Daytime irrigation significantly reduces air and surface temperatures in backyards

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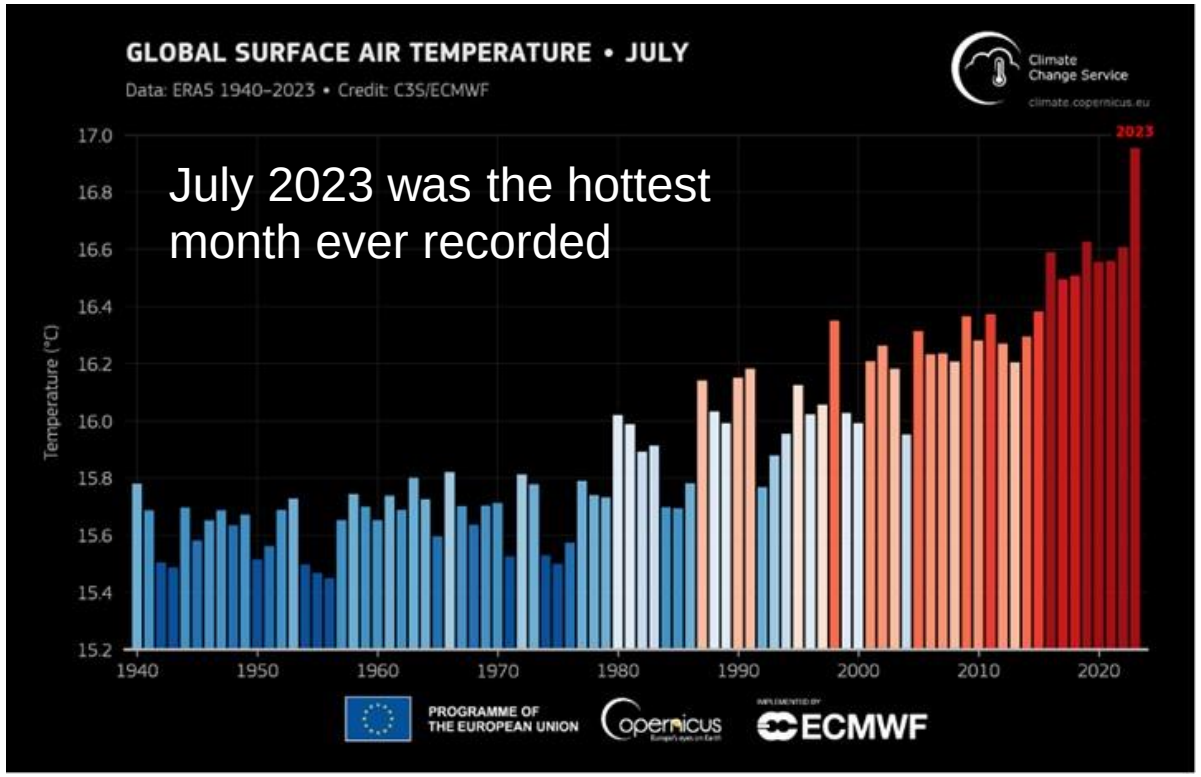
Private backyards are important green spaces

