


CRC for
Water Sensitive Cities

Program B: Water Sensitive Urbanism | Project B3.1 | Project duration: July 2012 - December 2014

Cities as water supply catchments – Green cities and microclimate

Overview

Reduced water availability and vegetation cover, as well as the high thermal mass of impervious surfaces associated with urban development, limit evapotranspiration in urban areas, leading to unique urban climates in Australia. At the city-scale, this transformation can lead to an Urban Heat Island (UHI) effect where the urban areas are often warmer than the surrounding rural areas, especially at night. Drought, water restrictions and the implementation of drought tolerant landscapes all contribute to drier urban landscapes which can exacerbate urban heat. This will be further intensified by the projected increases in the intensity, frequency and duration of extreme heat events under climate change. The combined drivers of excessive urban heat from urban development and climate change increases heat stress and puts vulnerable populations at risk of heat related illness and mortality.

Implementing stormwater harvesting systems that incorporate vegetation offers unique opportunities to build water sensitive, low-energy and visually attractive cities with improved urban microclimates. This project aims to understand the climatic benefits of stormwater harvesting, water sensitive urban design (WSUD) and urban greening at the household- to neighbourhood-scale, including the relationship between extreme heat and health outcomes.

Key outcomes

This project, in partnership with the National Climate Change Adaptation Research Facility (NCCARF), has identified threshold temperatures above which mortality and morbidity increase in all Australian capital cities, and have developed a mapping tool to identify areas of high vulnerability during extreme heat events. The vulnerability maps can be used for emergency response planning by hospitals, the ambulance service and local governments to protect vulnerable residents and to plan for the future. Even small temperature reductions of 1-2°C can save many lives. Researchers also found a clear association between area-based measures of extreme heat vulnerability and heatwave morbidity. Research demonstrates the critical role of shade in reducing outdoor heat stress, demonstrating that trees should be incorporated as a WSUD feature. Providing fit-for-purpose water to ensure trees and vegetation remain healthy will deliver positive benefits for human thermal comfort.

Together with the Victorian Centre for Climate Change Adaptation Research (VCCCAR) and other universities, this project has also established a framework for prioritising urban greening interventions based on population vulnerability, areas of excess heat and behavioural exposure (areas of high population activity). This framework provides a step-by-step guide to the selection and placement of green infrastructure, especially trees, to maximise cooling benefits. This project will determine how effective stormwater harvesting technologies, tree cover, green infrastructure and WSUD are improving urban climates at a range of scales. It will also identify the key characteristics required to reduce temperatures to save lives under heat wave conditions and to enhance human thermal comfort and liveability.

Key findings on how WSUD can mitigate urban heat

The project has found that heat extremes and the number of days exceeding the critical heat-health thresholds are projected to increase in all Australian capital cities in the coming decades. Therefore, city planners and urban designers should be guided by heat vulnerability maps to integrate WSUD principles into high vulnerability areas. WSUD principles such as vegetation and water and stormwater harvesting are potential solutions for mitigating urban heat through shading and cooling.

- High resolution thermal remote sensing data has shown that during hot and dry conditions, trees and water bodies show considerably lower land surface temperatures during the day than urban surfaces like concrete. Land surface temperatures of irrigated grass can be up to 20°C cooler than non-irrigated grass.
- Based on the relationships between vegetation cover, built area index and land surface temperature for the three Victorian local government areas of Darebin, Melbourne and Monash, researchers have found that for every 10% increase in tree cover there is a reduction in land surface temperature of between 0.5°C and 1°C.
- Satellite images of Dubbo, New South Wales, taken during extreme summer temperature days while the city was in severe drought between 2000-2011 and while it was experiencing flooding rains between 2010-2011, shows that the use of irrigation water on green infrastructure in Dubbo's urban landscape had a cooling effect. In one instance, when air temperatures reached nearly 40°C, Dubbo's urban landscape was 3-5°C cooler than the surrounding rural areas.

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Project design

There are two main streams of research in this project. The first one uses a combination of observational, remote sensing and modelling approaches from the household- to the neighbourhood-scale to determine the microclimate impacts of decentralised stormwater harvesting solutions. This includes assessments of how microclimates change through tree cooling processes, lighter coloured roofing material and evapotranspiration from green roofs. Other components look into local-scale and landscape-scale variability of surface and air temperatures and their relationship to green infrastructure and built environment. This will inform the development and validation of urban climate models at a range of scales.

The second stream draws on a range of data sources to understand the relationships between extreme heat and heat-health outcomes including mortality and morbidity. Assessments of threshold temperatures across a range of cities and identification of optimal environmental conditions for human thermal comfort help set benchmarks for improving urban climates through WSUD.

Outlook

The next step is to draw together the key findings of the observational, remote sensing and modelling research on WSUD elements and evaluate their capacity to mitigate urban heat and improve human thermal comfort. From this, strategies to incorporate WSUD principles and green infrastructure into existing or new developments to create cooling effects will be outlined. The final step involves a shift from evaluating individual WSUD elements (such as green roofs, street trees and biofiltration systems) to assessing the climatic benefits of wider implementation in neighbourhoods and catchments.

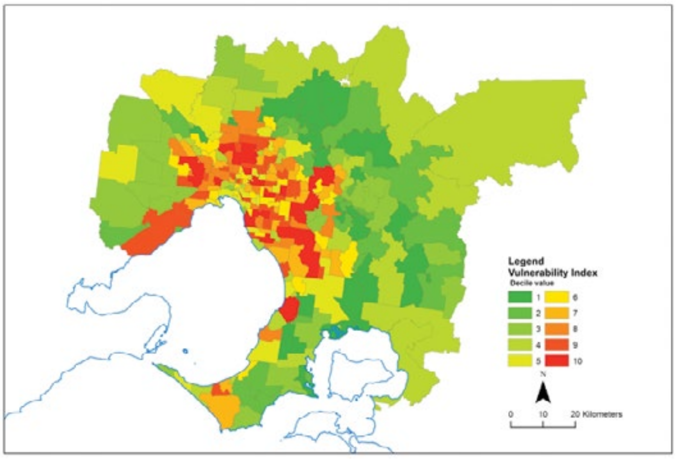

Figure 1. Heat vulnerability map of Melbourne identifying the city's most at-risk suburbs (© CRCWSC)

About the Cooperative Research Centre for Water Sensitive Cities

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) brings together interdisciplinary research expertise and thought-leadership from Australia and the world to address current urban water management challenges facing our cities and regions. In collaboration with over 80 research, government and industry partners, it develops and synthesises knowledge into powerful tools and influences key players aiming to achieve sustainable, resilient and liveable water sensitive cities.

Further information

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