Health impacts of greening strategies to cool urban environments

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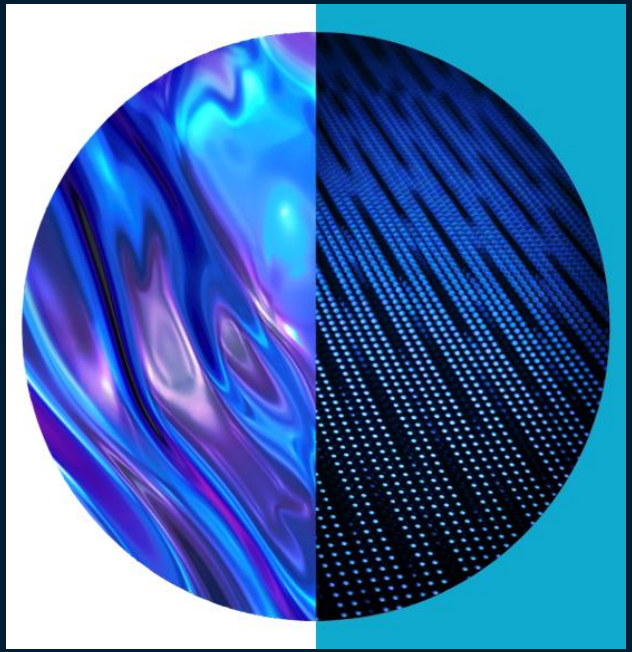
27 July 2023

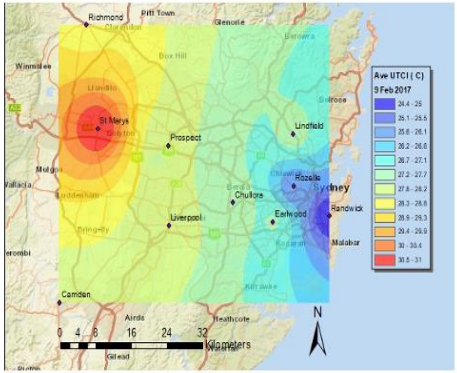


I would like to begin by acknowledging the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.

Collaborative project funded by:

NHMRC Centre for Air pollution, energy, and health Research (CAR)

NSW DPIE & NSW Health



Impact of Greening Technologies on Urban Heat, Climate Change and Health

Human Health and Social Impacts Node
NSW Department of Planning, Industry, and Environment – NSW Health

REPORT DEVELOPED BY:

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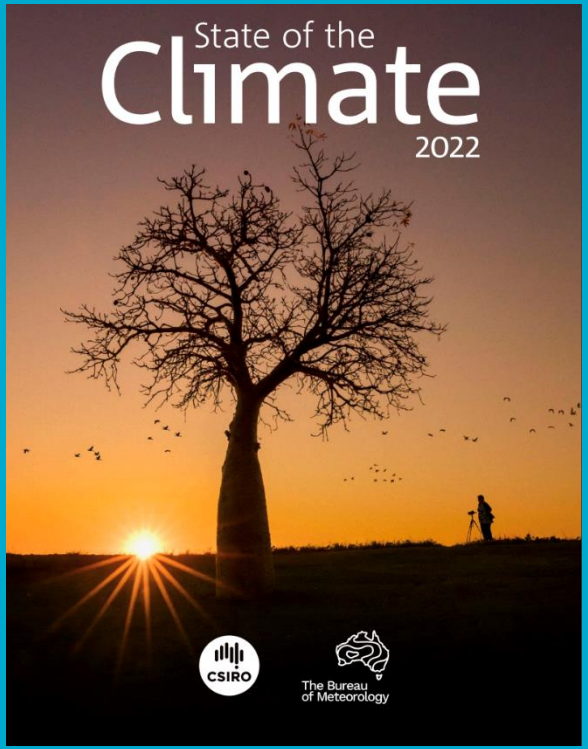
Problem statement

Australian cities has been exposed to increased heat and unexpected extreme events , i.e., heat waves (BoM 2022)