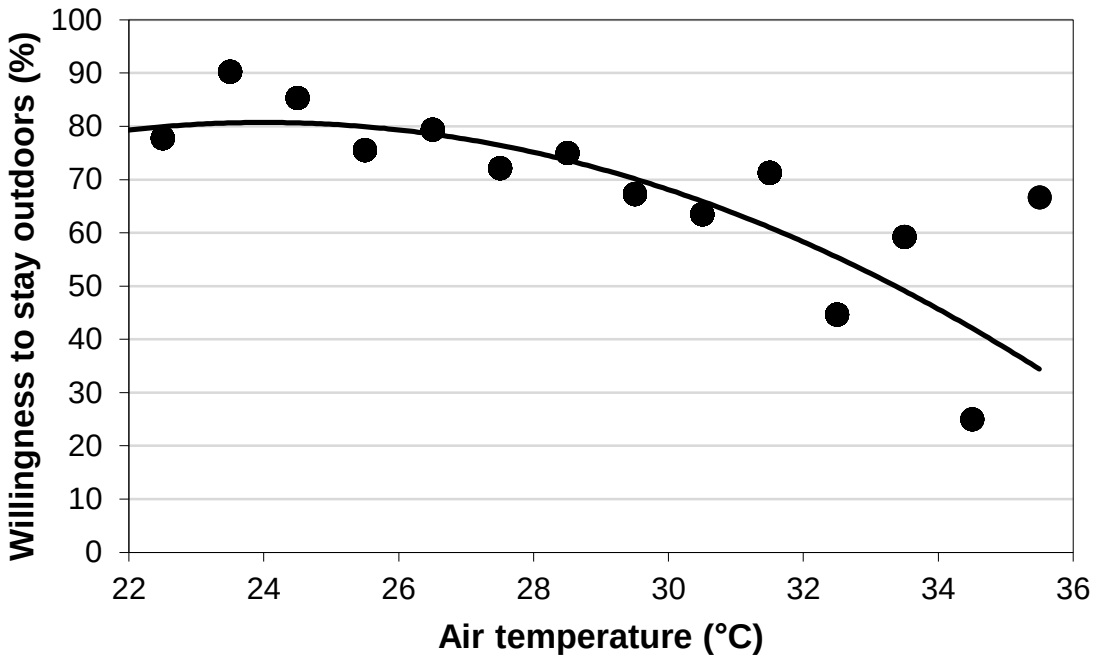
Socialise and relax

Children to exercise and get exposed to nature

Warmer climate reduces willingness to stay outdoors



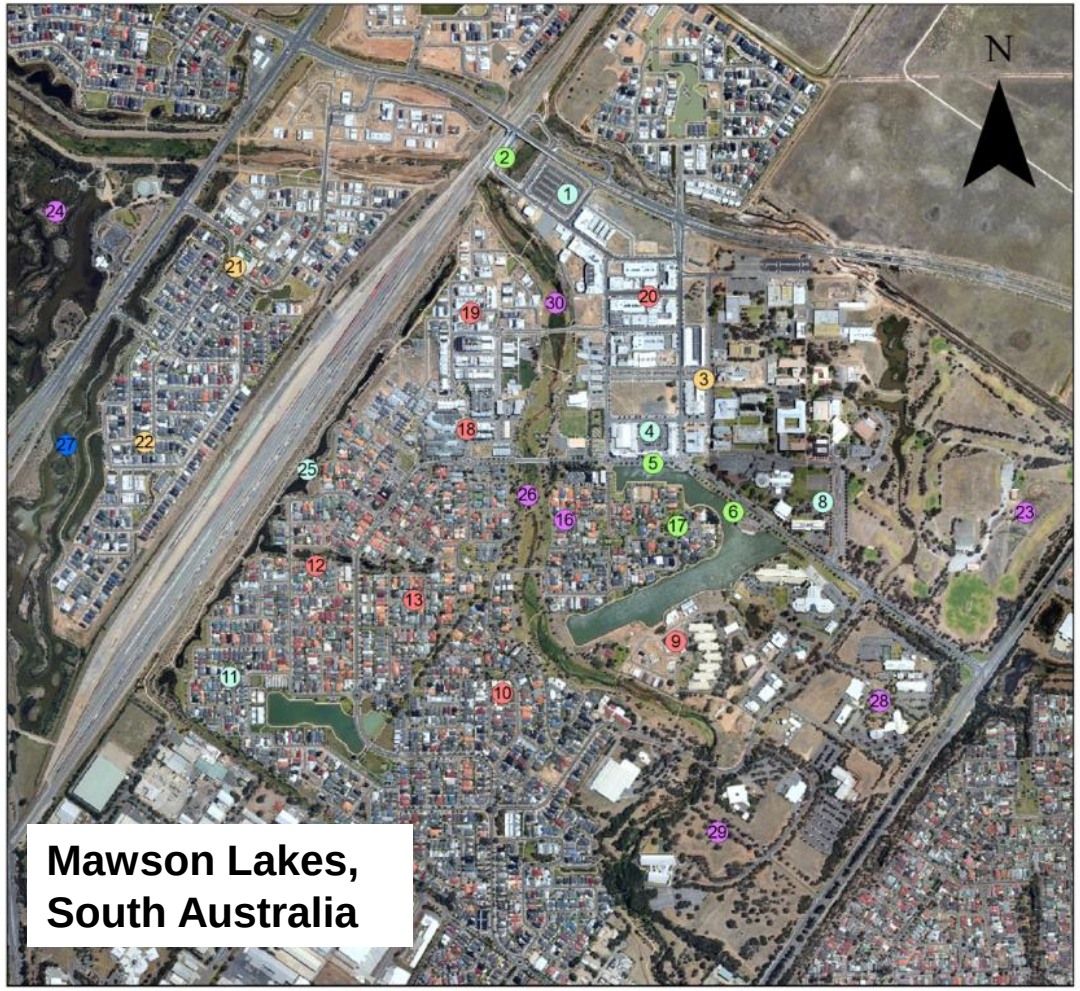
https://public.wmo.int/en/media/news/copernicus-confirms-july-2023-was-hottest-month-ever-recorded

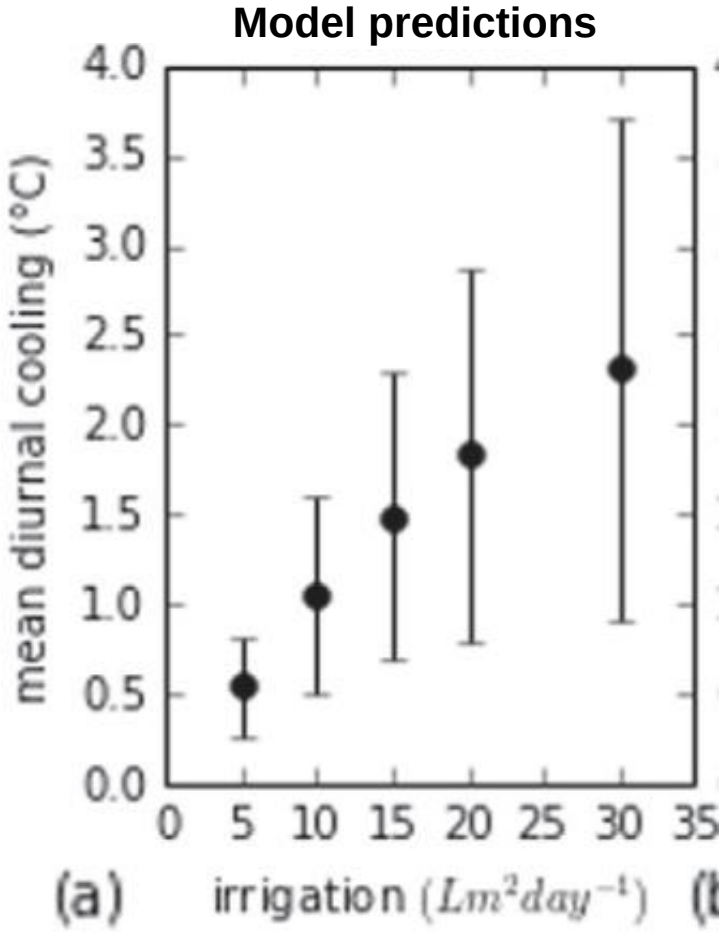


Cheung, P. K., & Jim, C. Y. (2019). Improved assessment of outdoor thermal comfort: 1-hour acceptable temperature range. *Building and Environment*, *151*, 303-317.

Planting trees in backyards is not feasible

Irrigation as a cooling strategy





Broadbent, A. M. et al. (2018). The cooling effect of irrigation on urban microclimate during heatwave conditions. *Urban climate*, *23*, 309-329.

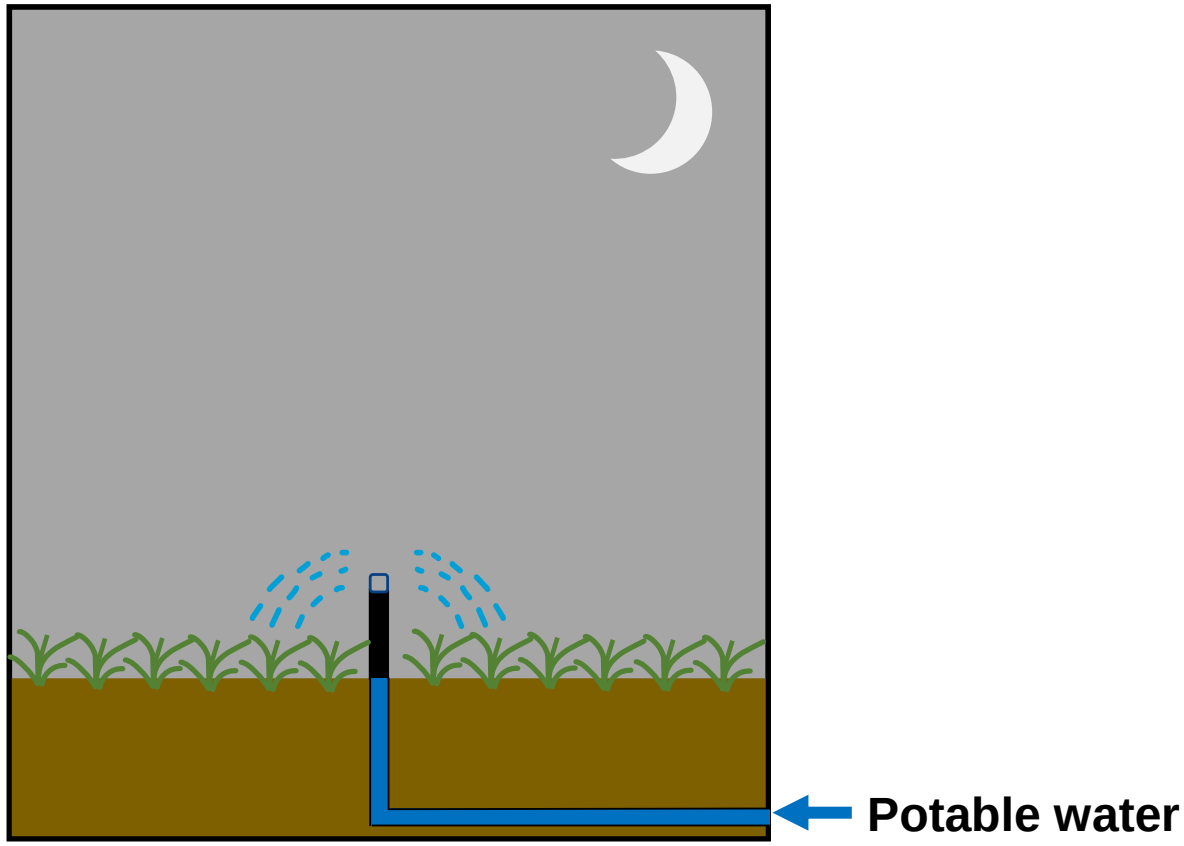
More experimental data is needed

Irrigation cooling experiment at Burnley Campus

Irrigation for cooling green spaces is different

Irrigation for plant health:

1. Irrigate by **night**
2. Maximise **water use efficiency**



Irrigation for cooling green spaces is different

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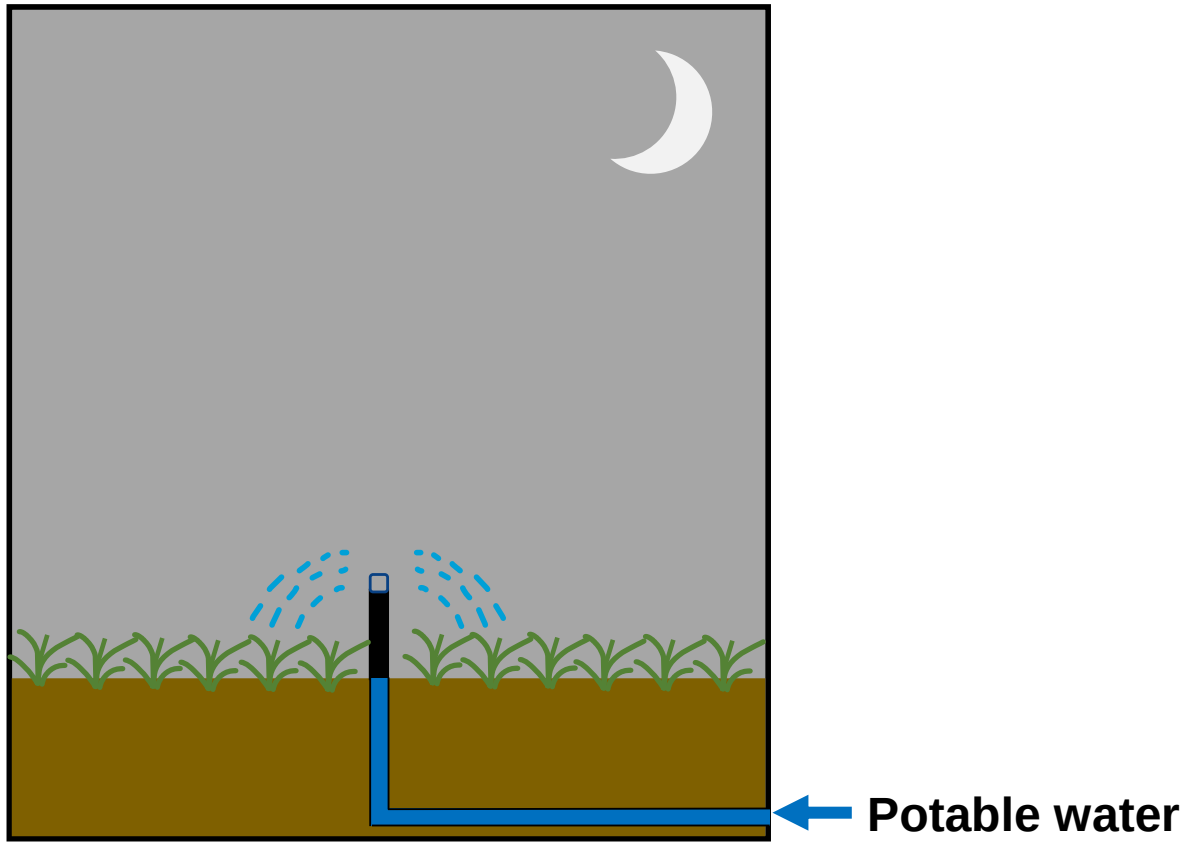
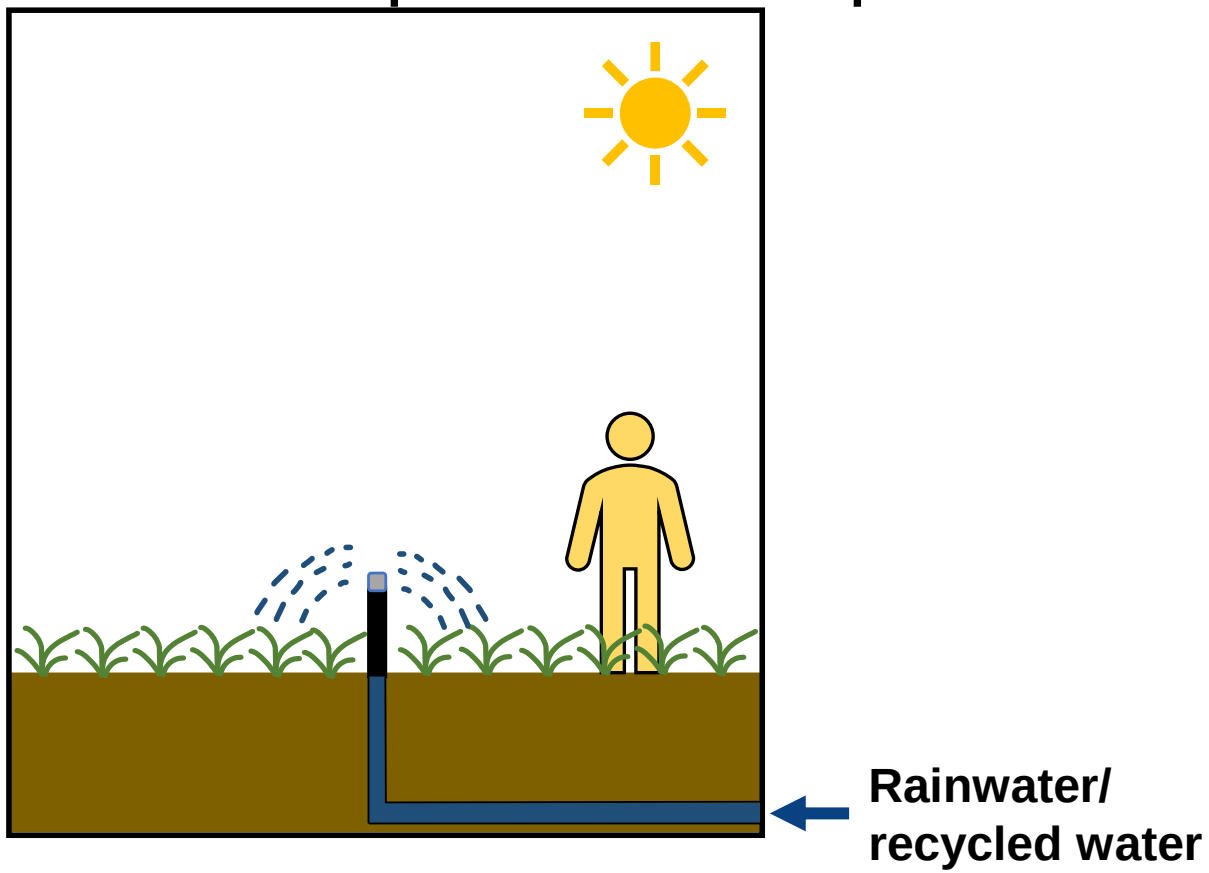


Irrigation for cooling green spaces:
1. Irrigate by **day/night**
2. Maximise **evaporation** and **transpiration**



Irrigation cooling experiment

Hypotheses:

1. Irrigated turf is significantly cooler than unirrigated turf during the day.
2. Daytime cooling effect strengthens with increasing irrigation amount (2, 4 and 7 mm d^{-1}).

