Analytical Methods: Quasi-experimental design

Dr. Kerry Nice

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Dr. Kerry Nice

Urban climate scientist; Urban systems modelling

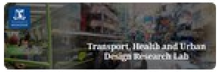
- **Senior Research Fellow**
  Faculty of Architecture, Building and Planning
  University of Melbourne, 2016-Present.
- **Deputy Director**
  Transport, Health and Urban Systems (THUS) research lab

Research Areas

Research in urban climates and human thermal comfort (HTC) with a focus on urban micro climate modelling and WSUD (water sensitive urban design).
Research in urban design, transport, health, micro-climates, and urban green space typology using neural network machine learning, agent based modelling, and climate modelling.
Software engineering using Java J2EE for application development and architecture.

Affiliations

Transport, Health and Urban Systems (THUS) research lab



Research design types

Descriptive (e.g., case-study, naturalistic observation, survey)

Correlational (e.g., case-control study, observational study)

Experimental (e.g., field experiment, controlled experiment, quasi-experiment)

Review (literature review, systematic review)

Meta-analytic (meta-analysis)

Quasi-experiment

- Used to estimate causal impact of an intervention
- Some similarities to experiments and randomized control trials
- Lack random assignment to treatment or controls (as in medical drug trials)
- Random assignment is ideal but not always possible
- Instead, compare to what happens in the absence of the experiment

Types of quasi-experiment designs

- Non-equivalent group design (treatment and control groups not randomly assigned, potential selection bias problems)
- Time-series design (measure outcomes before and after an intervention)
- Regression discontinuity (assign based on a threshold score)
- Pretest/post-test (compare before/after with the same group)
- Propensity score matching (pair participants between treatment/control based on similar characteristics)

Quasi-experiment methods

- Data collection (surveys, observations, preexisting records)
- Statistical analysis (Covariance, regression, propensity score matching)
- Controls for confounding variables (match participants that are similar, subgroup by characteristics, sensitivity analysis)
- Mixed methods (combine quantitative and qualitative methods)

Time series observations compared to controls

- Aim: Quantify the impacts of irrigation scheduling and weather conditions on cooling from turf grass
- Experiment to simulate what happens in typical suburban backyards, can we induce cooling through different irrigation methods

> This is study is unique because it directly measures the cooling effect of irrigating turfgrass in a replicated experiment, which provides empirical evidence to help optimise irrigation scheduling as a strategy to cool urban green spaces and the urban landscape more broadly.

Cheung, P.K., Jim, C.Y., Tapper, N., Nice, K.A., Livesley, S.J., 2022. Daytime irrigation leads to significantly cooler private backyards in summer. Urban Climate 46, 101310. https://doi.org/10.1016/j.uclim.2022.101310

Cheung, P.K., Nice, K.A., Livesley, S.J., 2024. Impacts of irrigation scheduling on urban green space cooling. Landscape and Urban Planning 248, 105103. https://doi.org/10.1016/j.landurbplan.2024.105103

Cheung, P.K., Meili, N., Nice, K.A., Livesley, S.J., 2024. Identifying the mechanisms by which irrigation can cool urban green spaces in summer. Urban Climate 55, 101914. https://doi.org/10.1016/j.uclim.2024.101914

Experimental setup

- Observe identical plots set up at the Burnley campus
- Vary irrigation amounts and irrigation times
- Measure and compare the different plots to each other and to a control plot that is unirrigated

Additional experimental setup

- Use the observations to validate a climate model (does the model accurately reproduce your observed time series?)
- Use the climate model to test scenarios you didn’t/couldn’t observe (what if you double the irrigation, irrigate every 30 minutes, etc).

Conceptual framework

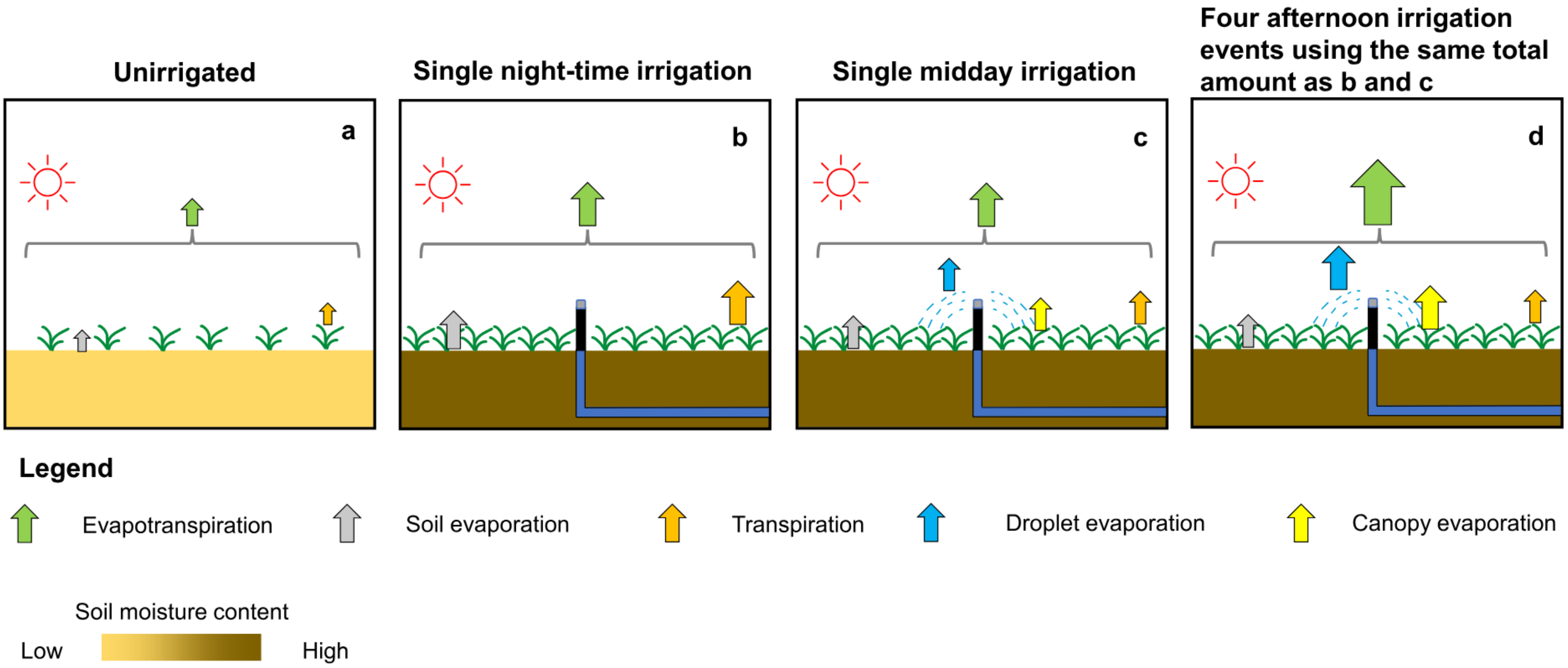


Fig. 9. A conceptual diagram that explains the impact of different irrigation schedules on evapotranspiration processes in the afternoon.