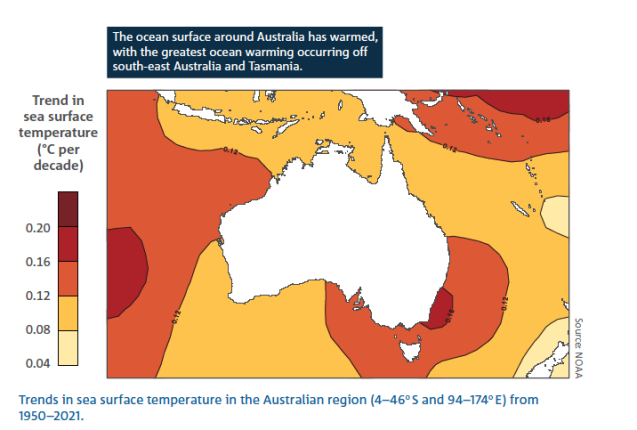
- Increased urban density
- Urban Heat Island (UHI) effect
- Modern lifestyle
- Increase demand for electricity for cooling
- Electricity derived from fossil fuel power stations: Escalate greenhouse gas emissions and global warming



Source: CSIRO State of Climate, 2022
https://www.csiro.au/en/research/environmental-impacts/climate-change/State-of-the-Climate

Gaps in the literature

- Urban heat and urban heat island mitigation technologies have been studied before, however, the impact of heat on human thermal physiology and its association with population health yet to be studied.



Trends in sea surface temperature in the Australian region (4–46° S and 94–174° E) from 1950–2021.

Source: CSIRO State of Climate, 2022
https://www.csiro.au/en/research/environmental-impacts/climate-change/State-of-the-Climate

Objectives of the research

a) Develop a method to predict the duration and intensity of exposure to heat stress and to assess its impact on human thermal physiology (named: Heat Stress Exposure (HIS) metric).

b) Propose an adaptation technology to reduce urban heat.

c) Predict the impact of reduced urban heat on heat stress exposure.

d) Analyse association between heat and health.

Research Methods

To address the research objectives three phase of study were conducted

1) Assessment & visualization phase

- Reference Scenario – Sydney 2017

2) Intervention phase

- Adaptation Scenario – greening strategies

3) Health benefits phase

- Development pf Heat Health Impact model using Health Impact Assessment method

Research Methods

Phase 1: Climate analysis

10 stations across Sydney GMR

- Richmond
- St Marys
- Prospect
- Liverpool
- Camden
- Chullora
- Earlwood
- Randwick
- Rozelle
- Lindfield