Study period:

2021-01-27 to 2021-03-02 (35 days)

Burnley Campus,
University of Melbourne

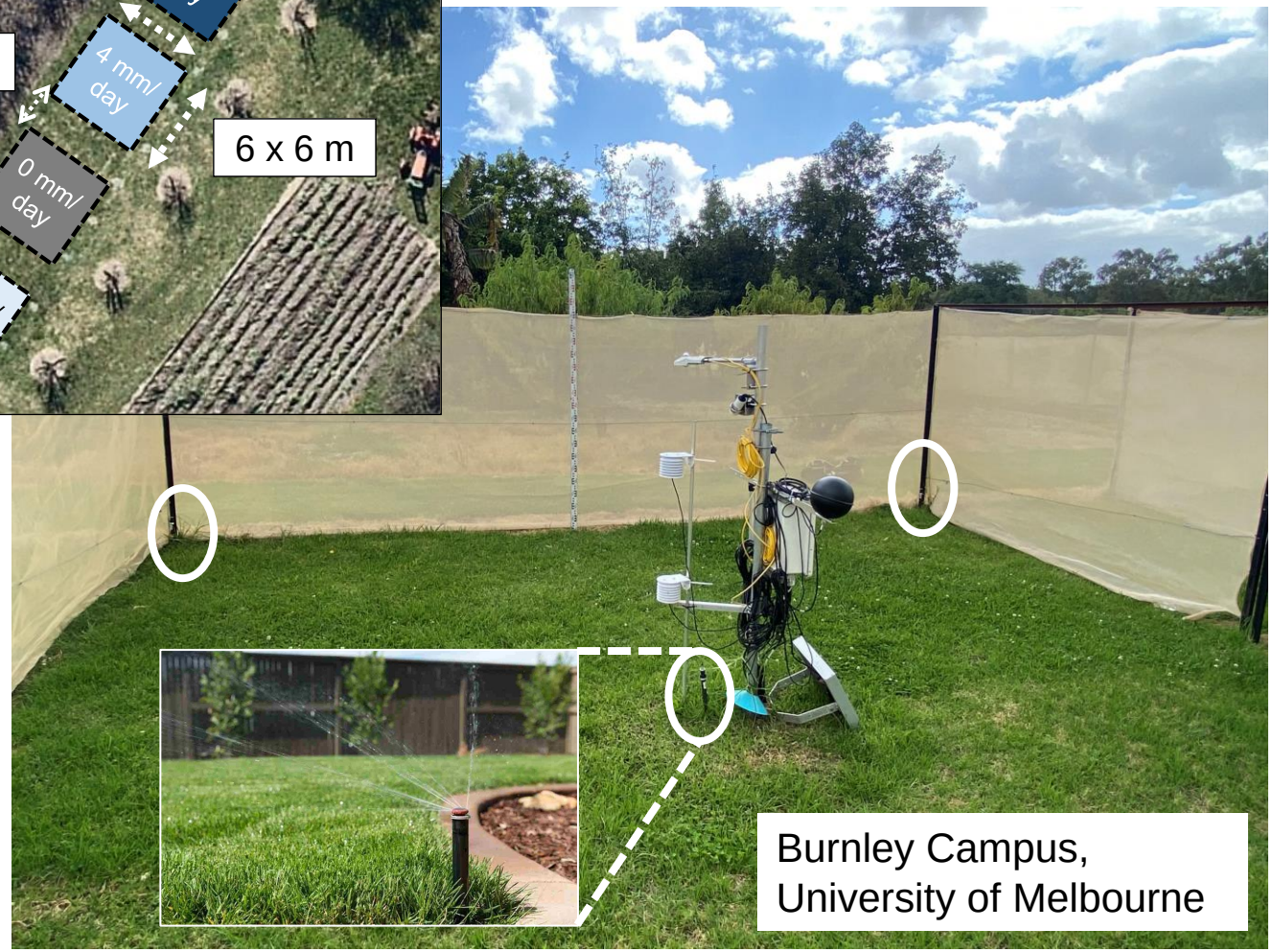
Irrigation cooling experiment – Methods

Measurements in each plot:

1. Soil moisture content (–0.04 m)
2. Air temperature (1.1 m)
3. Turf surface temperature
4. Vapour pressure (1.1 m)
5. Wind speed (1.1 m)
6. Black globe temperature (1.1 m)

