# Urban overheating mitigation and building adaptation in Mt Druitt – An integrated approach in Western Sydney

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**INTRODUCTION:** The combination of global climate change and urban overheating are leading to an increase in peak summer temperatures and intensity of heatwaves. Urban overheating has consequences for human thermal comfort, health, building cooling energy needs, and even the ability to live outdoors in the public space during significant fractions of summertime, especially for the vulnerable population. Here, we studied heat-mitigation and its benefits on ambient temperature, building energy needs, electricity demand and risk of heat-related mortality in Mt Druitt, is a socio-economically disadvantaged area in Western Sydney.

**METHODS:** With a network of six temperature and humidity sensors, we monitored the local conditions for more than one year. Then, we performed detailed measurements on a clear sky hot day at 23 locations in Mt Druitt, with mobile weather stations and a drone equipped with a thermal camera. Thus, we used the collected data to validate a microclimate simulation model. Upon consultation with Blacktown City Council, with the measured data, we calibrated a microclimate model to assess five design scenarios:

- Base case – unmitigated
- Unirrigated greenery – 10 unirrigated trees on Dawson Mall and 337 additional trees in other locations
- Irrigated greenery – 10 passively irrigated trees on Dawson Mall and 337 additional trees in other locations
- Cool materials – Albedo of roofs increased to 0.75 and to 0.40 for car parks and pedestrian areas
- Combined – Combination of all the above mitigation strategies plus shading of car parks

Then, we computed the cooling energy needs, electricity demand and risk of heat-related mortality in unmitigated and mitigated scenarios, using the ratio of mitigated to unmitigated temperature from modelling.

**RESULTS:** In peak conditions, Mt Druitt is 1.2-1.7 °C hotter than the values recorded at the Bureau of Meteorology's station in Horsley Park, which is approximately 10 km south of Mt Druitt, in a non-urban area at the same distance from the cost. Especially, the air temperature in Mt Druitt is even 2.5 °C hotter than in Horsley Park in the evening and night. The maximum reductions are achieved in the combined scenario and equal a peak air temperature reduction of 1.24 °C, followed by the cool materials scenario with a peak reduction of 1.17 °C, and then irrigated and unirrigated greenery scenarios with reductions of 0.76 °C and 0.71 °C. These temperature reductions are in line with results previously achieved with heat mitigation on a small area, while peak air temperature reductions of 2.2-2.9 °C are possible only with Sydney-wide heat mitigation.

The cooling energy needs for all simulated buildings is 20-40% higher in Mt Druitt (urban area) than at Horsley Park (non-urban), depending on insulation level and internal heat loads, showing an energy penalty for all urban buildings in Mt Druitt. A reflective roof (albedo = 0.75) instead of a conventional roof (albedo = 0.15) can deliver cooling energy savings in all situations, with the greatest advantage for poorly insulated low-rise buildings (e.g., existing office buildings). Here, we computed cooling energy savings up to 18% for an uninsulated low-rise office building. High levels of roof insulation (as per current building code levels) are not beneficial in buildings with high internal heat gains, because they reduce heat dissipation and increase cooling energy needs. Cooling energy savings in the range between 10% and 24% can be achieved with the combination of cool roofing and urban heat mitigation. Also, the electricity demand (all uses) over the hot period (November-March) for all uses can be reduced by 1.5% with urban heat mitigation. Finally, heat mitigation can reduce the risk of heat-related mortality, which in Western Sydney is significantly higher than on the coast.

**CONCLUSIONS:** Heat mitigation should be implemented in the most comprehensive way, with a combination of heat mitigation technologies, as in the combined scenario. Heat mitigation of a single hot spot is helpful to improve the local thermal comfort, but in the case of Dawson Mall in Mt Druitt an advective inflow of hot air due to the north-south axis of the pedestrian mall reduces the air temperature reductions. Instead, heat mitigation should be implemented at the regional scale, i.e., Sydney-wide, to achieve reductions in the ambient temperature exceeding 2°C, thus contrasting the effects of urbanization. A single council cannot alone achieve this level of urban heat mitigation.