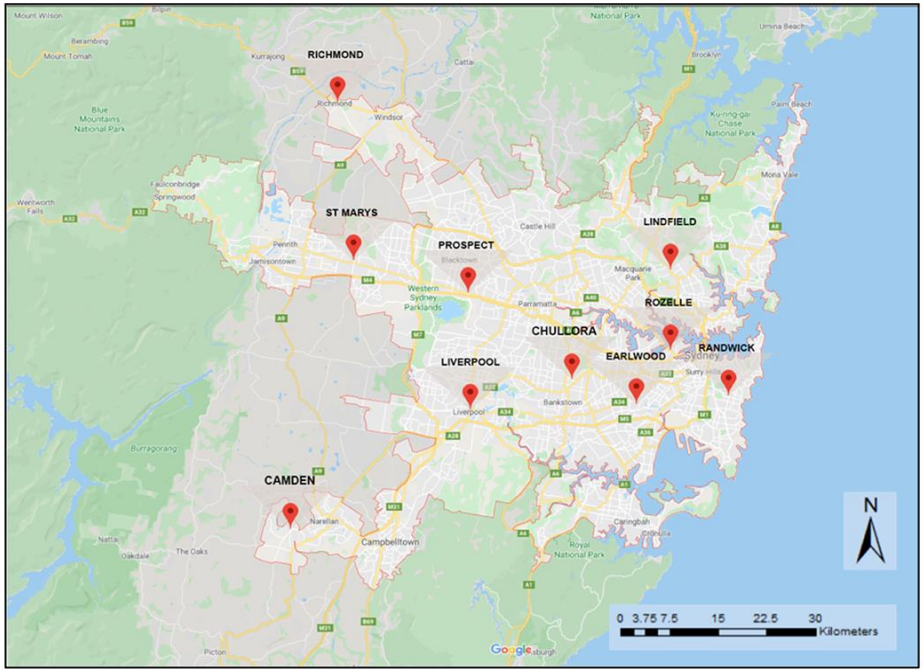


Fig. 1. Location of Sydney meteorological stations used in this study (map source: Google maps 2020).

Research Methods

Phase 1:

a) Climatology study

Climate data observation from BoM downloaded (NSW DPIE website) for 10 stations

8760 hours observation per year

- Air temperature, T_a (°C)
- Relative Humidity (%)
- Wind speed (m/s)
- Solar radiation, global horizontal radiation (wh/m^2)

Available solar radiation data

- Prospect:

Assigned to three stations in west Sydney Basin: St Marys, Richmond, Camden

- Chullora:

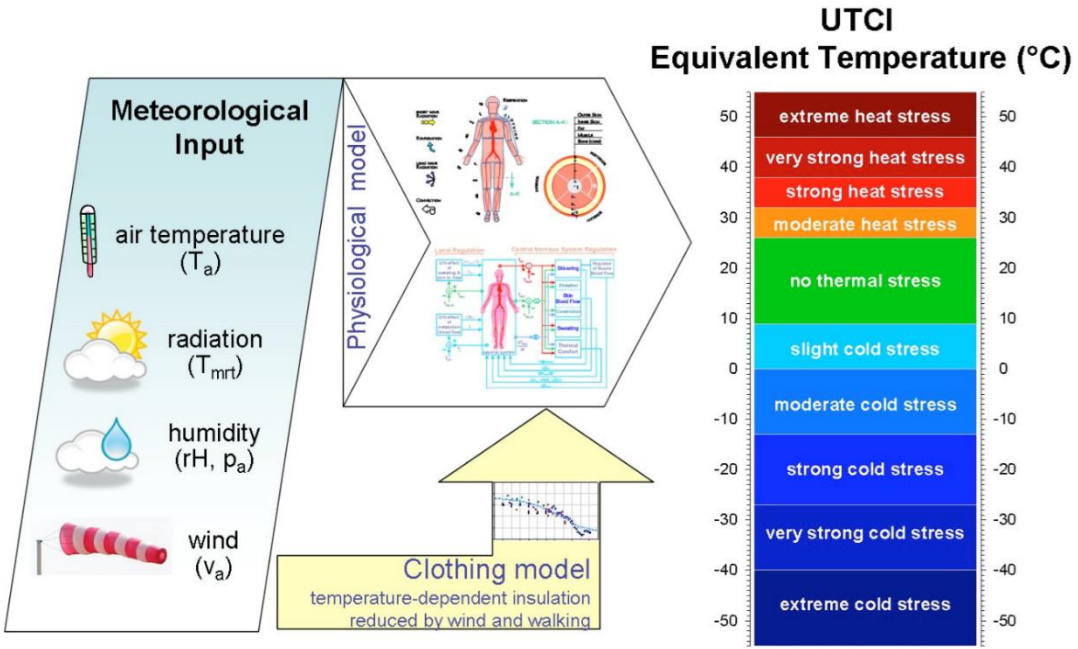
Two stations in central southwest of Sydney, Earlwood and Liverpool

- Rozelle:

two stations in eastern side of Sydney Basin and within approximately 8 Km of Sydney Harbor, Randwick and Lindfield.