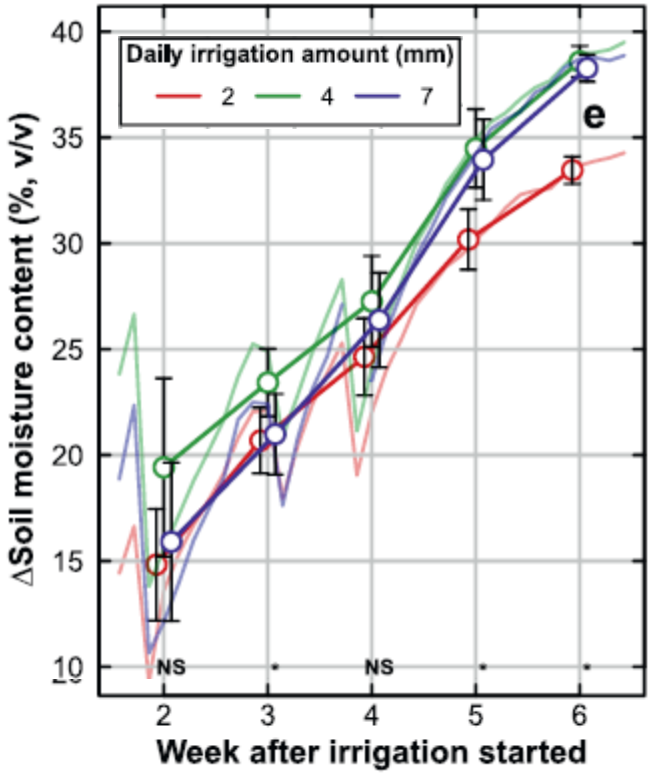
→ *Mean radiant temperature (1.1 m)*

→ *Universal Thermal Climate Index (1.1 m)*



Burnley Campus,
University of Melbourne

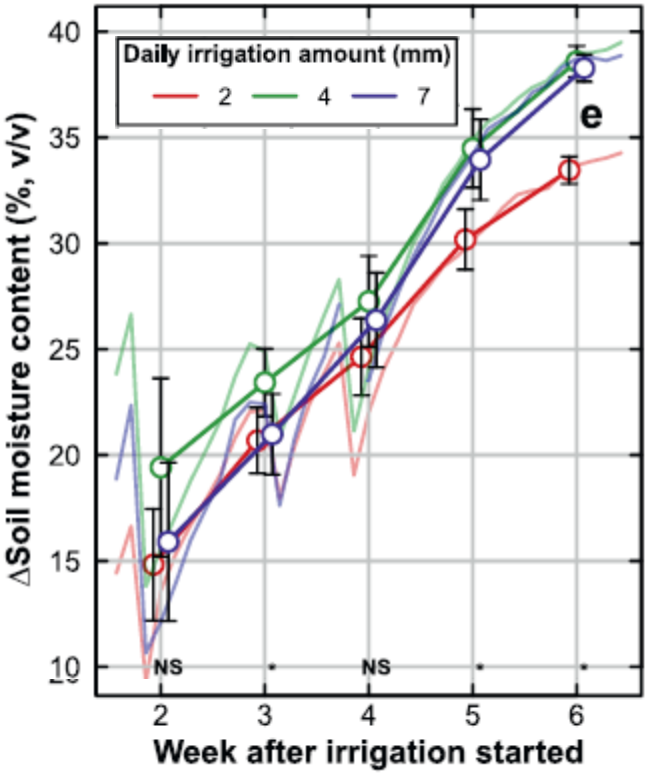
Irrigation cooling experiment – Results



x-axis = Week after irrigation started

y-axis = Daytime (10:00 – 15:59) mean difference in soil moisture or microclimate (irrigated plot – unirrigated plot). Δ = difference.

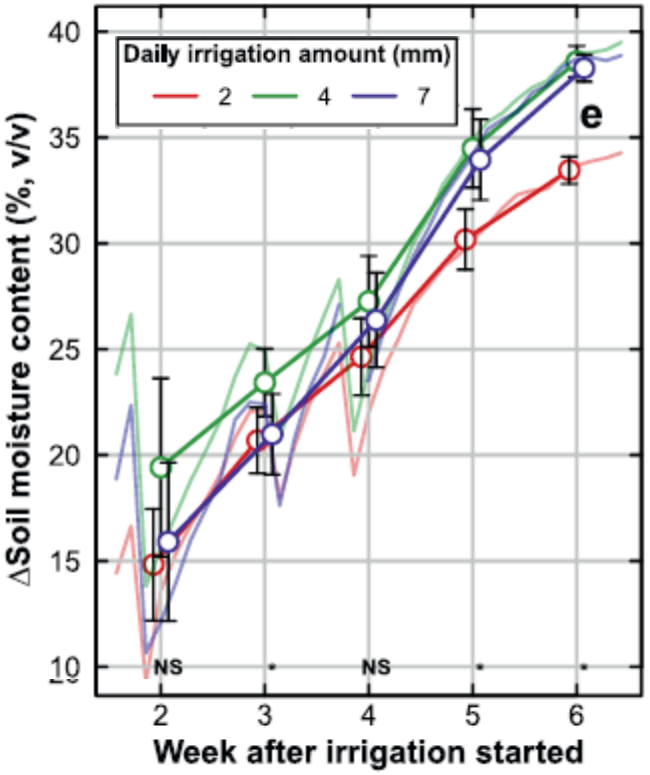
Irrigation cooling experiment – Results



Soil moisture content

1. ΔSoil moisture increased from week 2 to 6.

Irrigation cooling experiment – Results



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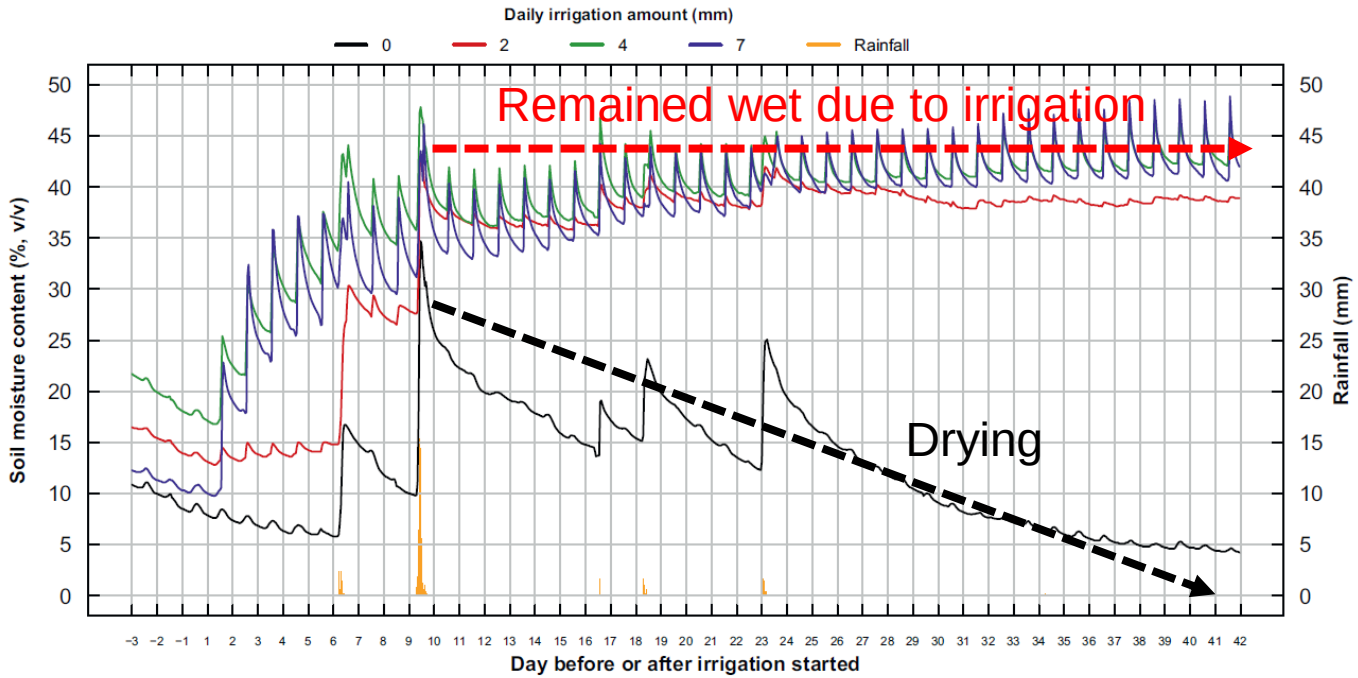

