Transforming cities: using green infrastructure to mitigate heatwaves

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Acknowledgement of Country

I acknowledge and pay respect to the traditional custodians of the land on which we, in our various places, are meeting today. I pay respect to Aboriginal and Torres Strait Islanders Elders past, present and future, and the continuing contribution they make to the life of this region and our country.

Reconciliation Australia
RECONCILIATION ACTION PLANS

Outline

1. Implications of increasing heat
2. Challenges in urban areas – those most vulnerable
3. Green infrastructure as one solution
4. Stepped approach
5. Opportunities

Acknowledgements: colleagues Tony Matthews GU, Jason Byrne UTAS, fellow urban planners

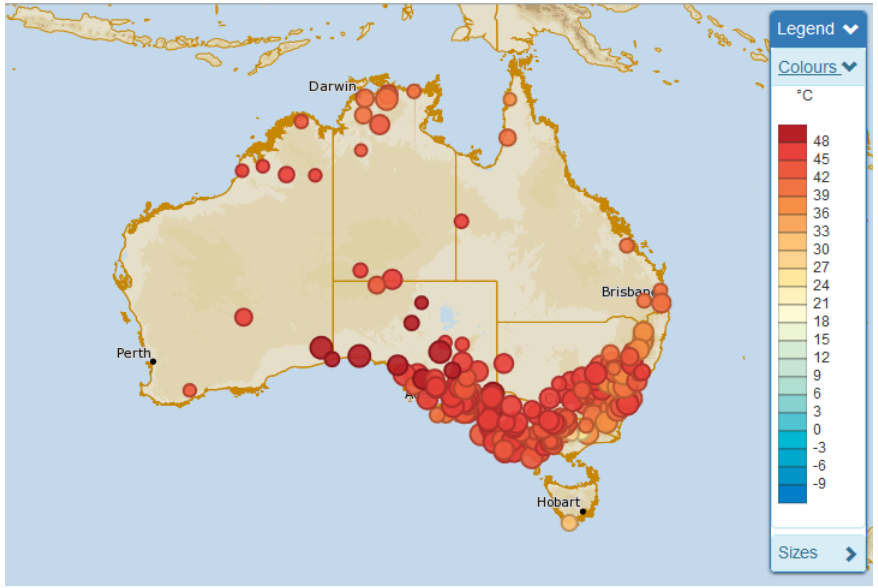
- The Conversation: Baldwin, Byrne, Matthews, March 2019, Saving ageing Australians from the heat – by greening our cities

https://theconversation.com/how-do-we-save-ageing-australians-from-the-heat-greening-our-cities-is-a-good-start-112613

- Baldwin C, Byrne J, Matthews T, 2020, 'Planning for older people in a rapidly warming and ageing world: the role of urban greening', *Urban Policy and Research*.38 (3): 199-212, DOI: 10.1080/08111146.2020.1780424