Research Methods

Prediction of Heat Stress Exposure



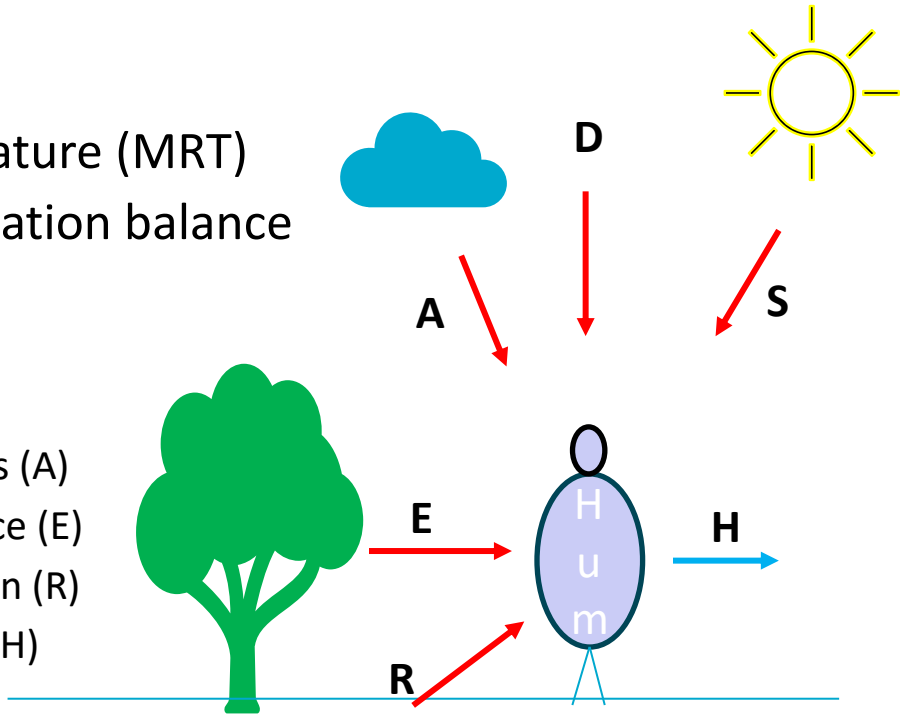
Source: Brode et al., 2011

Research Methods

Mean Radiant Temperature (MRT)
Component of the radiation balance

Direct solar radiation (S)
Diffuse radiation (D)
Longwave radiation of atmos (A)
Longwave radiation of surface (E)
Shortwave reflected radiation (R)
Longwave radiation human (H)

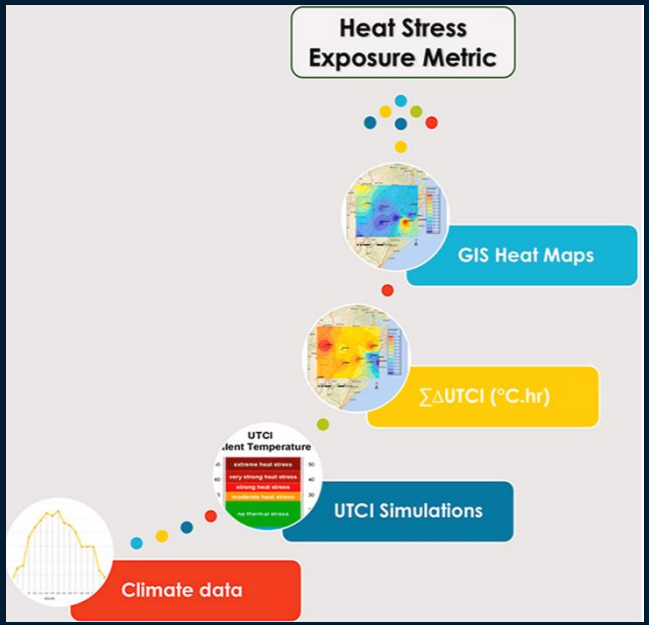
Matzarakis and Ruts (2011)