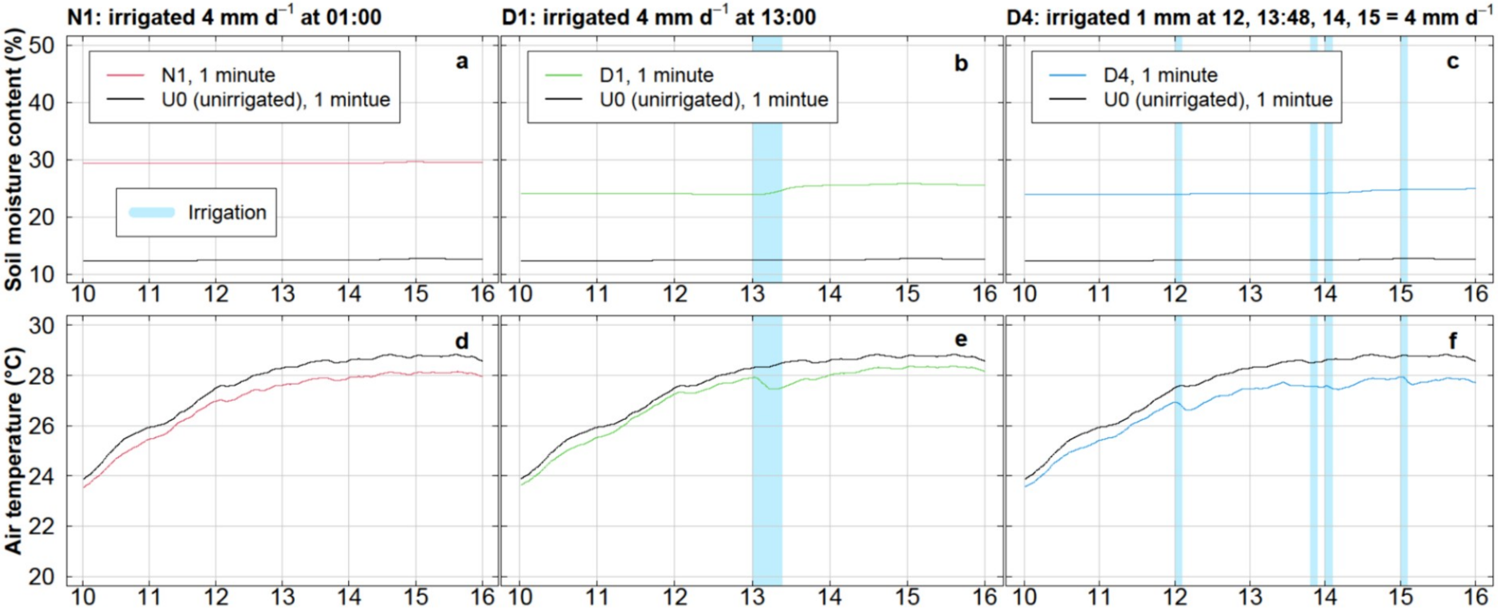
Hypothesises for the irrigation scheduling study

(1) all three irrigated treatments would induce significant afternoon (12:00–15:59) mean cooling effects;

(2) the strongest afternoon (12:00–15:59) mean cooling effect would be irrigating four times in the afternoon (D4), and the least significant would be irrigating once at night (N1);

(3) the afternoon (12:00–15:59) mean cooling effects of irrigating turf would be significantly and positively associated with background air temperature, vapour pressure deficit, wind speed and incoming shortwave radiation.

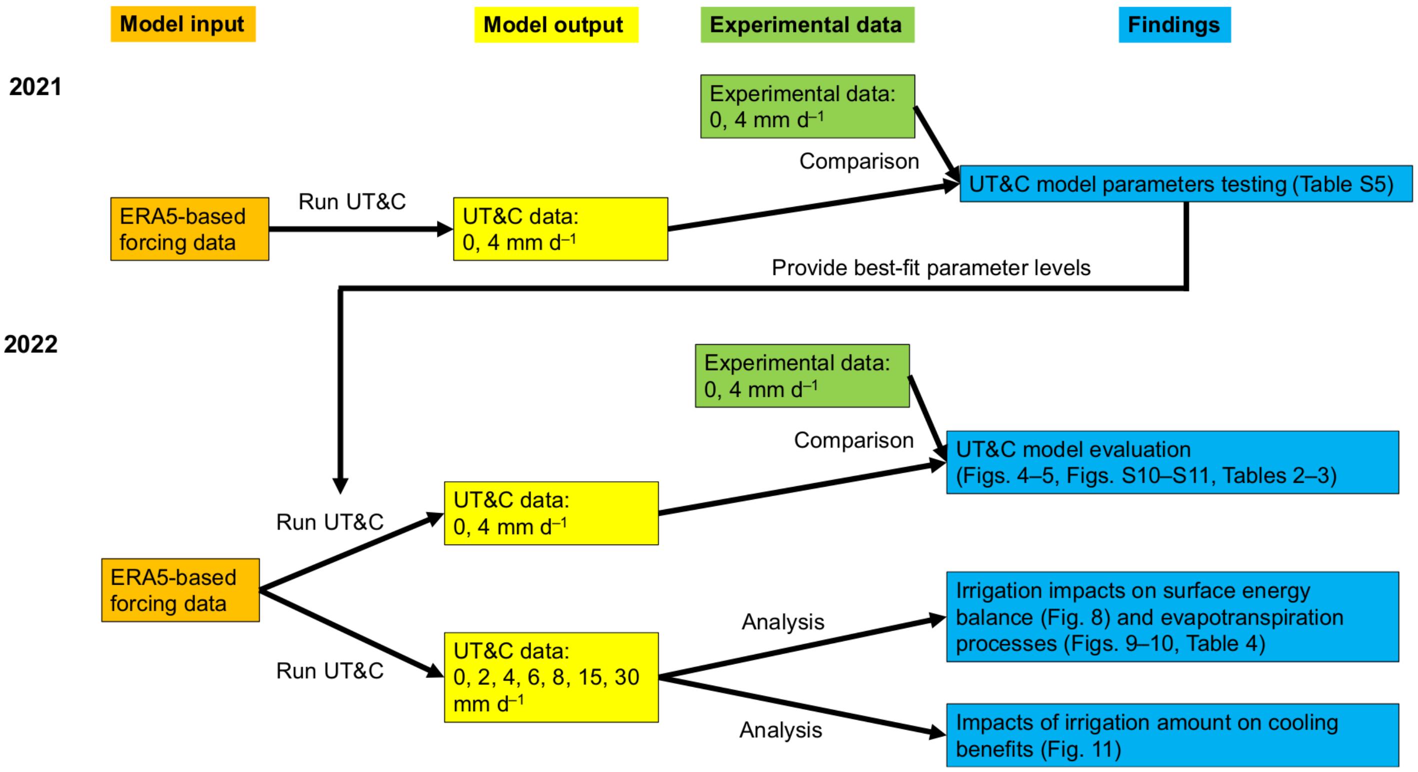
Did we prove our hypothesises?



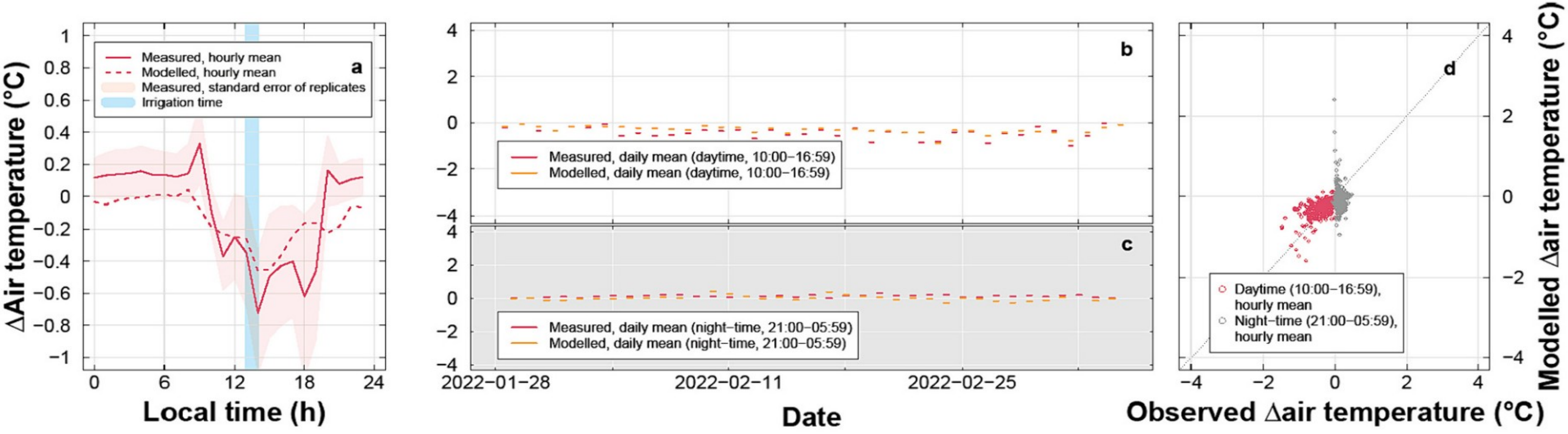
All three irrigated treatments induced significant afternoon (12:00–15:59) mean cooling effects on air temperature and turf surface temperature, whereas the cooling effects on mean radiant temperature and UTCI were inconsistent. This means that our results partially support Hypothesis 1 as measured cooling benefits from irrigation were evident for air temperature and turf surface temperature only.