The problem: increasing heat waves

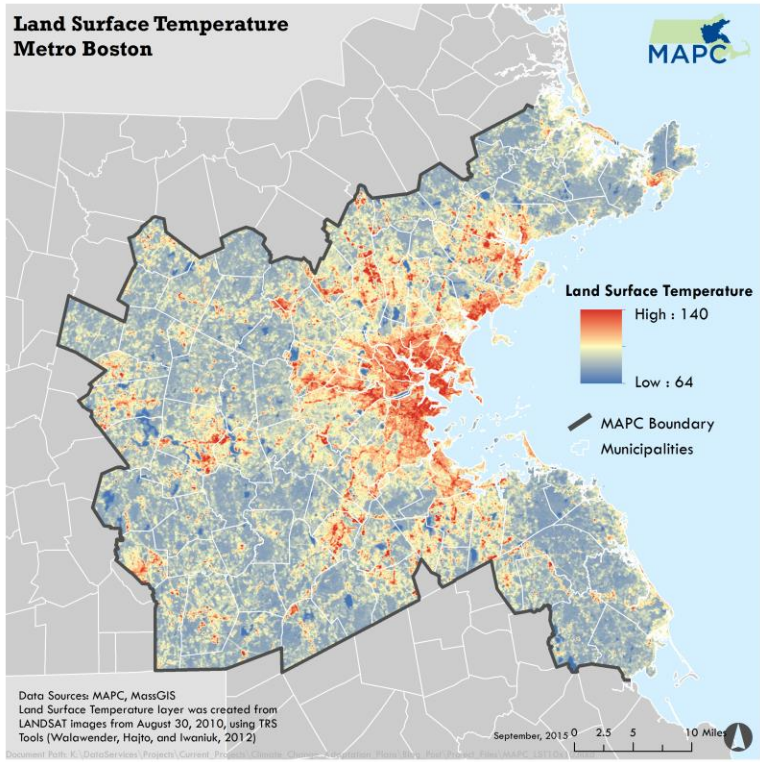
- Extreme heat events or ‘heat waves’ have increased in frequency, duration and intensity internationally over last two decades
- Continuing trend in future
- A heat wave - three or more days of high maximum and minimum temps that are unusual for a given location (BOM, 2016). It includes a combination of intensity and duration of high temp periods.
- Average temps continue to increase in all seasons. The 2018–19 summer was the hottest on record for Australia by a margin of 0.86 °C.
- 2019 was Australia’s warmest year on record, with annual national mean temperature 1.52 °C above average.
- In December 2019 there were 11 days in which the national area-averaged maximum was 40 °C or above. Prior to December 2019 there had been only 11 such days recorded since 1910. Many new records.(BOM 2020)
- By 2050, heatwaves on Gold Coast to Sunshine Coast could last for 10% of the year https://app.longpaddock.qld.gov.au/heatwave/
- While in tropical Qld they could last more than 50 days each year.



Locations with 30 or more years of data that had their hottest December day on record (BOM 2020)

Increasing problem for cities: urban heat island effect (UHIE)

- Australia's urban areas are densifying and expanding, increasing UHIE, where there are more hard surfaces and less green cover absorbing heat during the day (Deilami et al 2016).
- A comprehensive study of urban heat islands in Australia identified Ipswich, Logan, Toowoomba and Cairns as the most heat exposed among the 10 LGAs analysed in Queensland
- Many in southern Australia, including Botany Bay and Bankstown in NSW; and Darebin, Moreland, Frankstown, Ballarat in Vic.
- Measurements were based on VHHEDA index – vulnerability to **h**eat, **h**ealth, **e**conomic **d**isadvantage, **a**ccess to green spaces). (Amati et al 2017)
- See p 10 wsattg_combined-lr.pdf



Heat Map, Logan CC

Heat waves – a silent killer

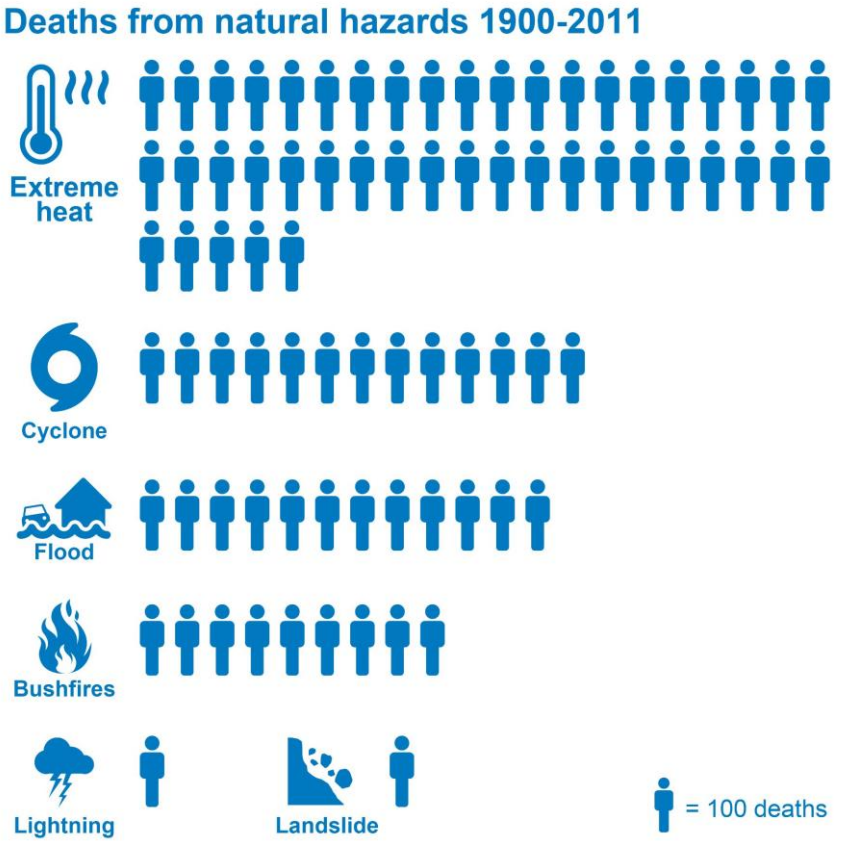
In Australia, up to 2011, more deaths from natural hazards were from extreme heat.