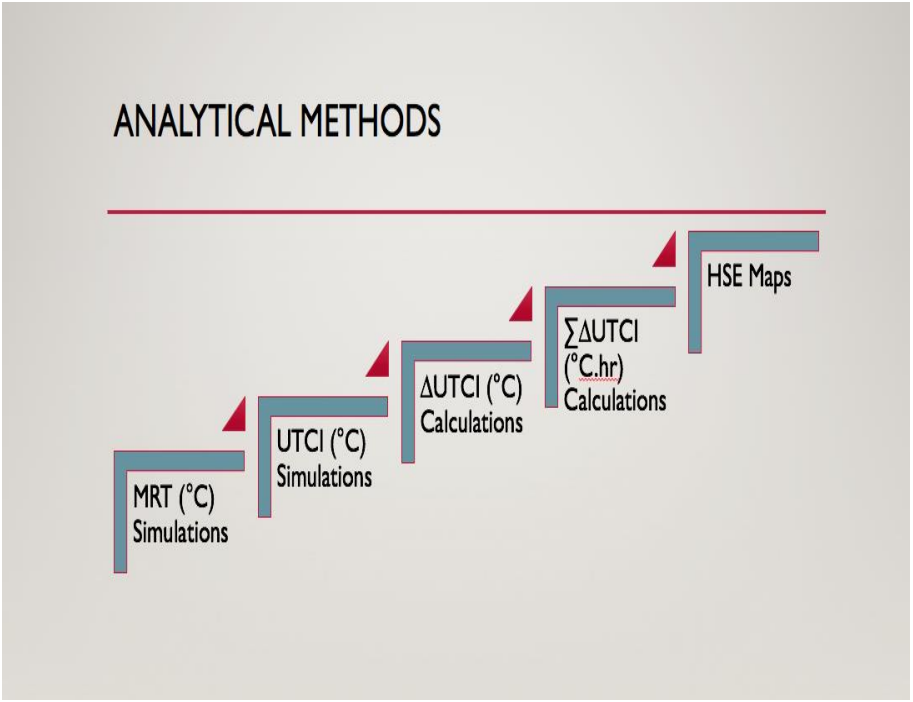
Research Methods

Metric for duration and intensity exposure to heat stress (HSE)

- Duration of HSE: number of hours exposed to heat stress (hours)- above threshold: 26 ° C
- △UTCI: each UTCI reading minus 26 °C
- Duration x Intensity of HSE: degree hours of heat stress exposure, ∑△UTCI (°C.hr)



