RP2005

RESILIENCE TO HEAT STRESS IN LOW CARBON CITIES

Research Question

1- ***To what extent do outdoor activities alter due to heat stress? When do changes start and how do changes fluctuate?***
2- ***What attributes of public space can facilitate resilience to heat stress?***
3- ***To what extent can heat resilient public spaces reduce cooling energy demand in low carbon cities?***

Figure 1: Hard urban surfaces such as asphalt, concrete and paving store heat in their thermal mass and make the public space a dangerous place to attend during heat stress (Riverbank Plaza, Adelaide, FLIR 6 thermal image taken by E. Sharifi).

Methodology

Spatial heat resilience – indicating the ability of public space to maintain its normal activities during heat stress conditions – is proposed and tested in three case studies in Darling Quarter (Sydney), Federation Square (Melbourne) and Festival Centre (Adelaide).

Data collection includes thermal photography, microclimate measurement and direct observation (air temperatures range 16-42°C and surface temperatures range 10-65°C). Data are analysed via correlational and segmented regression analysis. Findings are triangulated with a questionnaire survey in Adelaide.

Landsat 7 ETM+ and Landsat 8 surface temperature data are analysed and heat resilient urban cover are discussed regarding their application in low carbon cities.

Results

Increased tree canopy, surface water and shadow coverage results in higher resilient to heat stress. Outdoor activities start to decrease after the sensible temperature (in UTCI scale) reaches the threshold of 28-32°C. Necessary activities (including vital and habitual) can have a higher neutral thermal thresholds (NTT_{out}) up to 36°C. Most public spaces experience critical zero-activity conditions at 30°C < UTCI < 42°C.

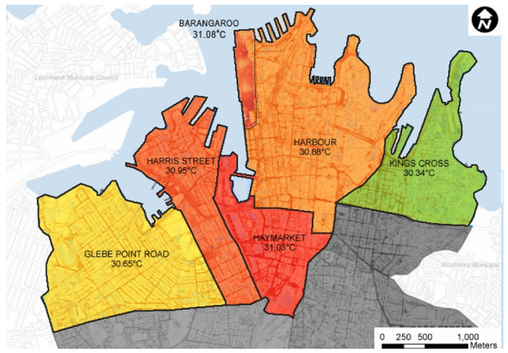

Figure 2: High ratio of urban greenery correlates with lower precinct average temperatures and extend outdoor activities in more inhabitable urban settings (Aerial thermal imagery, City of Sydney 2010)

Artificial-hard landscapes have the highest radiant temperature under direct sunlight which reached up to 15°C higher than tree canopy and surface water, and 8 °C higher than grass cover and natural-hard landscapes. An ideal urban landscape transformation scenario of having 30% tree canopy, 30% soft and natural cover, and 40% hard surface cover could decrease the ambient temperature in urban precincts by up to 1.0 °C in winter and 3.0 °C in summer.

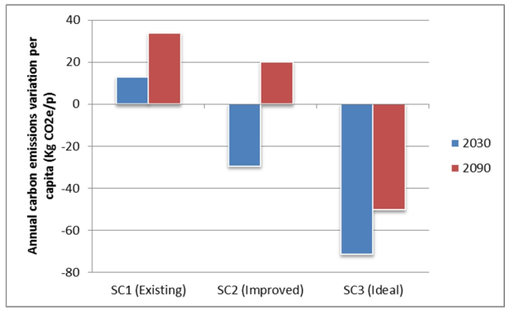

Figure 3: Carbon emission variation per capita resulted from urban heat resilience scenarios in Sydney

It is estimated that having heat resilient public spaces could save a total carbon emission of 140 Kt CO2-e in Adelaide, 365 Kt CO2-e in Melbourne, and 620 Kt CO2-e in Sydney metropolitan areas annually. In addition, heat resilient public spaces facilitate adaptation and support public health in the context of climate change.

Conclusions

Urban greening and heat resilience transformation can make Australian urban precincts more resilient to heat stress. Heat resilient public spaces can support outdoor activities during outdoor heat stress conditions. This increases the adaptive capacity of local communities to the outdoor thermal environment, and leads to a decrease in the carbon emissions of urban life in Australia.

Anticipated impacts

In the context of climate change, heat resilience in public space can support more vibrant, healthy and safer urban environments in low carbon cities. Urban policy making, planning and design benefit from findings of this research.

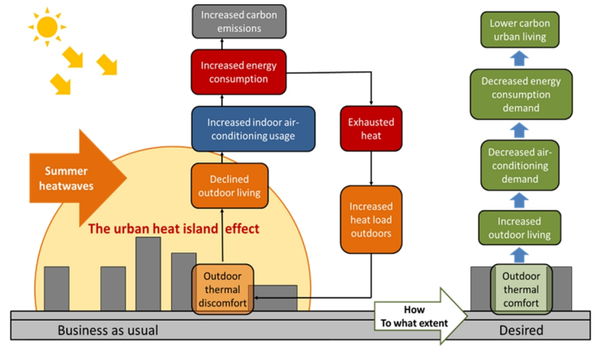

Figure 4: Heat resilient public spaces provide extended outdoor thermal comfort and support low carbon living in the context of the warming climate

Resilience to heat facilitates low carbon living in the context of climate change

Further information

http://www.urbanclimates.org

http://www.lowcarbonlivingcrc.com.au

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