Especially affect those who are vulnerable:

- babies, the aging, people with disabilities (physical and cognitive), and the poor (Balbus & Malina, 2009; Medina-Ramón et al., 2006)
- those with pre-existing medical conditions, eg risk of chronic kidney and cardiovascular diseases (Kjellstrom et al., 2010; Wesseling et al., 2012). sensitivity to dehydration (Kovats & Hajat, 2008).

- By 2050, 25% of the population will be over 70 years age.

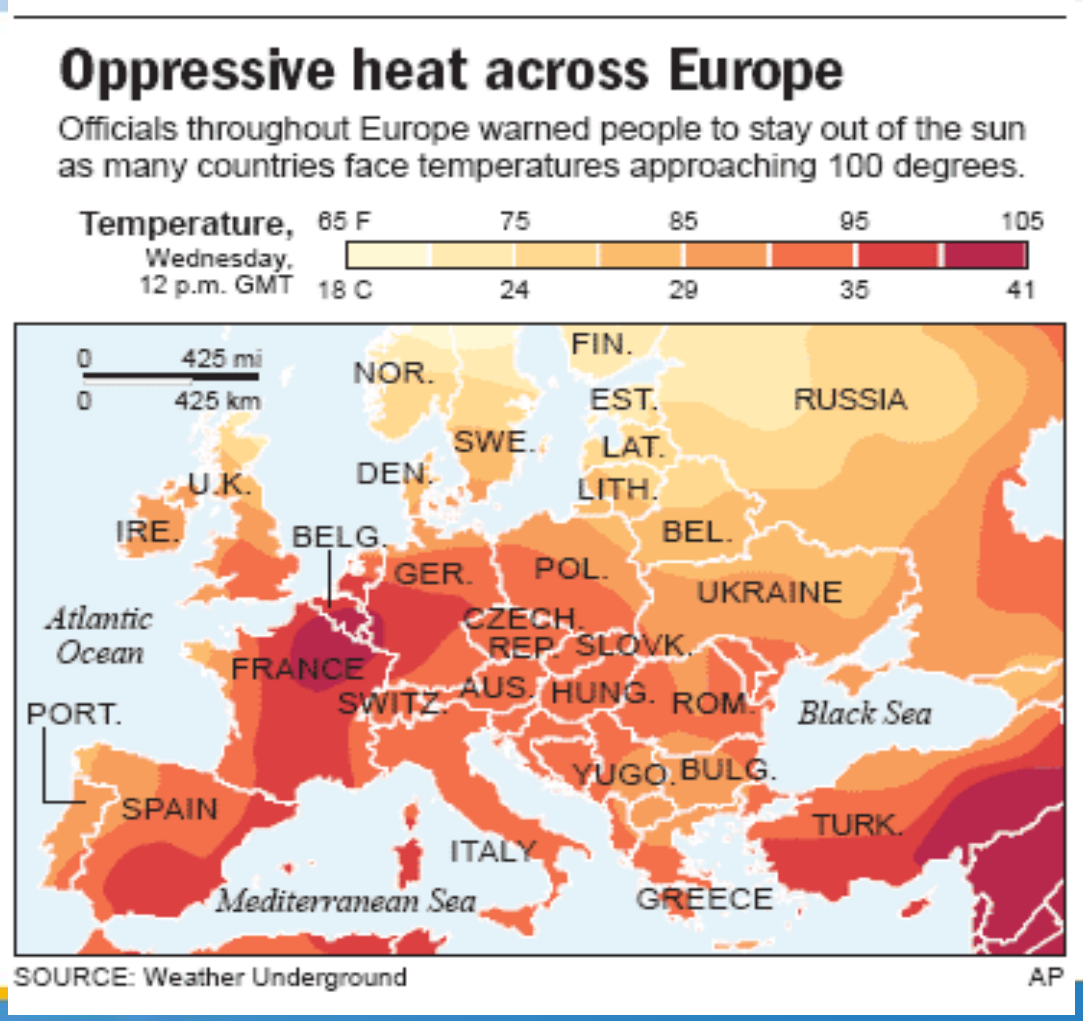
Coupled with decreased rainfall, heat results in an increase in bushfire risk, and intensifies drought. Heat waves have impacted GBR and marine life on WA coast, electricity, water and transport infrastructure.