Research Methods

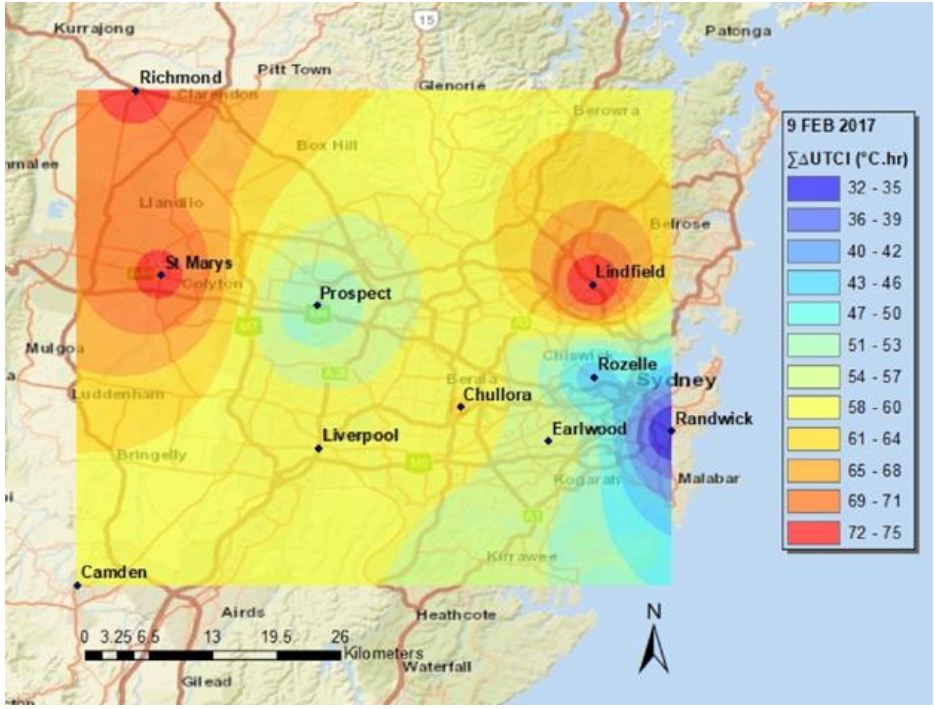


Results

Stations	H (h)	Duration x Intensity ΣΔUTCI (°C.hr)	Average UTCI Exceedance (°C)
Lindfield	1157	5191.3	4.5
St Marys	1033	5152.4	5.0
Richmond	1044	5093.4	4.9
Camden	982	4462.2	4.5
Chullora	946	4187.2	4.4
Prospect	869	4115.7	4.7
Earlwood	1016	3915.9	3.9
Liverpool	852	3825.1	4.5
Rozelle	785	2842.1	3.6
Randwick	520	1571.7	3.0

Table 1. Annual exceedance hours (h), duration and intensity of exposure to heat stress (∑ΔUTCI), average UTCI exceedance for 10 metrological stations through-out Sydney in 2017.

Results
Reference



Spatial distribution of Heat Stress Exposure (∑ΔUTCI; ◦C.hr) during heatwave 2017, 9th Feb.

Results
Intervention

Greening strategies

Three scenarios:

- Urban trees (scenario a), two million additional trees
- Green roofs (scenario b)
- Combination of urban trees and green roofs (scenario c)

Greening Strategies

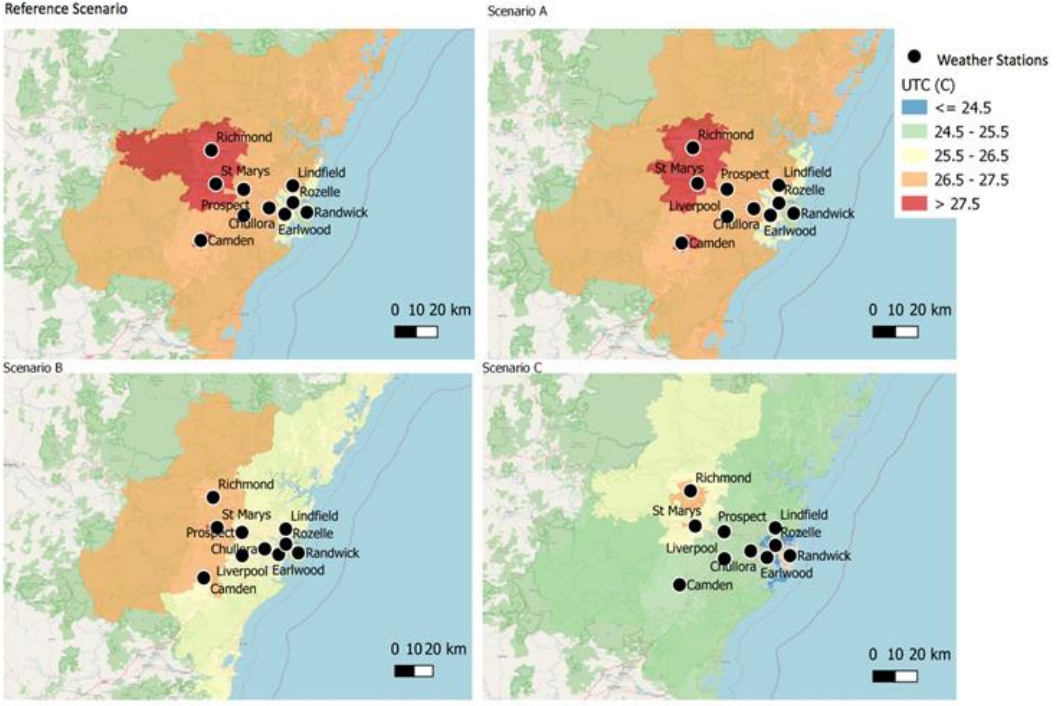
- Simulate greening Ta
- Simulate greening UTCI
- Calculate greening HSE
- $\triangle UTCI = UTCI_R - UTCI_G$

= Cooing effect of greening

- Plot greening HSE map

Results

Distribution of daily average UTCI (◦C) during heatwave 2017. Daily average UTCI reduced between -0.2 ◦C in the coastal eastern suburbs to -1.7 ◦C in the inland western suburbs on the heatwave day.