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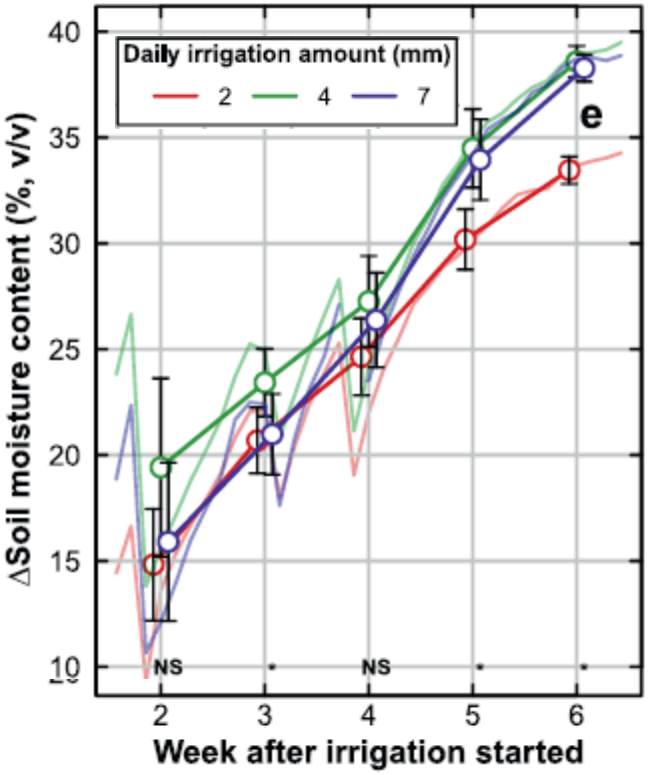
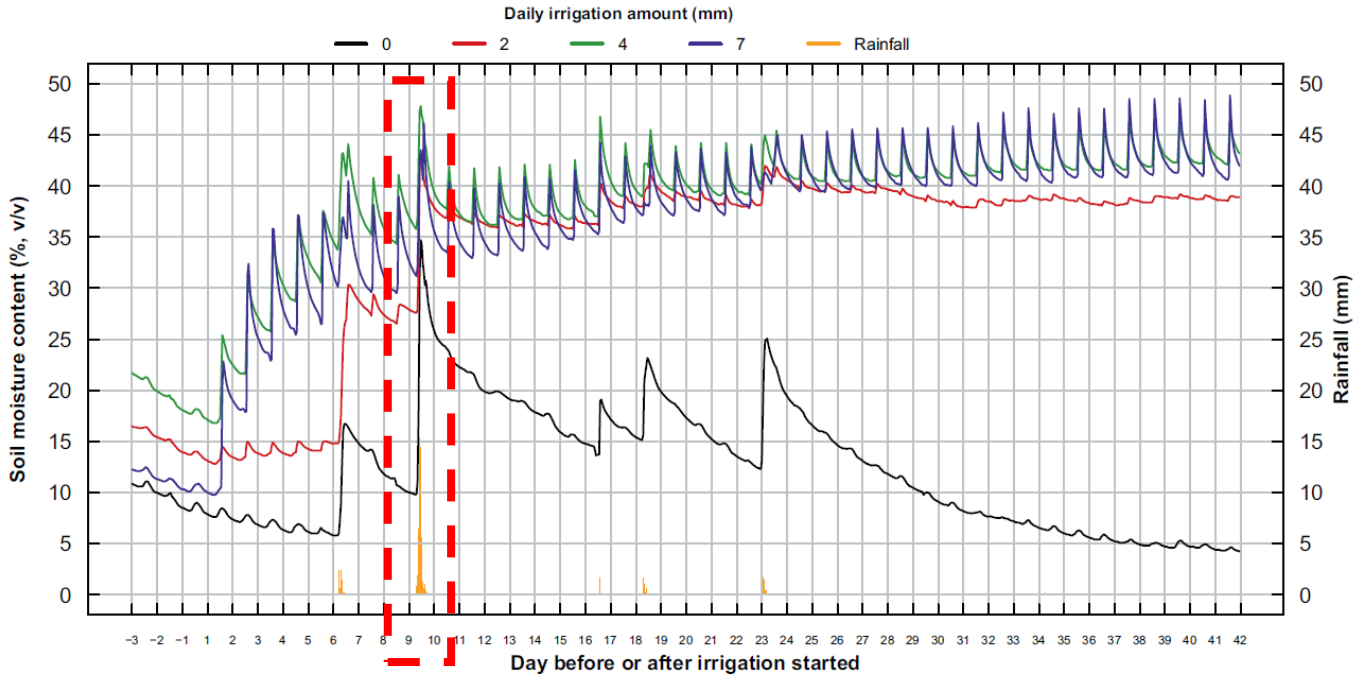


Soil moisture content

1. ΔSoil moisture increased from week 2 to 6.
2. Differences between the three treatments were small (<10%).



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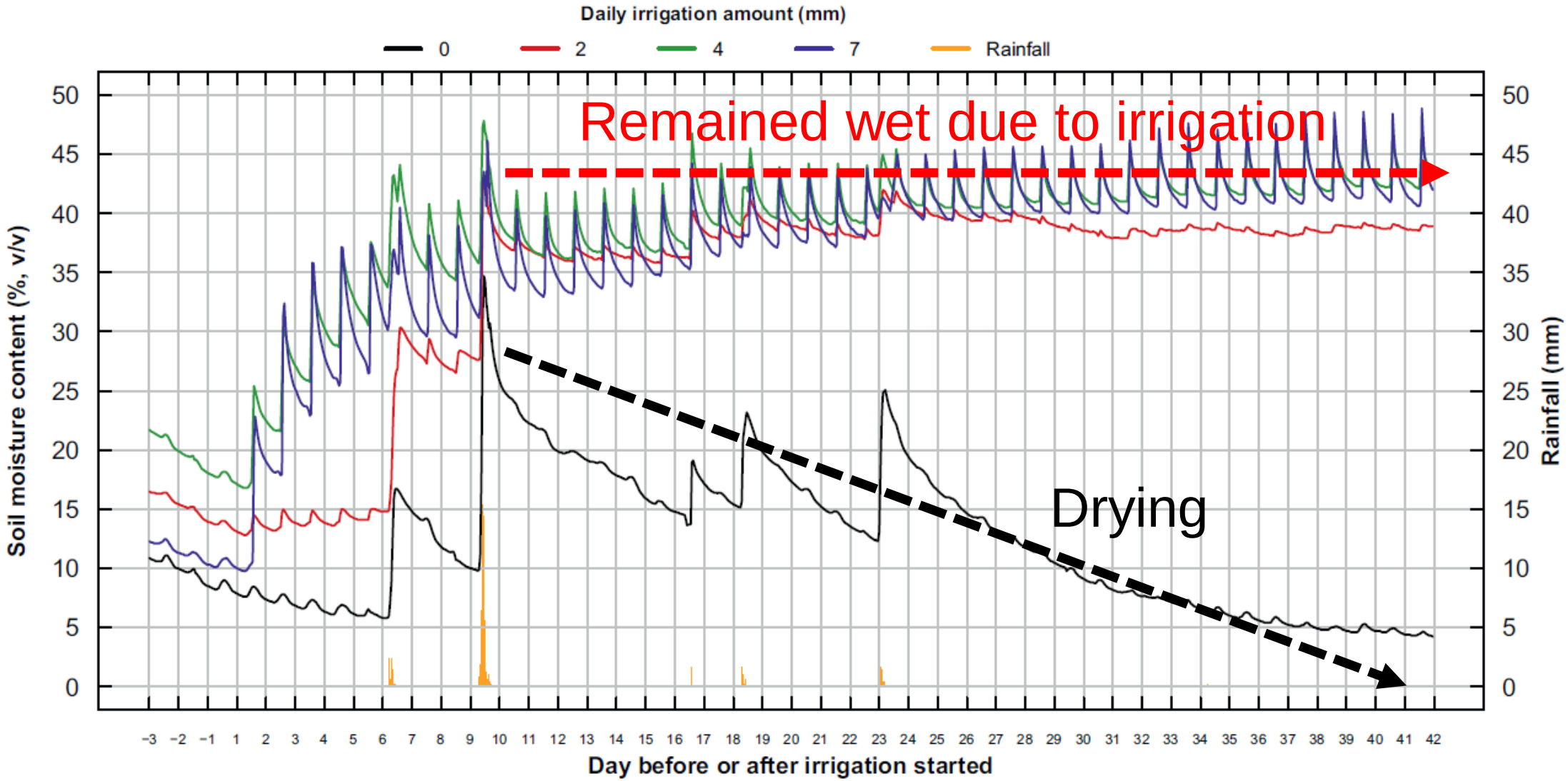