In this study, the afternoon (12:00–15:59) mean cooling effects of irrigating turfgrass on air temperature and turf surface temperature were significantly and positively correlated with background air temperature, vapour pressure deficit and incoming shortwave radiation, but not wind speed. The results provide partial support for Hypothesis 3 that the cooling effects would significantly correlate with all four weather variables. Our findings were consistent with Vivoni et al. (2020)'s findings, which showed a significant linear correlation between daily total evapotranspiration and daily mean air temperature (R2 = 0.79) and incoming shortwave radiation (R2 = 0.82) in an irrigated turfgrass.

Modelling experiments



Model validation



- Compare modelled results to observed conditions
- Great, the model works, let’s use it now

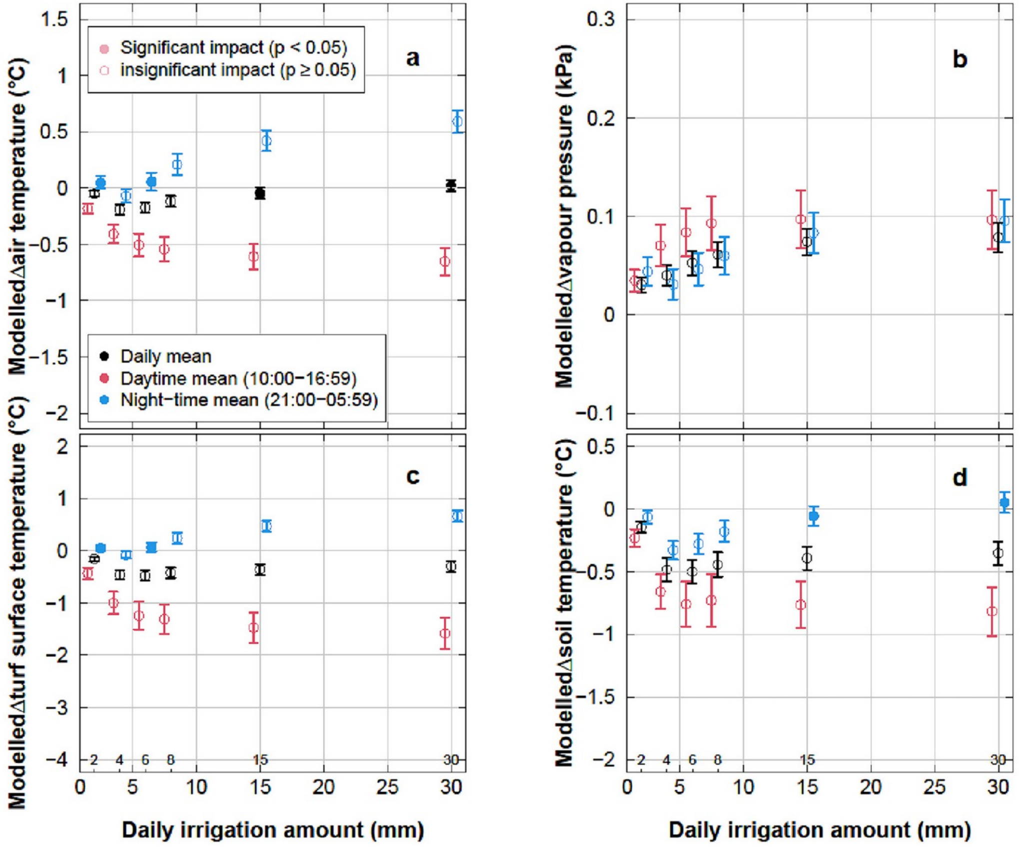
Modelling scenarios

Objectives

- (1) identify the proportional contribution of different evapotranspiration processes to irrigation cooling effect; and.
- (2) quantify the impacts of different irrigation amounts (from 2 to 30 mm d 1) on the cooling effect of irrigating turfgrass in Melbourne, Australia during normal summer conditions.

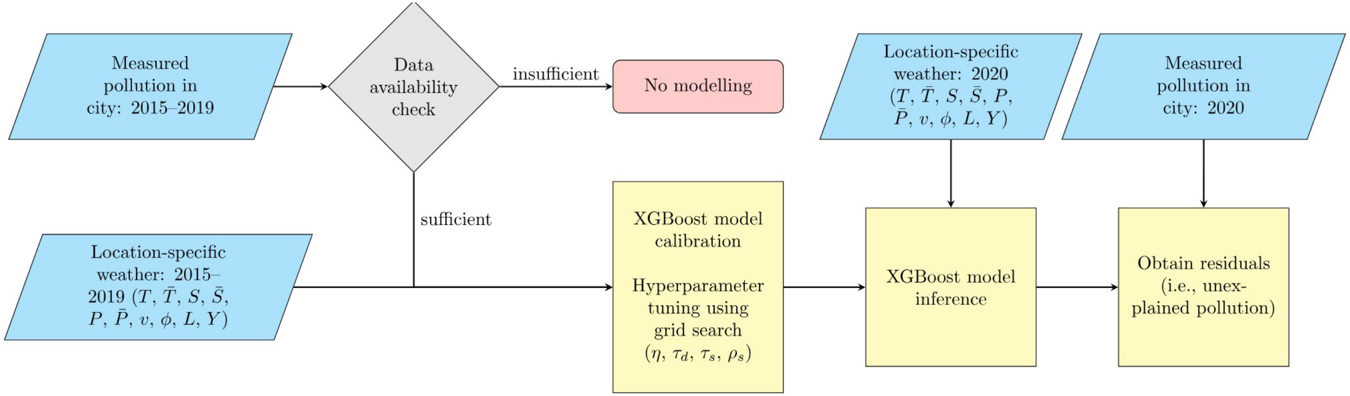
Innovation

- This study is unique because a replicated experiment with controlled treatments was conducted to disentangle certain contributory factors and mechanisms of irrigation cooling effect. Both above- and below-ground observations were taken in the experiment to evaluate the performance of UT&C comprehensively. This study can contribute to the development of climate adaptation strategies for cities because it directly measured and assessed the cooling benefits of a promising cooling strategy.



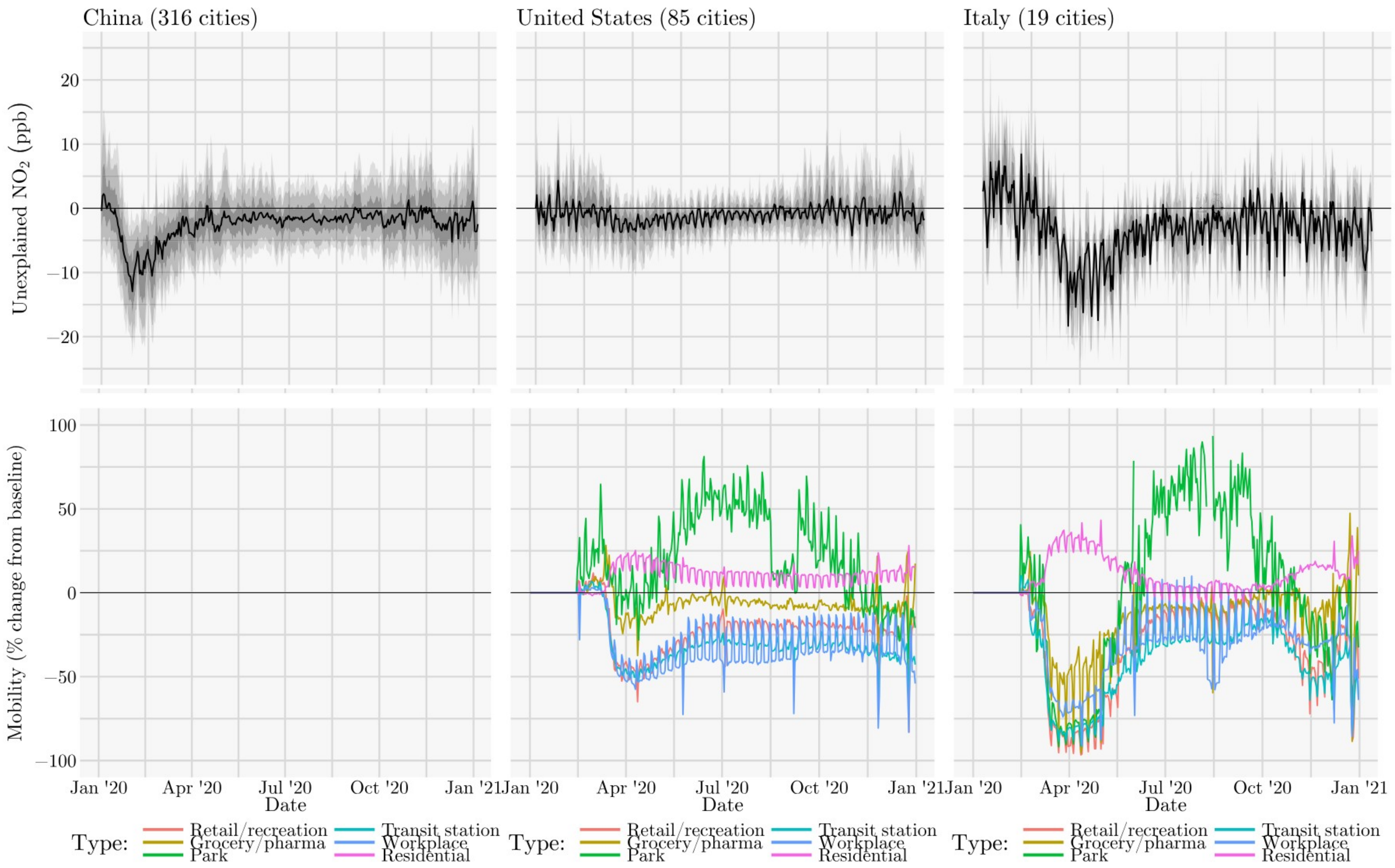
Some of my other quasi-experimental research