Source: Department of Environment and Science adapted from McMichael et al., 2003

Heatwaves and the elderly

- Highest mortality in dense built up areas due to impervious surfaces and lack of vegetation (Harlan et al., 2013; Uejio et al., 2011); solar exposure and reflectivity (Rosenthal et al., 2007).
- Multi-day heatwave in Melbourne in 2014: 228 suspected heat-related deaths; 140 heat stroke
- Highest mortality during heatwaves in Melbourne 2009 were those aged 75 and older (Vic Dept of Human Services, 2009).
- Fire fatality in Vic - 2X as many older people died (Handmer et al., 2010)
- 2003 heatwave in Italy – 92% of mortality occurred among people 75+ (Conti et al., 2005)



What's the problem in a nutshell?

There is an urgent need to prepare our cities and residential environments to minimise heat stress in future climate.

What is the solution?

While short-term preparation and prevention include warning systems, behavioural change, and emergency services (Kovats& Hajat 2008) are needed, but we need to mitigate UHIE

Strategic use of Green Infrastructure (GI) can make a difference

- GI research is not well integrated with urban design and planning
- Multifunctional green-spaces need to be strategically planned and managed to provide ecological, social, and economic benefits (Matthews *et al*. 2015, p.155).
- Green infrastructure interventions can occur in:
  - Public open space - street trees, permeable and vegetated surfaces, green alleys and streets, urban forest, public parks, community gardens, golf courses, parking lots, urban wetlands and constructed wetlands (WSUD)
  - Buildings and private spaces – green roofs or walls of private buildings such as offices and warehouses, and public buildings such as hospitals, schools; wide overhangs; trees, permeable and vegetated surfaces.

Different types of green infrastructure

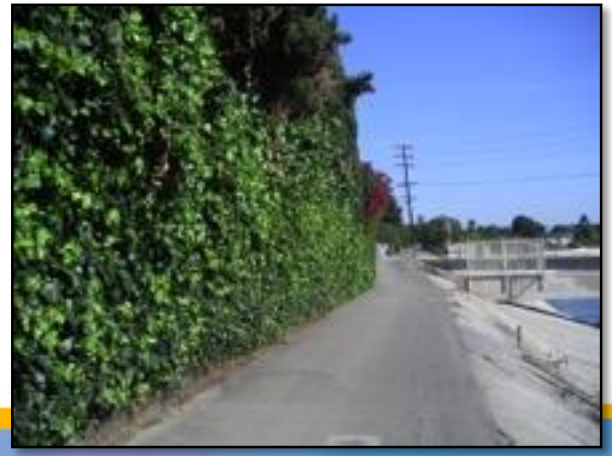
Wetlands (Copenhagen)

Street Trees (Barcelona)

Swales (Malmo)

Permeable Paving (Malmo)

Parks (Los Angeles)



Green Walls (L.A.)

Greenways (L.A.)