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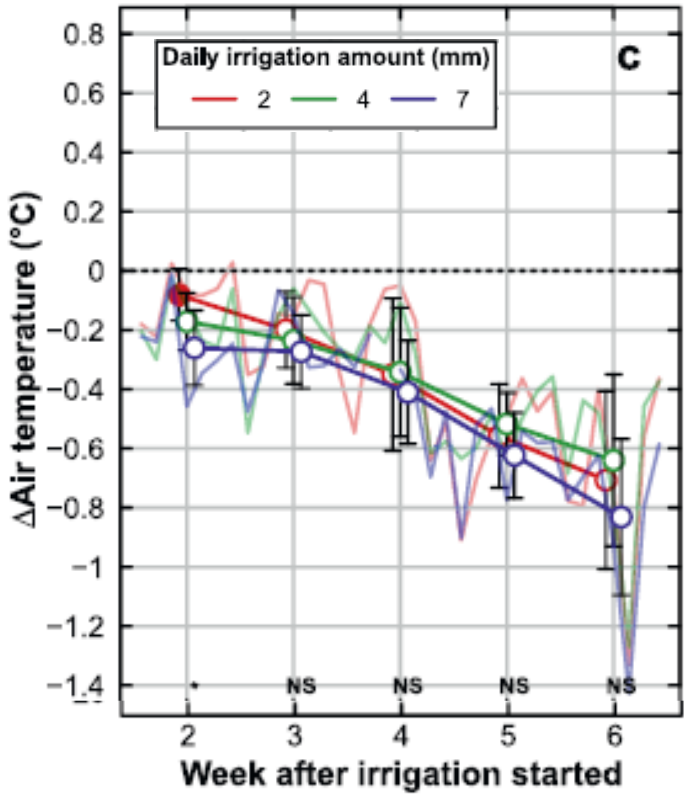
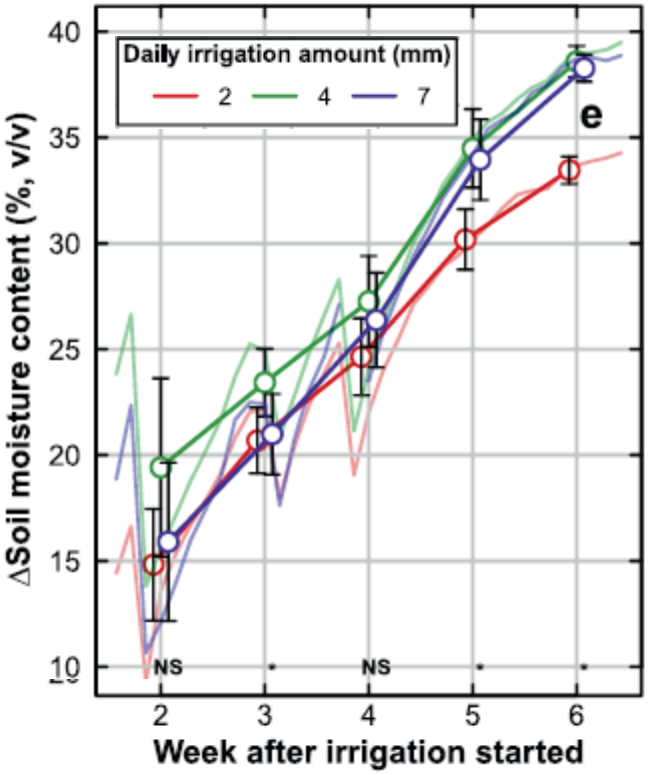
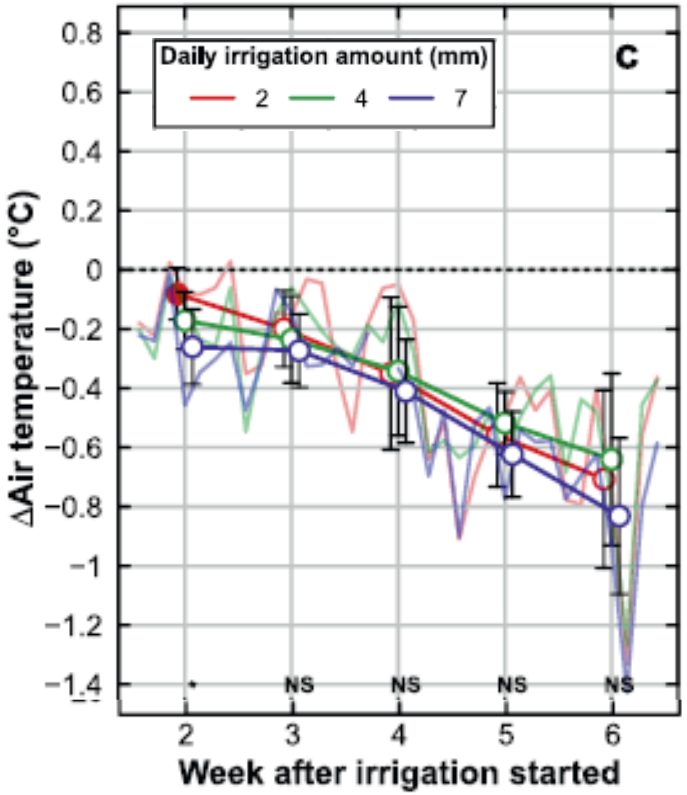


Air temperature

1. Cooling effects were significant.
2. Daytime mean cooling in week 6 = –0.8°C
3. Differences between the three treatments were small and not significant.

Irrigation cooling experiment – Results





Air temperature

1. Cooling effects were significant.
2. Daytime mean cooling in week 6 = –0.8°C
3. Differences between the three treatments were small and not significant.
4. Cooling effects strengthened from week 2 to week 6 as soil moisture differences increased.

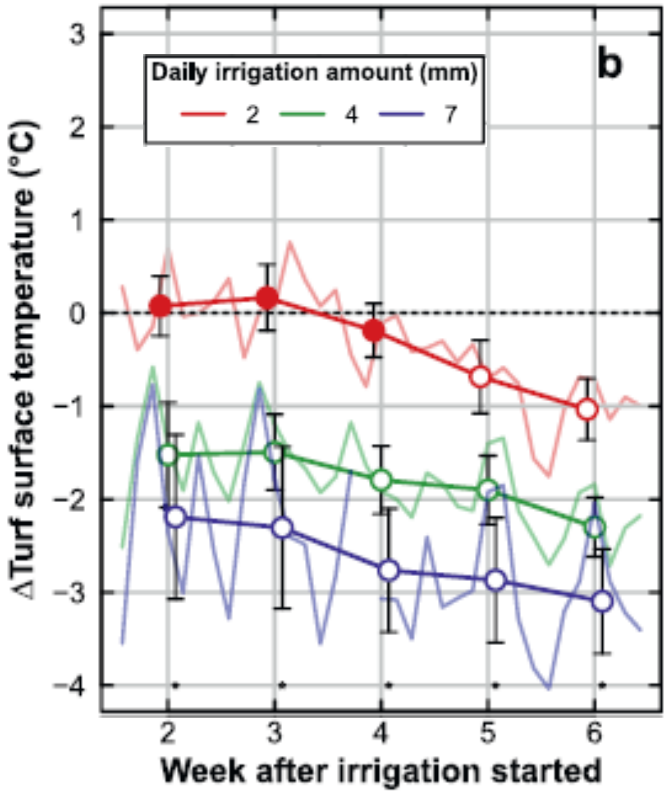
➢ Cooling came from drying (and warming) of the unirrigated plot.