- Natural experiments: take advantage of something you observe when one variable changes
- What happened to pollution levels when COVID-19 lockdowns changed global mobility levels?
- We train neural networks to predict 2020 pollution levels (if there wasn't a pandemic) and compare them to actual 2020 pollution levels



Wijnands, J.S., Nice, K.A., Seneviratne, S., Thompson, J., Stevenson, M., 2022. The impact of the COVID-19 pandemic on air pollution: A global assessment using machine learning techniques. Atmospheric Pollution Research 13, 101438. https://doi.org/10.1016/j.apr.2022.101438

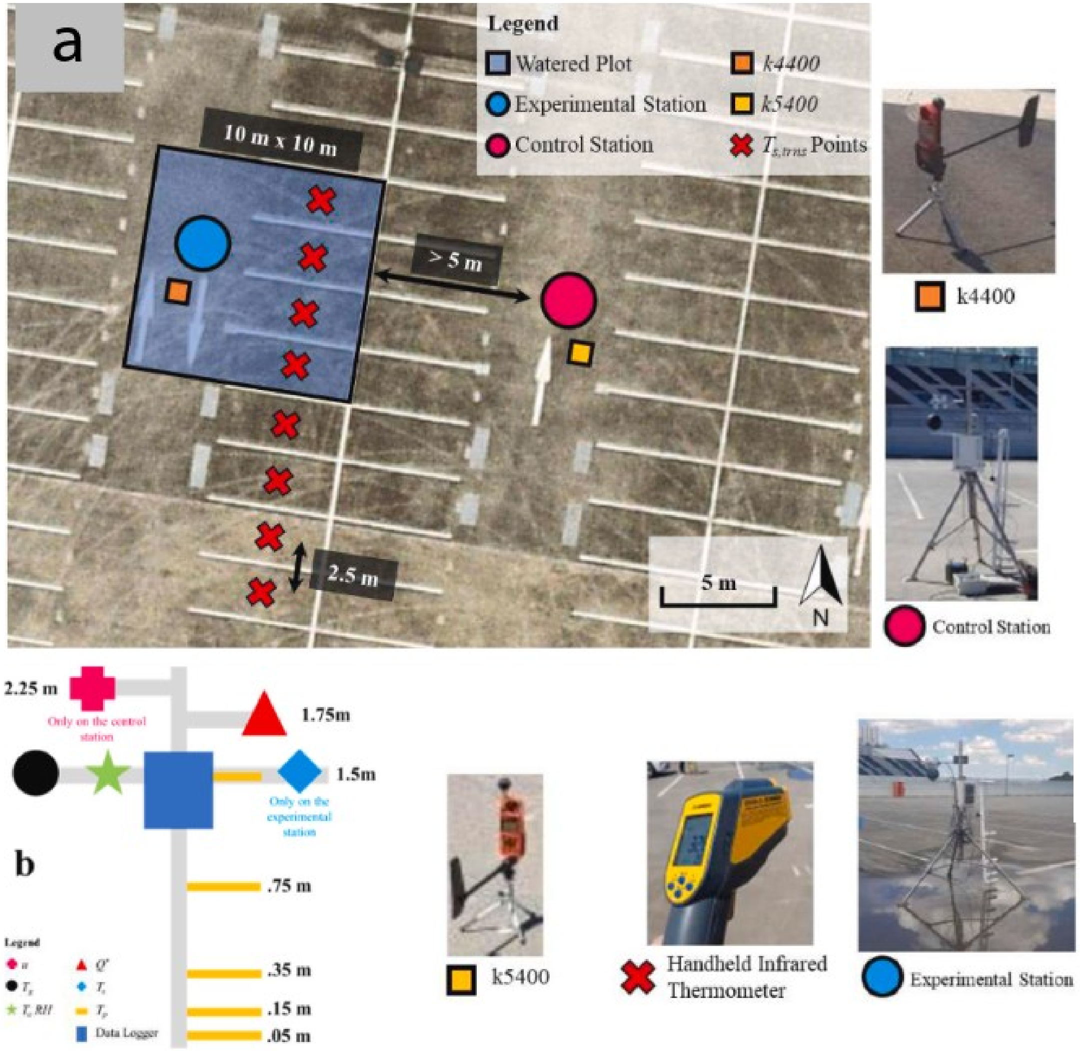
Pollution anomalies due to COVID-19

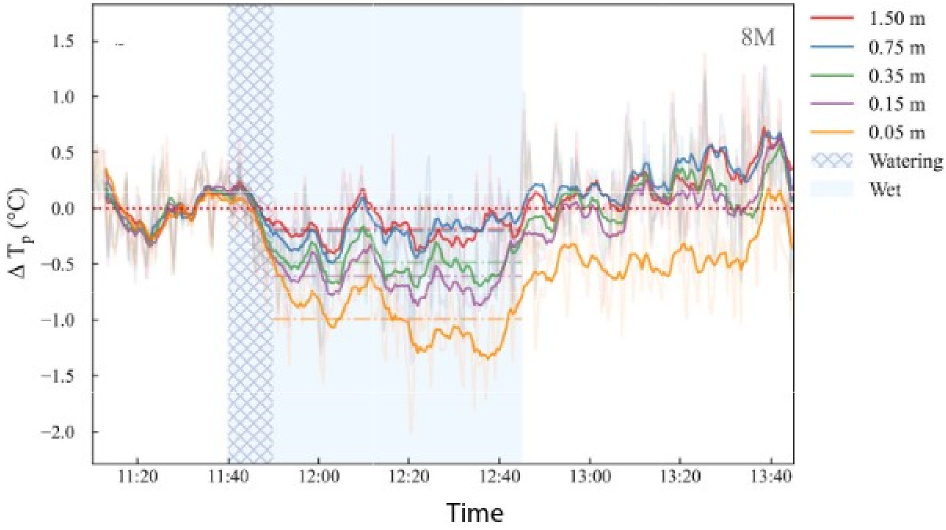


Lots of other research I can talk about

Research Areas (mostly quantitative)

- Climate model development
- Urban climate observations (cooling with vegetation)
- Modelling urban heat scenarios
- Analysis of infrastructure with GANs (intersections/public health)
- Neural networks (active transport mode shares/driver drowsiness/urban typologies impact on public health/pollution prediction)
- Climate informatics/urban analytics (Sky view detection)
- Agent based modelling (COVID-19)
- Built form impact on active transport/quantifying cycling mode share
- Analysis of spatial disadvantage
- City design/mode share/health risks
- Tools to guide climate sensitive development
- Community co-design





Traill, E., Nice, K.A., Tapper, N., Arblaster, J.M., 2024. Pavement watering as an urban heat mitigation technique. Urban Climate 56, 102042. https://doi.org/10.1016/j.uclim.2024.102042