Green Roof (Melbourne)

- Hard surfaces may comprise up to 67% of urban land area
- ‘Green’ areas in cities as low as 16%
  - Each 1°C rise in temperature drives electricity demand by 2 - 4%
  - Mortality increases up to 3% with every 1°C increase in temperature
  - Increasing tree cover by up to 5-10% can reduce diurnal temperatures by as much as 2-5°C
  - Green walls and roofs may cool some urban areas by up to 8°C; up to 20°C over roads (Byrne, Lo & Jianjun, 2015)

‘Thermal inequity’ (Byrne, Matthews & Ambrey, 2016)

- People who live in greener, leafier suburbs tend to be wealthier
- Greener neighbourhoods are usually healthier and happier
- The opposite often occurs in poorer suburbs, with residents suffering more heat stress
- A consequence of fewer street trees, less green space and denser urban design
- Therefore the costs of staying cool fall more disproportionately on less well-off residents – ‘thermal inequity’

Functions of GI

(Adapted from de Groot et al., 2010; Roy et al., 2012)

Environmental

- regulate ambient temperatures
- reduce noise
- lower wind speeds
- sequester carbon
- attenuate runoff/flood prevention
- enhance/augment biodiversity habitats
- intercept pollution

Urban wetland, Malmo, Sweden

Functions of GI

(Adapted from de Groot et al., 2010; Roy et al., 2012)

Social

- relieve stress, restorative
- reduce morbidity and mortality
- restore attention
- foster active living – health and recreation
- encourage social interaction
- moderate incivility

Hyde Park, London

Functions of GI

(Adapted from de Groot et al., 2010; Roy et al., 2012)

Economic

- reduce stormwater costs
- reduce cooling costs
- decrease health-care expenses
- increase property values
- provide food and medicine
- fosters tourism

Planchonella House, Cairns

GI Disservices (Roy et al., 2012)

Environmental

- human-wildlife conflict, weeds and/or pest species, lower groundwater, wildfire, reduced wind-flow.

Social

- eco-gentrification, health impacts (e.g. asthma, allergies), changed character of an area, fear of crime, animal attacks

Economic

- increase property values, increase heating expenses, infrastructure damage, increased maintenance costs, insurance costs, light reduction

A Stepped Approach to transforming UHIE

(adapted from Norton et al 2015)

1. Identify priority neighbourhoods, street and alley/property scale – heat/solar exposure and vulnerability – thermal mapping, ABS stats, community profile
2. Audit existing and potential for GI and WSUD: water sources, building heights, geometry and orientation, using visual field survey and remote sensing imagery, supplemented by heat sensors to provide a baseline.
3. Undertake CPTED (Crime Prevention and Environmental Design) and accessibility audit.
4. Potential for tree canopies for shading and evapotranspiration cooling; mix of trees to minimise heat trapping; green open space; green facades along walkways; green roofs (more complex); WSUD/stormwater harvesting/rainwater tanks.
5. Community engagement throughout to maximise uptake.

Three Queensland-based Studies

Location	Benefits	Concerns
Gold Coast - Upper Coomera (Byrne, Lo & Jianjun, 2015)	Shade; wildlife; air quality; scenery; energy savings; increase park use; cleaner air; friendlier neighbourhood	Maintenance costs; footpath damage; attract pests; increase fire risk; increase storm damage; allergies
Aged care facility operators (Baldwin et al, 2020)	Cost savings from natural cooling; health and well-being benefits from interaction with nature and activity; cultural and social connections; attractiveness for marketing purposes/product differentiation	Suitability of GI – species selection, trip hazards, accessibility; cost-benefit; maintenance; retrofitting
Seniors living in neighbourhood – Brisbane and Sunshine Coast (Baldwin et al, 2012)	Cost-effective natural sustainability features; accessibility/walkability in shady public spaces; outdoor amenity; fostering interaction	Maintenance; safety; security

Multiple benefits of greening

- Cools surroundings, shade reduces skin exposure to sun
- Cost-effective means of heat reduction, less energy required to cool buildings
- Improves aesthetics
- Improves quality of life, health and wellbeing:
  - Provides stress relief, improves mental health
  - Enables maintaining social connections
  - Increases physical activity level e.g. promotes walking for leisure – translates into medical cost-savings
- Benefits local residents and tourists

