CRC for
Water Sensitive Cities

Economic value of urban heat island mitigation

Project IRP2

Using both biophysical and climate modelling, the CRCWSC has explored the urban heat island (UHI) mitigation generated from different scales of investment in urban greening for a new suburban development. The study also identifies the dollar value of the benefits of the urban cooling effect produced by water sensitive urban design (WSUD).

Introduction

The UHI effect can be mitigated by applying elements of WSUD, for example, lining large trees along suburban streets, irrigating public open space with fit-for-purpose water, and restoring wetlands. Increasingly, there are more investments in urban greening. These investments produce benefits from UHI mitigation through cooler land surface and air temperatures, but the dollar value of these benefits is unclear.

To add to the evidence base of UHI mitigation from WSUD, this case study assessed the impact of different policy settings on the biophysical environment, and then quantified the economic benefits of the reduced heat produced by those settings.

The study assessed several policy settings (scenarios):

No integrated water management (IWM) (S1)

Current situation (S2): Current IWM policy setting, incorporating landscape features to meet stormwater quality for residential subdivisions that are required by planning policy and building codes in the case study area.

Moderate greening (S3): Potential future IWM policy setting, which introduces a 60% flow volume reduction target as well as water quality targets for residential subdivisions.

Maximum greening (S4): Targeted UHI mitigation scenario, which incorporates IWM and landscape initiatives necessary to significantly reduce the UHI effect.

These scenarios represent different levels of WSUD intensity, with associated levels of vegetation, perviousness, and water availability that ultimately affect the surface energy balance and drive the near-surface climate.

Melbourne case study

The case study examined a greenfield development on Melbourne's outskirts, comprising 33,000 residential dwellings; roads, commercial and industrial space; and both non-irrigated and irrigated public open space. The study focused on the benefits to the core residential area.

Biophysical and climate modelling

The research team conducted biophysical modelling, using a model known as TARGET, to consider soil moisture, tree canopy area, and other outputs that influence temperature.

Table 1: The difference in average daily temperature (at 2m height) between the three scenarios for each of the climate conditions for the residential area only.

Scenario difference	Cool (°C)	Mild (°C)	Hot (°C)
Moderate greening (S3 minus S2)	−0.12	−0.10	−0.10
Maximum greening (S4 minus S2)	−0.51	−0.40	−0.31

TARGET modelled street level air temperature from a standard height of 2m (from the surface) with a resolution of 30m, and then provided the UTCI (Universal Thermal Climate Index) outputs to measure thermal comfort. The team then conducted climate modelling to produce daily average minimum (overnight) and maximum (midday) temperatures for each scenario and three summer climate conditions (cool, mild, and hot). The team used various meteorological variables including, but not limited to, air temperature (°C), relative humidity (%), and wind speed (km/hr).

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Economic framework

The economic framework used a discounted cash flow method and a 50-year time period to produce benefit estimates that reflect the different scenarios. The 'avoided cost' method was largely used to estimate these benefits, and can be used for benefit cost analysis of IWM options. The team drew on economic and scientific literature to identify a range of costs linking heat and economic outcomes. Costs were attributed to different temperatures, and when a scenario reduced daily temperature compared with the current situation, the reduction in heat-related cost reflected a benefit of that scenario.

Biophysical modelling results

- In the residential area, the maximum greening scenario (S4) produced the most cooling relative to current policy settings (S2): 0.5˚C for the cool summer days (see Table 1).
- At midday in residential areas, the maximum greening scenario (S4) produced ***2˚C of cooling almost everywhere*** during the cool summer conditions, relative to no IWM (S1). However, the cooling was less effective in mild and extreme summer conditions.
- The UTCI results indicated that a cooling of 0.5˚C ***'feels' like cooling of 0.8˚C***, which means WSUD is very effective at cooling the environment and improving human thermal comfort.
- WSUD is effective at mitigating heat impacts during moderate conditions but less effective at mitigating heat effects under very high temperatures.

Economic results

- Significant greening associated with plausible policy settings will produce meaningful economic heat reduction benefits.
- At a household level, the maximum greening scenario might derive a UHI mitigation value of over $1,500 per household in present value (PV) terms over the 50-year period. This result averages around $80 per household per year.
- For all scenarios, mortality benefits and lower electricity use are the main drivers of benefits (Figure 1).
- UHI mitigation is one of many benefits WSUD investments in urban greening produce, and all these benefits should be included during formal benefit cost analysis of urban development projects.

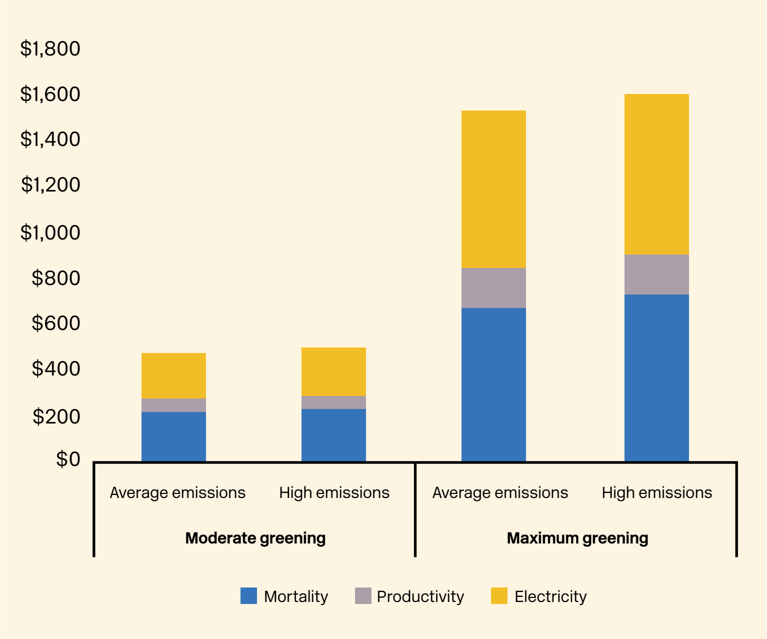

Figure 1: Results by benefit type, average and high emissions scenarios, $ present value per household

Further reading

Tapper, N., Lloyd, S., McArthur, J., Nice, K., and Jacobs, S. (2019). Estimating the economic benefits of Urban Heat Island mitigation – Biophysical Aspects. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Whiteoak, K. and Saigar, J. (2019). Estimating the economic benefits of Urban Heat Island mitigation – Economic Analysis. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Broadbent, A. et al (2019) . The Air-temperature Response to Green-blue-infrastructure Evaluation Tool (TARGET v1.0): an efficient and user-friendly model of city cooling. Geoscientific Model Development, 12, p785 – 803.

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