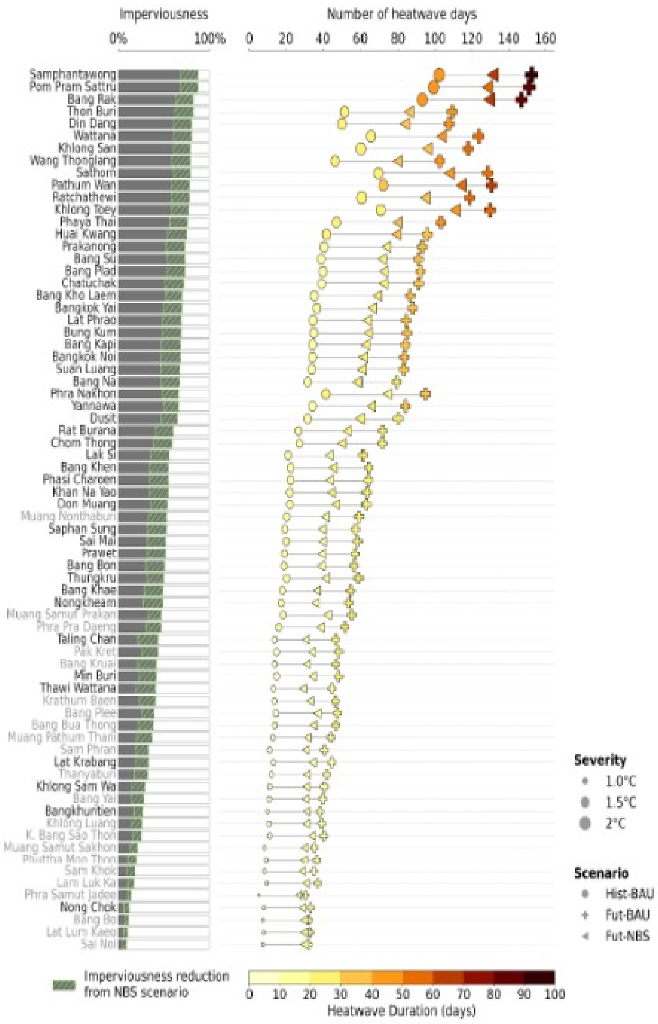
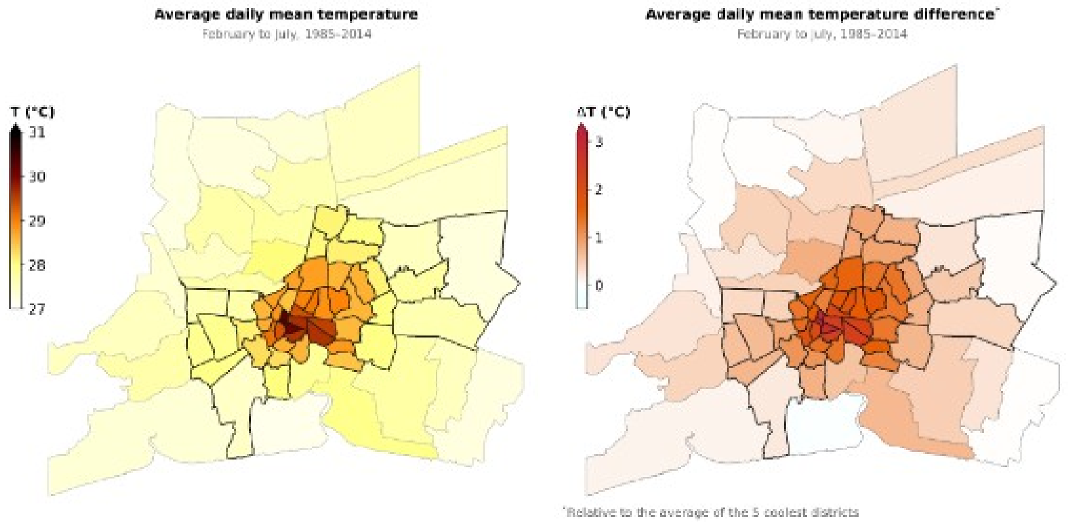


Figure 15 . Heatwave trends in Bangkok: past, future, and the NbS impact.(B-Kode, 2025)

Gupta, N., Bhatia, A., Dutta, R., Basanayake, S., Hammer, S., Demuzere, M., Nice, K., Duc, T.T., Sakkhamduang, J., 2025. Urban Heat Resilience: Bridging Science, Policy, and Sustainable Design, Flagship Report (No. 978-616-91999-4–6). Asian Disaster Preparedness Center, Bangkok, Thailand.



Notes: The five coolest districts are white-colored in the right panel, and are Sai Noi (THA.36.6_1), Lat Lum Kaeo (THA.37.3_1), Phra Samut Jadee (THA.57.6_1), Bang Bo (THA.57.1_1), Nong Chok (THA.3.28_1). Values in brackets refer to the GID_2 id from the gadm database.
Source: B-Kode analysis based on TARGET simulations.

Figure 16 Central districts within the Bangkok Metropolitan area exhibit significantly higher temperatures compared to their surrounding less urbanised districts (B-Kode, 2025

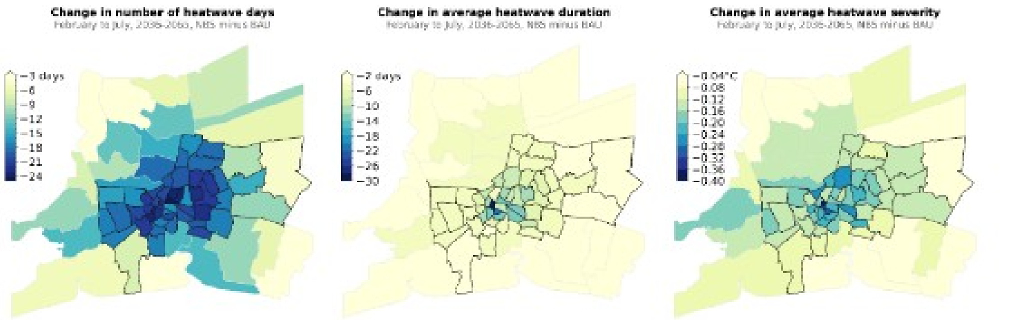
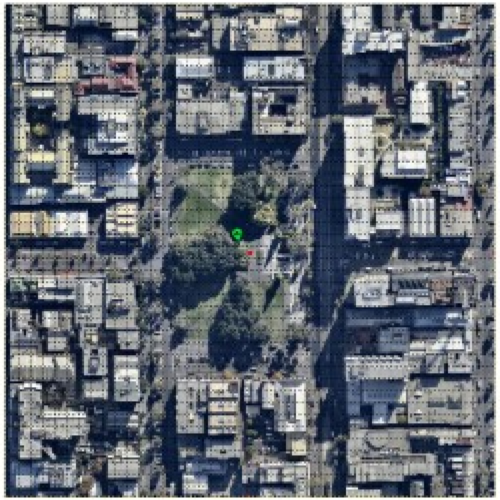
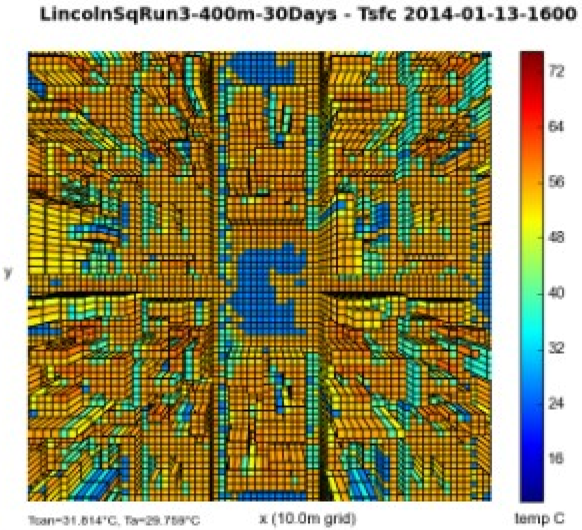


Figure 17 Extreme heatwave characteristics dampened by nature-based solutions (BKode, 2025)