Some challenges

- Increasing heat is inevitable with climate change effects ‘locked in’ for the near future
- Need to be cautious that adaptation approaches do not compound UHIE (e.g. air conditioners)
- Hotter climate and water availability may affect the type of plants used and viability; species could vary with climate change
- Increasing severe storm and bushfire events make people wary about planting trees near homes
- Trend in high site coverage reduces space for private vegetation cover
- In new denser subdivisions, there is increasing reliance on public space to mediate effects - implications for Council budgets

02 NEWS

FEELING HEAT ON REMOVING TREES

It's so hot up north kids can't even use playground

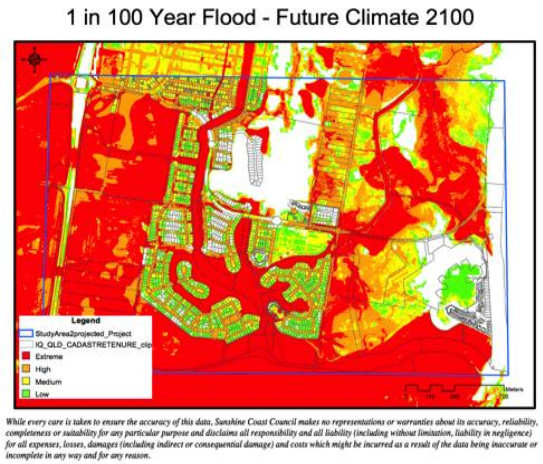
Opportunities

- Improved and mandatory thermal mapping in cities and towns to identify priority areas to target with GI
- Consider vulnerable institutions and people (health, aged care, education)
- Strategically use green space for cooling effects; reduce impermeable surfaces in tandem with better water management
- While WSUD is incorporated in new developments, need to review options in existing communities
- Consider use of green walls and roofs – need location and climate appropriate advice about vegetation; eg local laws in Toronto and Paris require new large buildings (e.g. warehouses) to have green roofs and/or solar panels

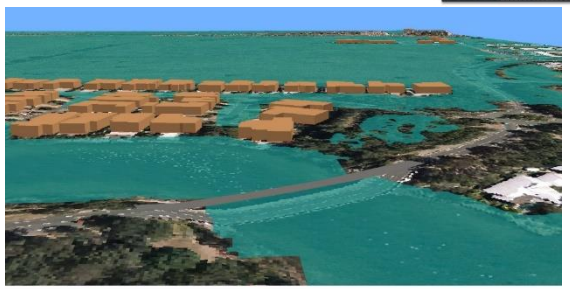
Opportunities

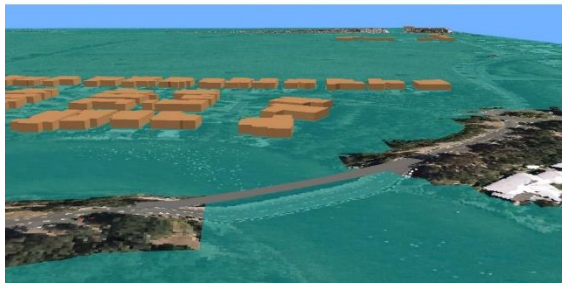
- Coordinate street tree planting with placement of services including electricity – revisit existing developments
- Multiple benefits from assessment/checklist of best practice GI, Universal Design features for accessibility, CEPTD for security, and Qdesign (subtropical/tropical)
- Build on and provide evidence of current good work of Councils e.g. SCC Street Tree Master Plan and Verge Guidelines; CCC heat monitoring
- Use visualisation methods in expert/community engagement

Using innovative visual techniques for 'imagining'



1) Community identified vulnerable areas; 2) provided photos of vulnerability and values (photovoice); 3) photos mapped on to vulnerable sites; 4) Council vulnerability maps; 5) visualisation of scenarios (Grant, Baldwin et al 2014)





Summary and way forward

- Compounding effect of increasing urban population; densification with accompanying reduced vegetation cover in cities; increasing heat from climate change; and social issues of aging and PWD
- Need to improve comfort, walkability and safety in public and private spaces during heat waves.
- Green infrastructure is one way of doing that with multiple health and well-being benefits, as well as biodiversity and carbon reducation benefits at reduced costs.

