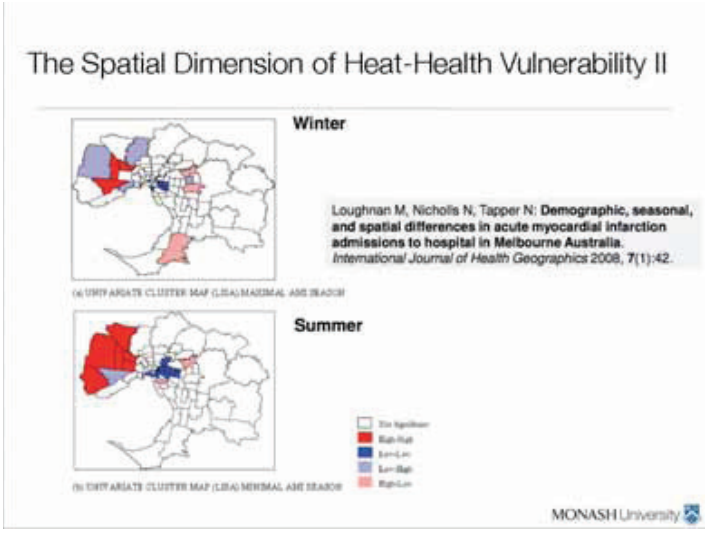
The Spatial Dimension of Heat-Health Vulnerability II
Winter
Loughnan M, Nicholls N, Tapper N: Demographic, seasonal, and spatial differences in acute myocardial infarction admissions to hospital in Melbourne Australia.
International Journal of Health Geographics 2008, 7(1):42.
Summer
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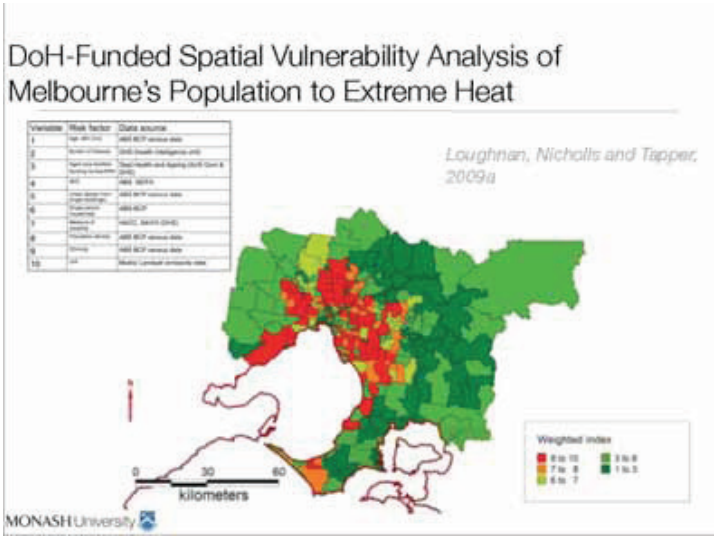
DoH-Funded Spatial Vulnerability Analysis of Melbourne's Population to Extreme Heat
Loughnan, Nicholls and Tapper, 2009a
Weighted index
0
30
60
kilometers
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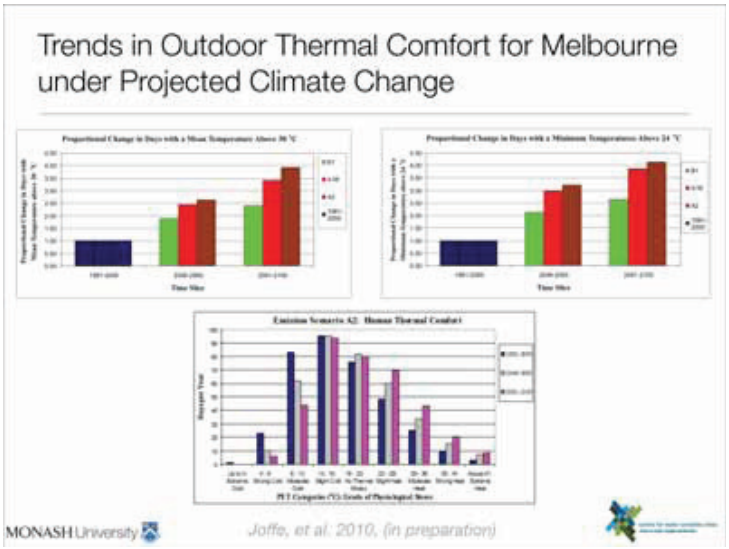
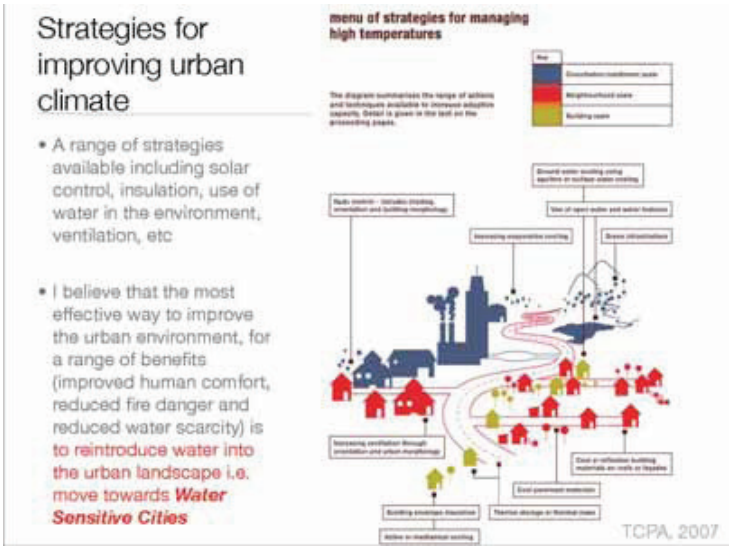