VTUF-3D, a tool to model the cooling effects of trees at a microscale



Lincoln Square, Melbourne

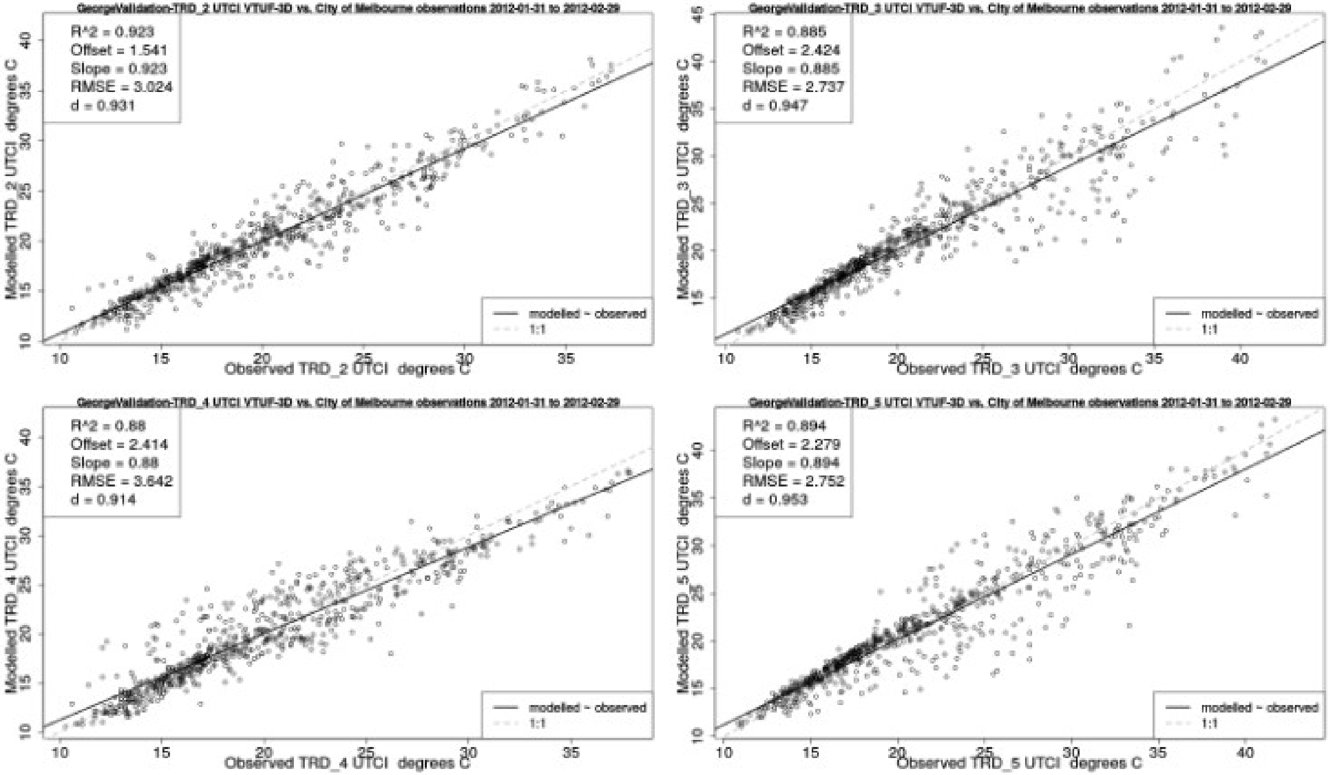


- **Can a model be devised for HTC assessments of WSUD?**
- **Can this new model be shown to be accurate and suitable for these assessments?**
- **Finally, can this new model be demonstrated as capable to answer questions and supply urban climate knowledge to the planning process about how to best utilise urban greening for maximum HTC impacts?**

Nice, K.A., 2016. Development, validation, and demonstration of the VTUF-3D v1.0 urban micro-climate model to support assessments of urban vegetation influences on human thermal comfort (PhD Thesis). Monash University.

Model testing and validation using City of Melbourne, George and Gipp St datasets

30 day comparison of predicted UTCI to observed - George St



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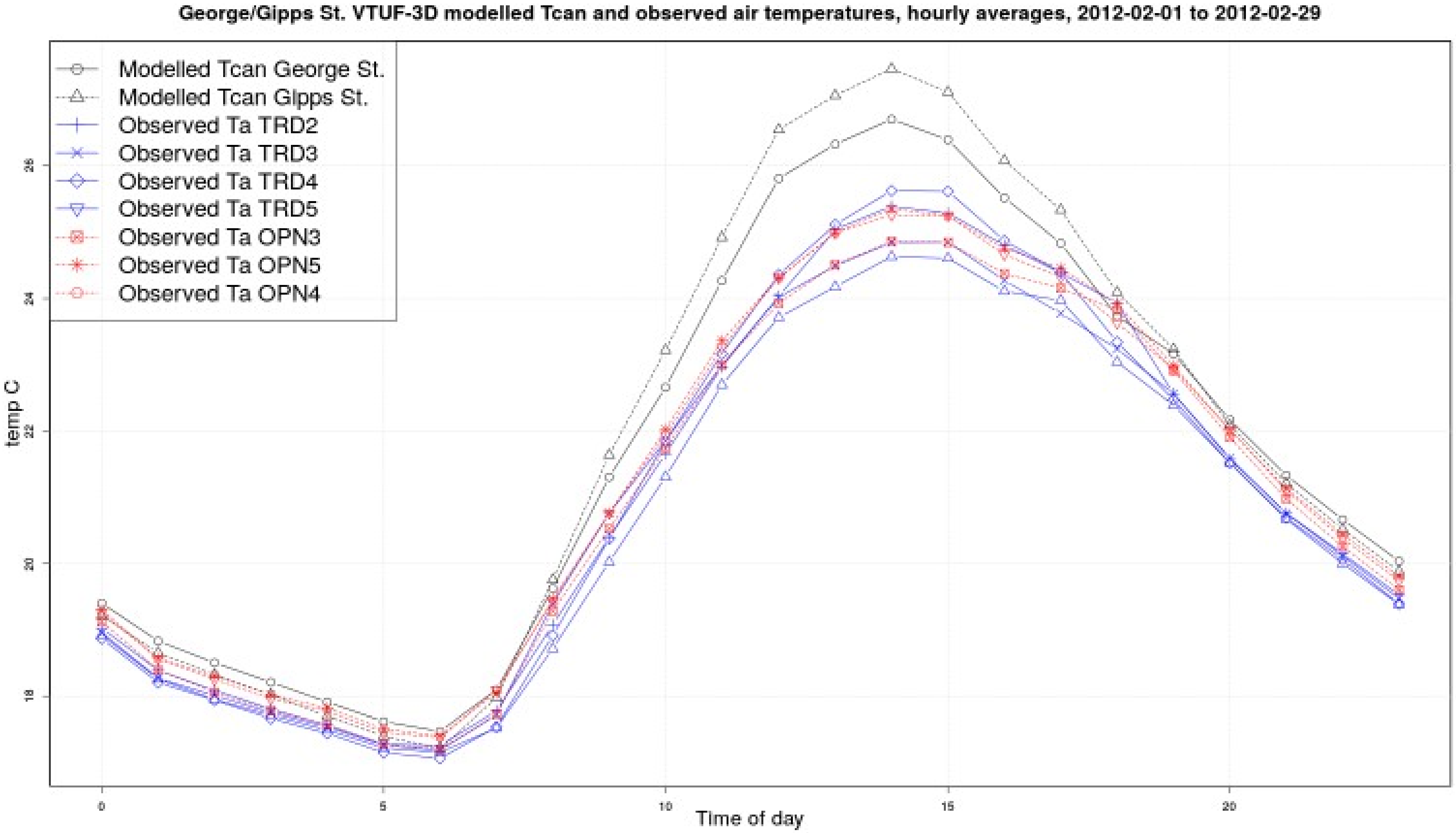
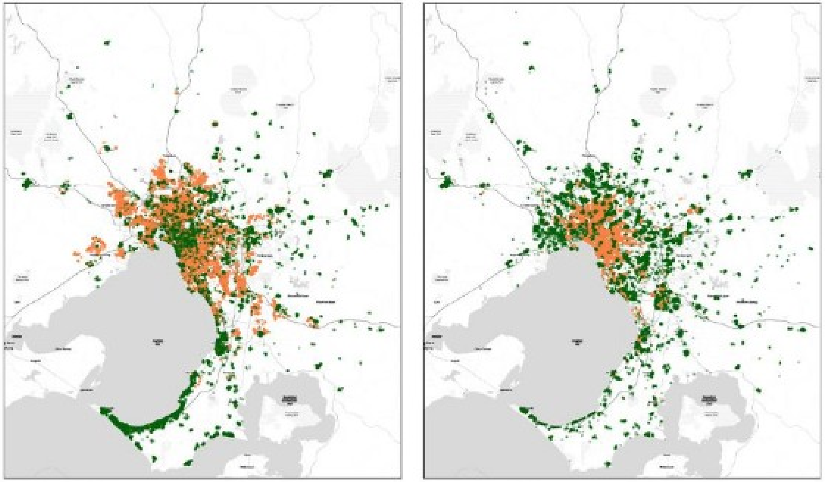


Figure 14: George/Gipps St. modelled T_{can} from scenarios GeorgeValidation and GippValidation compared to observed T_a of George St. 4 treed canopy stations and Gipps St. 3 open canopy stations, aggregated into hourly averages over February 2012 modelled period.