Results

Heat Health Impact model using Health Impact Assessment (HIA)

Excess UTCI-attributable number (AN) of deaths among the 5.7 million inhabitants of the Sydney Greater Metropolitan Region (GMR) were calculated for the heatwave day (baseline) and under adaptation scenarios based.

Under the most effective greening scenario (Scenario c), daily average UTCI reduced between 0.2 ◦C in the coastal eastern suburbs to 1.7 ◦C in the inland western suburbs on the heatwave day. This reduced summertime urban heat was estimated to reduce the number of premature deaths by up to 11.7 per day across the Sydney GMR compared to the baseline scenario.

Acknowledgment & Publications

Interdisciplinary project in collaboration between USYD Faculty of Medicine, Architecture, and UNSW School of Population Health, and School of Built Environment

Sadeghi, M., Chaston, T., Hanigan, I., de Dear, R., Santamouris, M., Jalaludin.,B., Morgan, G. (2022). The health benefits of greening strategies to cool urban environments – A heat health impact method. *Building & Environment, 207,* 108546. doi: https://doi.org/10.1016/j.buildenv.2021.108546

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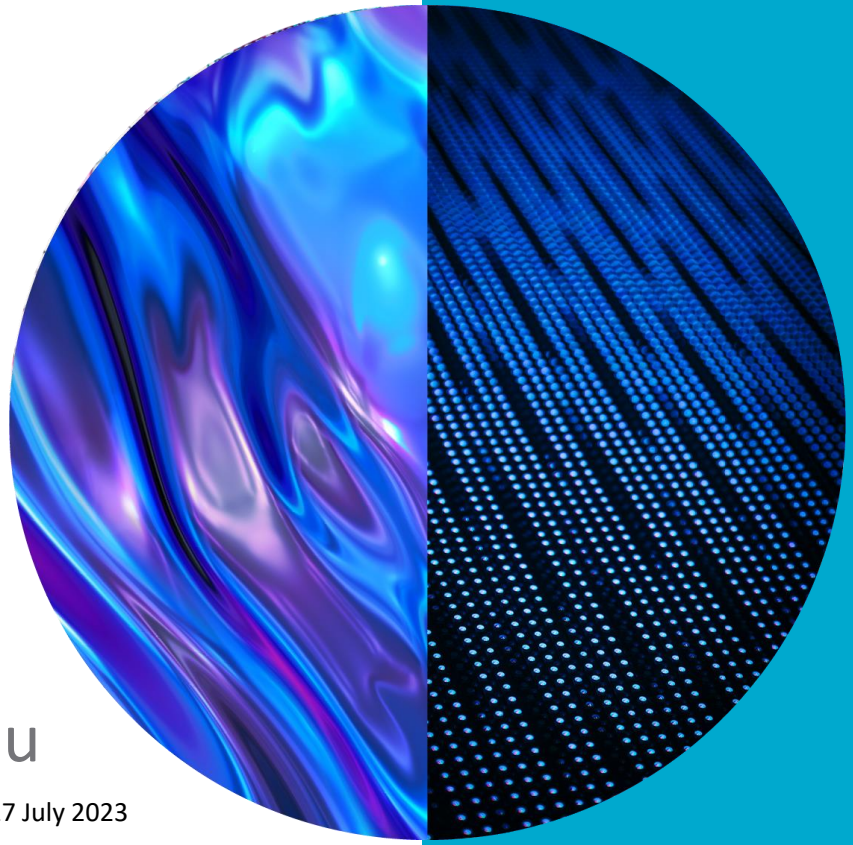

Thank You

Dr Mahsan Sadeghi | 27 July 2023