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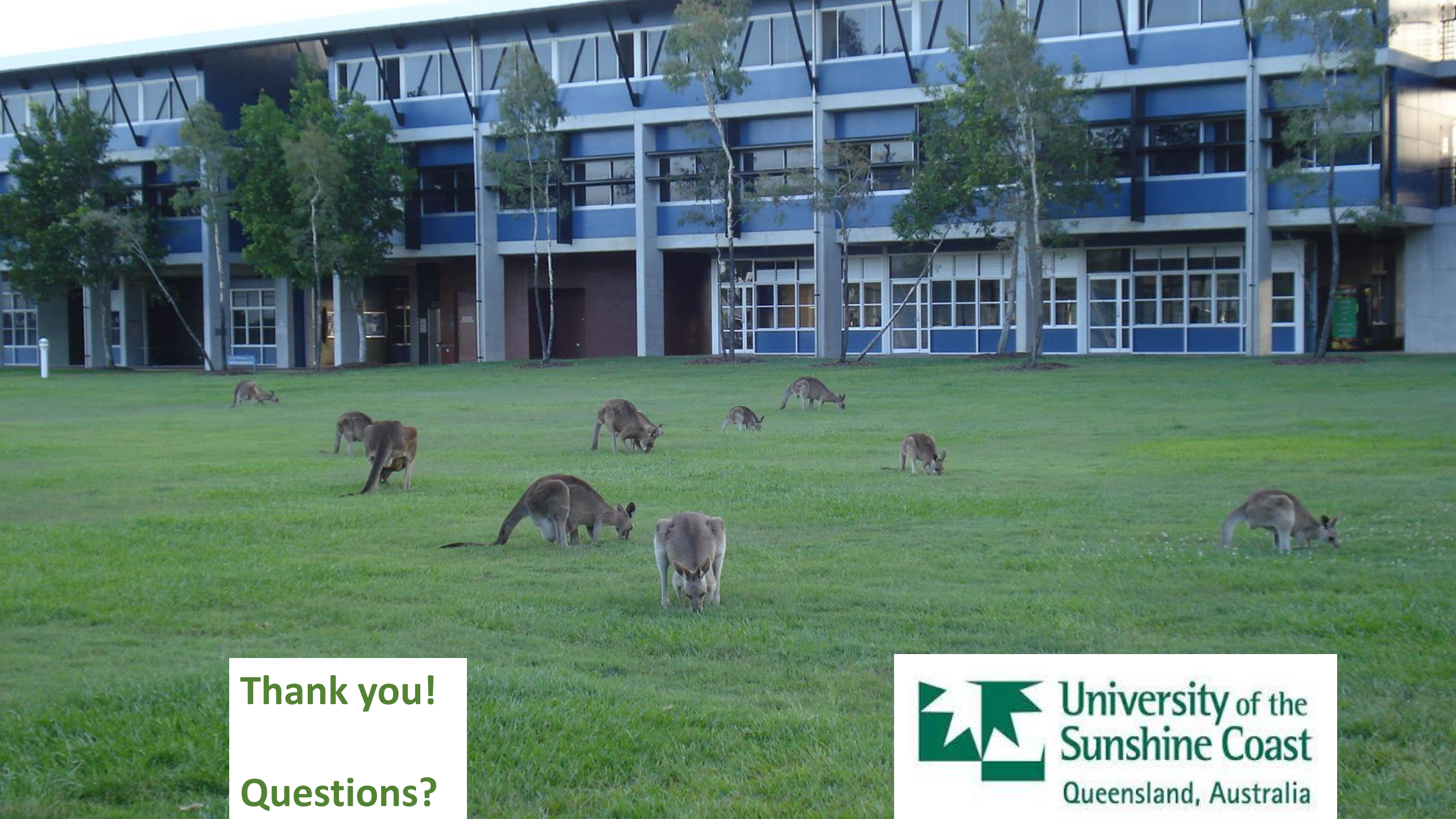

Thank you!

Questions?

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