Nice, K.A., Coutts, A.M., Tapper, N.J., 2018. Development of the VTUF-3D v1.0 urban micro-climate model to support assessment of urban vegetation influences on human thermal comfort. Urban Climate 1–25. https://doi.org/10.1016/j.uclim.2017.12.008

Augmented analysis through computer vision

- Use of generative computer vision models (GANs) to highlight characteristics of areas with good vs. bad outcomes.



(a) General health (b) Social capital

Good general health to bad

Wijnands, J.S., Nice, K.A., Thompson, J., Zhao, H., Stevenson, M., 2019. Streetscape augmentation using generative adversarial networks: insights related to health and wellbeing. Sustainable Cities and Society. https://doi.org/10.1016/j.scs.2019.101602

Infrastructure detection through computer vision

- Use of computer vision to quickly generate infrastructure inventories extracted from urban imagery across all of Australia
- How are different types of infrastructure used and what the public health outcomes

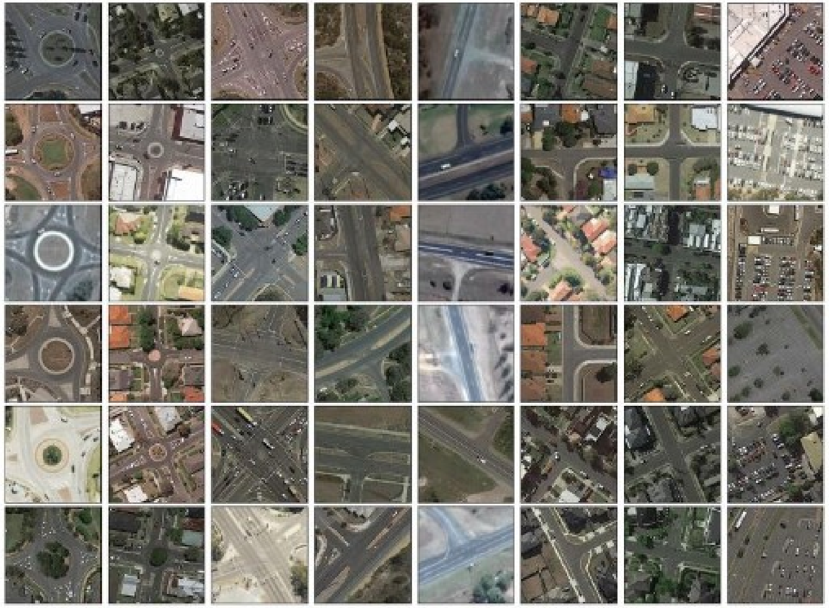


FIGURE 6 Each column provides sample images for the corresponding region in Figure 5. (a) Region A, (b) Region B, (c) Region C, (d) Region D, (e) Region E, (f) Region F_1/F_2, (g) Region G, and (h) Region H

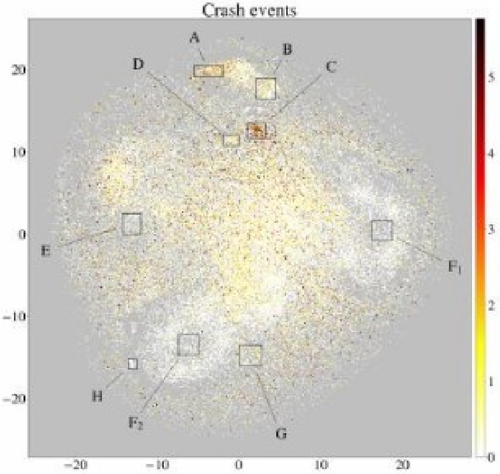


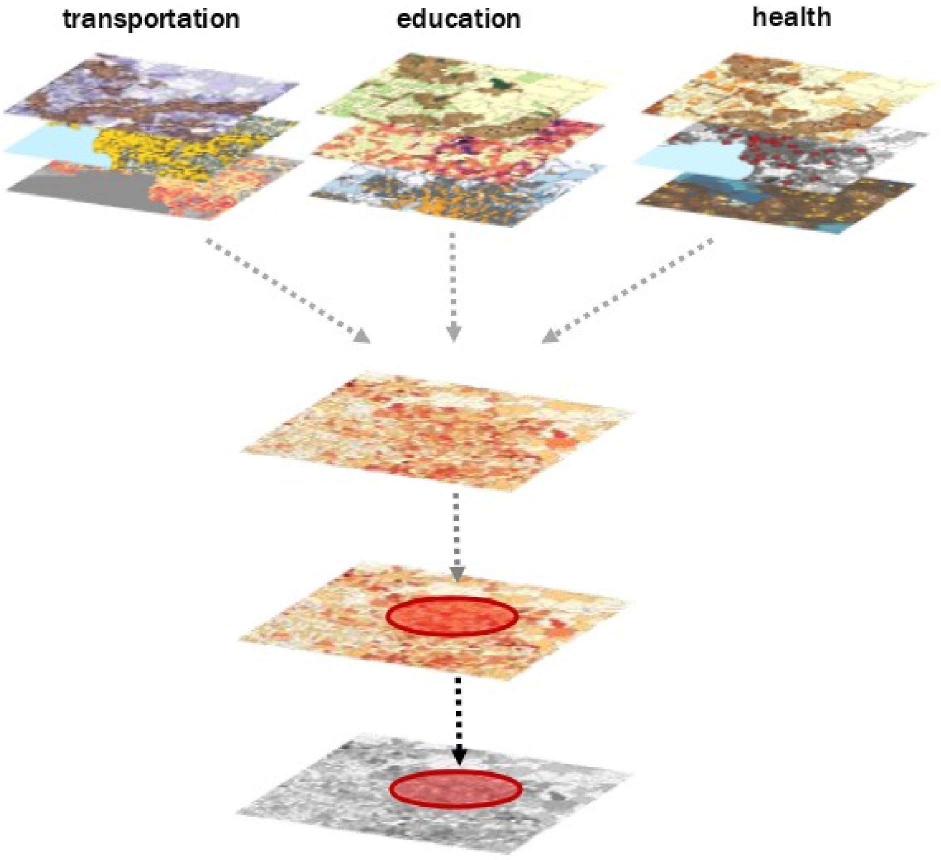
FIGURE 9 t-SNE clusters with matched crash events

900,000 intersections in Australia clustered by their design and relationships to safety outcomes (crashes) and unsafe driving behaviours (hard acceleration/braking)

Source: Jasper S. Wijnands, Haifeng Zhao, Kerry A. Nice, Jason Thompson, Katherine Scully, Jingqiu Guo, Mark Stevenson, Identifying safe intersection design through unsupervised feature extraction from satellite imagery, Computer-Aided Civil and Infrastructure Engineering, 2020