Trends in Outdoor Thermal Comfort for Melbourne under Projected Climate Change
MONASH University
Joffe, et al. 2010, (in preparation)


Strategies for improving urban climate
• A range of strategies available including solar control, insulation, use of water in the environment, ventilation, etc
• I believe that the most effective way to improve the urban environment, for a range of benefits (improved human comfort, reduced fire danger and reduced water scarcity) is to reintroduce water into the urban landscape i.e. move towards Water Sensitive Cities
menu of strategies for managing high temperatures
TCPA, 2007


Cities as "Water Supply Catchments"
• A multi-million dollar, innovative and multidisciplinary initiative lead in Australia by Monash University
• Being supported by the National Water Commission, the Victorian State Government and industry
• Highly relevant nationally AND internationally - particularly for cities with issues around climate change and water scarcity
http://www.watersensitivecities.org.au/
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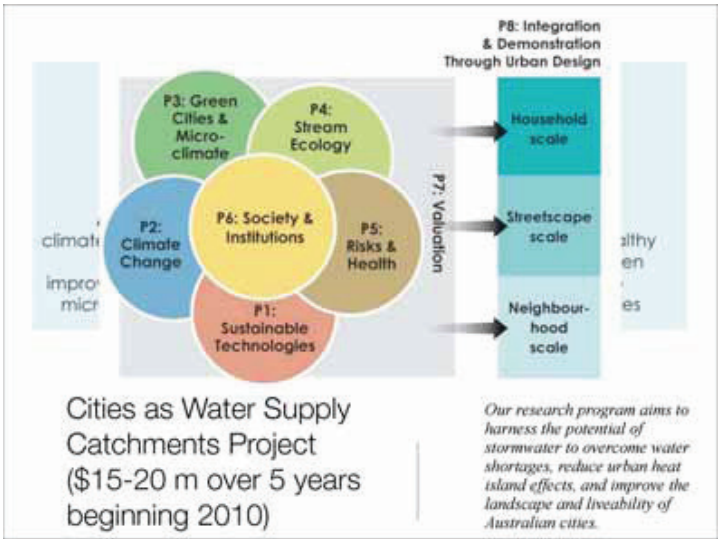
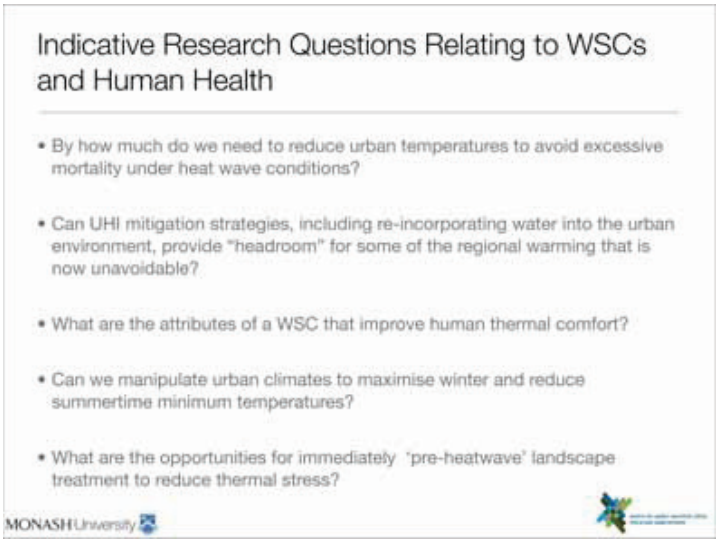
To harness the potential of storm water to overcome water shortages, reduce urban heat island effects, and improve the landscape and liveability of Australian cities.


P8: Integration & Demonstration Through Urban Design
P3: Green Cities & Micro-climate
P4: Stream Ecology
P2: Climate Change
P6: Society & Institutions
P5: Risks & Health
P1: Sustainable Technologies
P7: Valuation
Household scale
Streetscape scale
Neighbour-hood scale
Cities as Water Supply Catchments Project ($15-20 m over 5 years beginning 2010)
Our research program aims to harness the potential of stormwater to overcome water shortages, reduce urban heat island effects, and improve the landscape and liveability of Australian cities.