Irrigation vs tree shade in Melbourne

	Tree shade	Irrigation (4 mm d^{-1})
		
Cooling effect on		
Air temperature (°C)	–1.5 to –0.7	–0.8

Sanusi, R. et al. (2017). Microclimate benefits that different street tree species provide to sidewalk pedestrians relate to differences in Plant Area Index. *Landscape and Urban Planning, 157*, 502-511.

Irrigation cooling experiment – Results

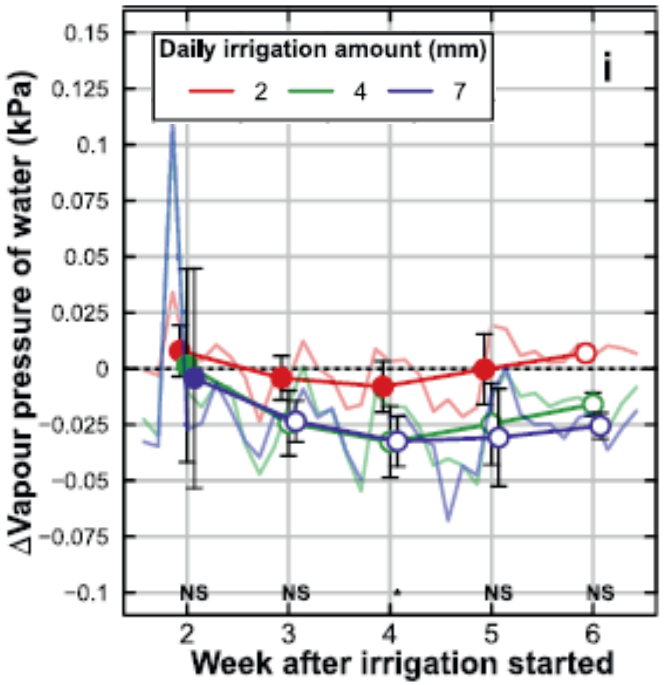


Turf surface temperature

1. Cooling effects were significant.

2. Daytime mean cooling in week 6 = –3.0°C

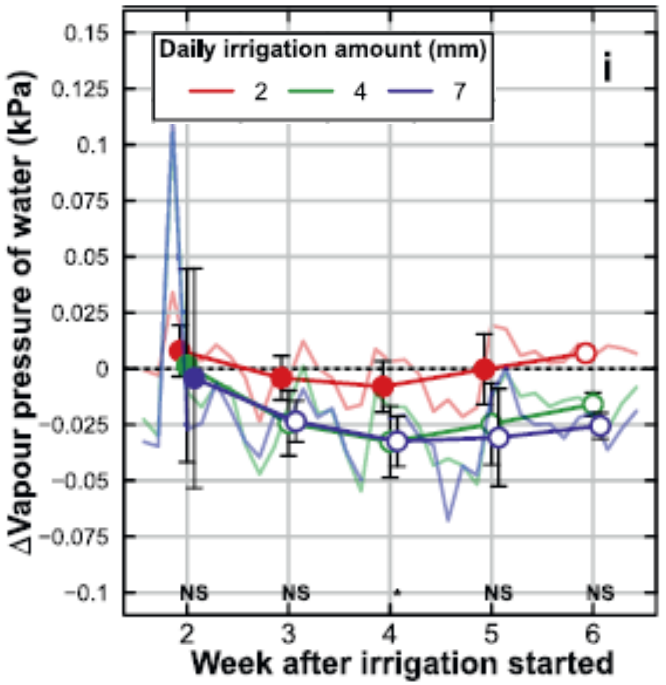
Irrigation cooling experiment – Results



Vapour pressure

1. Impacts were small (<0.05 kPa).
2. Accuracy of sensor = 0.05 kPa.

Irrigation cooling experiment – Results



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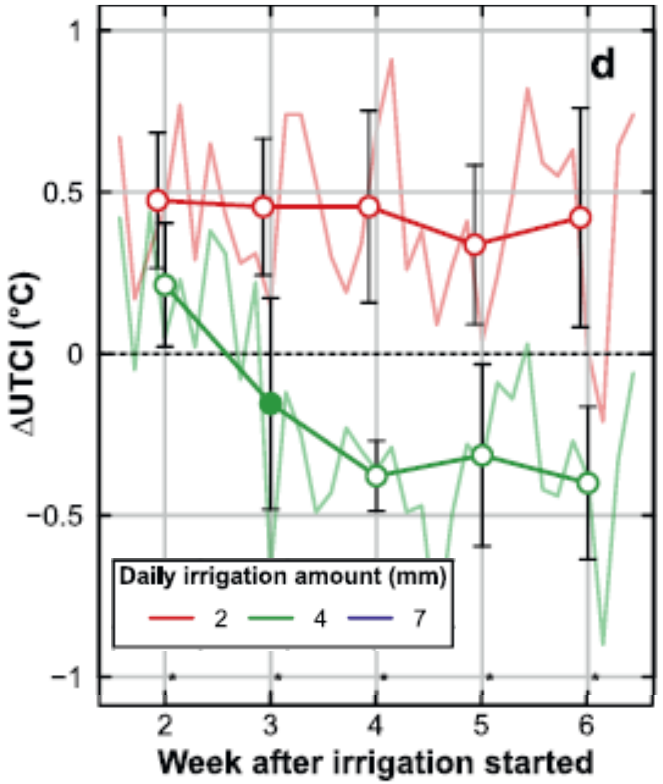

Universal Thermal Climate Index (UTCI)

1. Impacts were small (<0.5°C).

➢ One UTCI category ≈ 6°C

➢ Thermal comfort depends on
- Air temperature (reduced)
- Vapour pressure (no change)
- Wind speed (no change)
- Mean radiant temperature (no change)

Irrigation vs tree shade in Melbourne

	Tree shade	Irrigation (4 mm d^{-1})
Cooling effect on		
Air temperature (°C)	–1.5 to –0.7	–0.9
Human thermal comfort (°C)	–5.2 to –4.2 (PET)	–0.5 (UTCI)

Sanusi, R. et al. (2017). Microclimate benefits that different street tree species provide to sidewalk pedestrians relate to differences in Plant Area Index. *Landscape and Urban Planning, 157*, 502-511.

Conclusion

Response to hypotheses:

1. Irrigated turf is significantly cooler than unirrigated turf during the day.
    - True for air temperature and turf surface temperature.
    - False for human thermal comfort.
2. Daytime cooling effect strengthens with increasing irrigation amount (2, 4 and 7 mm d^{-1}).
    - Not being tested properly due to rainfall.
    - Daily irrigation (as little as 2 mm d^{-1}) is recommended to keep the soils from drying and warming.

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