Social Service Access Index

Process



Aggregate access indicators for each domain a
SA1 level

Calculate SSAI at SA1 level using different weights to create indexes

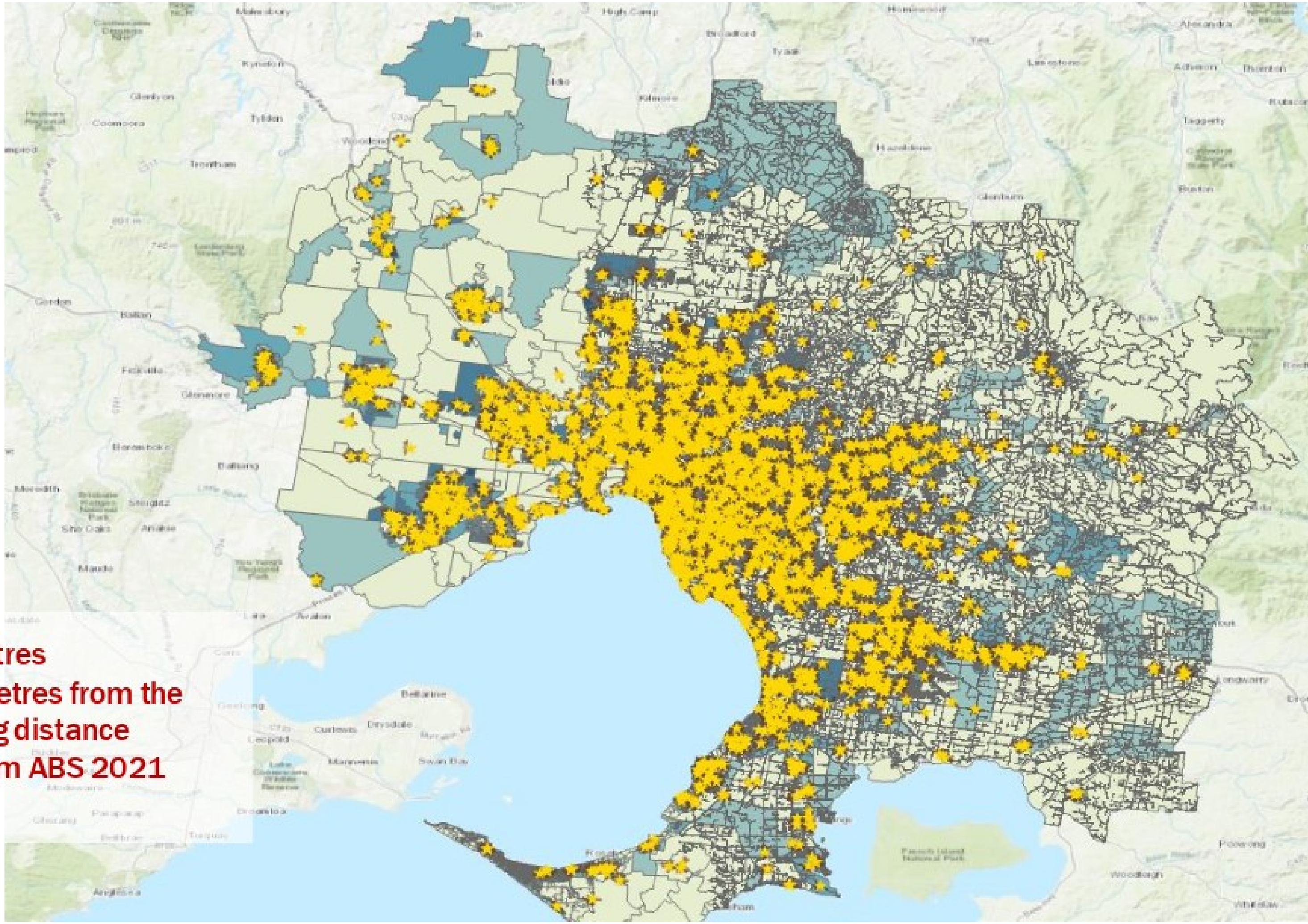
Identify potential service deserts in the target areas

Assess access level by different population groups (i.e., young families, elderly, etc.) in potential service deserts

Kerry Nice, Sachith Seneviratne, Youjin Choe, Mark Stevenson, Place-based Data Approaches: Data for analysis of spatial inequities in access to services, Life Course Centre Data For Policy Summit, Canberra, 15-16 August 2023.

Scenario example

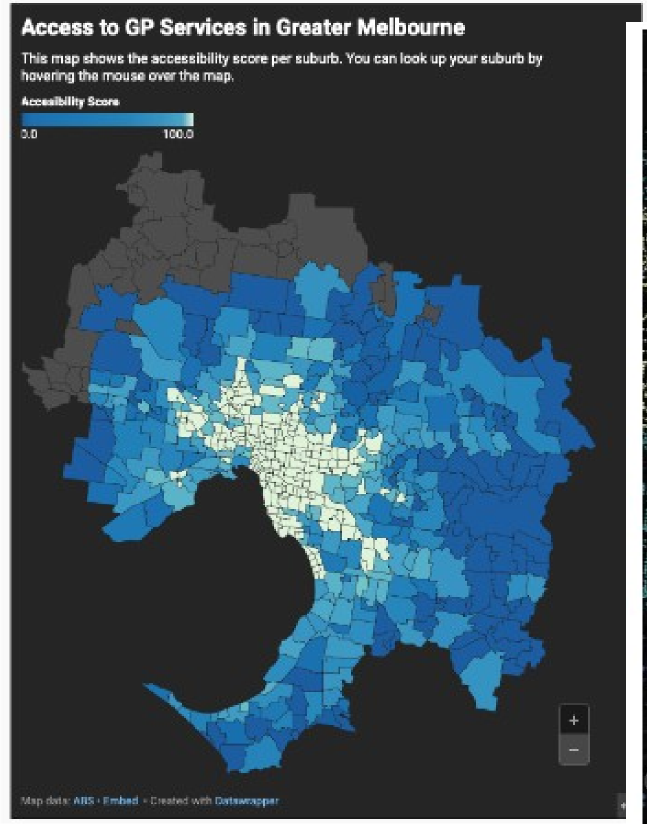
Access to childcare in Greater Melbourne area

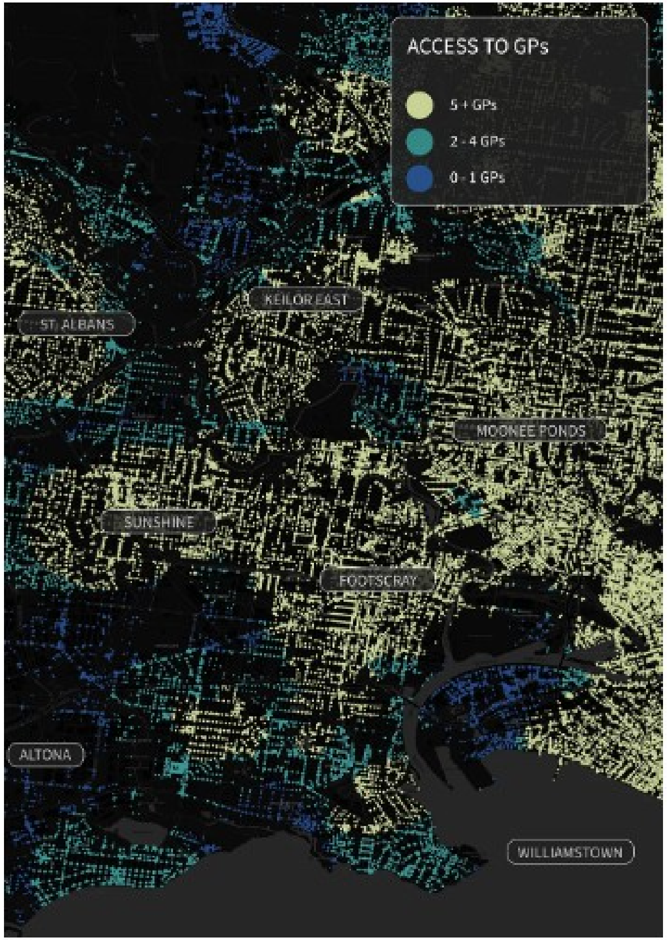


- Yellow stars: locations of childcare centres
- Service areas: 400, 800, and 1,000 metres from the centres (5-, 10-, and 15-minute walking distance
- SA1 areas: selected characteristics from ABS 2021 population census

Kerry Nice, Sachith Seneviratne, Youjin Choe, Mark Stevenson, Place-based Data Approaches: Data for analysis of spatial inequities in access to services, Life Course Centre Data For Policy Summit, Canberra, 15-16 August 2023.

Figure 3: This shows the shortest path analysis of access to services (represented by red dots) from every intersection in the region. Grey areas have no 20-minute access, dark green areas have access to one option and light green areas can access both options.





Nice, K., Seneviratne, S., Stevenson, M., 2024. How many 20-minute neighbourhoods does Melbourne really have? University of Melbourne.

Summary

- My methods have mostly been quantitative, calculate numerical values of things, quantify changes, what impact of changes on other things
- Note down what you have published/taught/presented
- Organise what you write, you will probably reuse some of it later
- Keep writing, first drafts are not perfect but that’s ok, they are something
- Keep reading, your research area will expand
- R makes the best graphs
- Worthwhile learning Latex (submitted papers do not need to look camera ready, but it doesn’t hurt)
- Version control? (git)
- Save everything locally, online stuff will disappear
- Collaborations, say yes (but also learn to say no)
- Try to focus your path, but you might not always end up where you think

Thank you

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