Indicative Research Questions Relating to WSCs and Human Health
• By how much do we need to reduce urban temperatures to avoid excessive mortality under heat wave conditions?
• Can UHI mitigation strategies, including re-incorporating water into the urban environment, provide "headroom" for some of the regional warming that is now unavoidable?
• What are the attributes of a WSC that improve human thermal comfort?
• Can we manipulate urban climates to maximise winter and reduce summertime minimum temperatures?
• What are the opportunities for immediately 'pre-heatwave' landscape treatment to reduce thermal stress?
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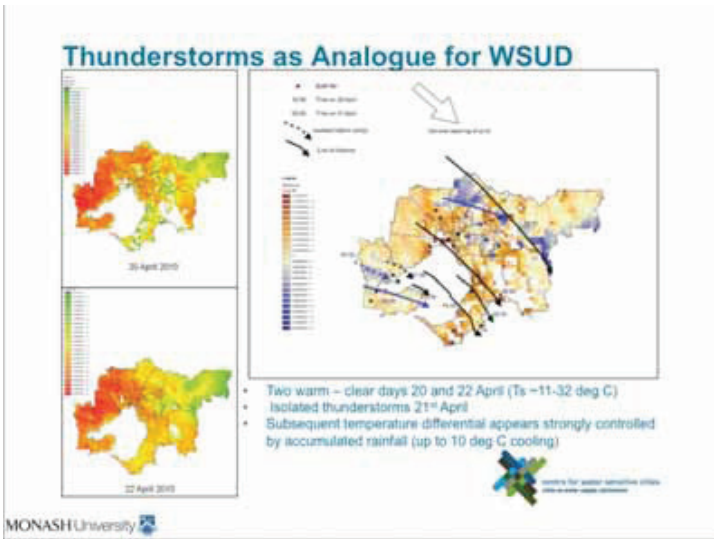
Thunderstorms as Analogue for WSUD
• Two warm – clear days 20 and 22 April (Ts ~11-32 deg C)
• Isolated thunderstorms 21st April
• Subsequent temperature differential appears strongly controlled by accumulated rainfall (up to 10 deg C cooling)
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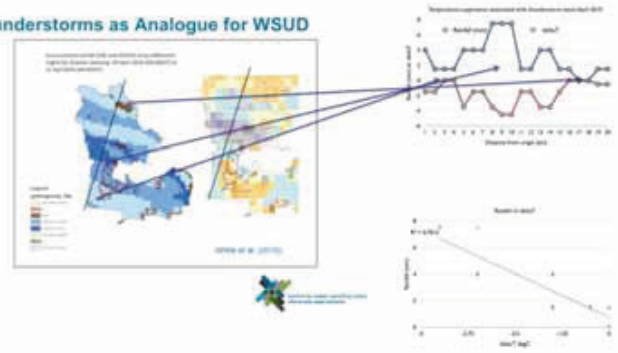
Water sensitive cities – keeping water in the urban landscape to achieve cooling II

Thunderstorms as Analogue for WSUD



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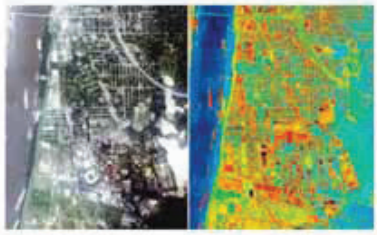
Concluding Comments

- Climate change poses particular problems in urban areas - probably no more so than in the world's Mediterranean regions
- It is critical to find innovative, cost effective and environmentally friendly approaches to mitigate the impacts of climate change in urban areas, particularly to solve issues around *human health and water scarcity.*
- We are working towards a solution for these problems. Inevitably some of these approaches will involve innovative use of urban water, in particular *wastewater reuse and storm water harvesting (and by implication dramatic increases in green infrastructure), water sources that are currently wasted*

Urban Heat Island



Recessed landscape for storm water capture and storage

Key References Cited

Coutts, A., Beringer, A. and N. Tapper, 2007, "Impact of increasing urban density on local climate: spatial and temporal variations in the surface energy balance in Melbourne, Australia", *Journal of Applied Meteorology*, 47 (4) 477-493, DOI: 10.1175/JAM2462.1

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Loughnan, M.E. Nicholls, N. Tapper, N.J. 2009c "When the heat is on: threshold temperatures for AMI admissions to hospital in Melbourne", *Australia. Applied Geography* 30,(1) pp 63-69.

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Tapper, N., White, E., Chandra, S. Beringer, J. and Coutts, A. 2010, Thunderstorms as analogue for water sensitive urban design. *Journal of Applied Meteorology (in preparation)*

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