Drivers and barriers to heat stress resilience in the urban context

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Heatwaves in Australia now

- Heatwaves are the most **deadly natural hazard** (Coates 2014)
- Cooling demand drives **peak electricity demand** (Australian Electricity Market Operator, 2011), contributing to soaring **electricity prices** and **energy poverty**
- **Air-conditioning (AC)** is one of the **most frequently used adaptation techniques**
- **Negative impacts** of AC:
  - Increased carbon emission
  - Increased dependence on it (Candido, 2010)
  - Warming up the outdoors
Heatwaves in Australia in the future

- Heatwaves are exacerbated by Urban Heat Islands with 89% of Australians living in cities (UN DESA 2011)
- The frequency and intensity of heatwaves are rising due to climate change (Nairn and Fawcett 2013)
- Population is ageing
- New buildings with high insulation and air-tightness rely even more on AC

>>> A wicked, interdisciplinary problem.
Framework for the population heat stress resilience

RESILIENCE

Vulnerability  Built environment

IMPACTS

Water  Ambulance

Adaptation  Electricity

Photos from https://unsplash.com/
Methods

1. Impacts

Time-series and regression analyses in Adelaide and Sydney
Daily data of: electricity consumption, demand; water demand and morbidity

2. Population resilience

Online survey
Representative sample from Adelaide (N=393) and questions about: demography, built environment, retrofitting activity, adaptation, heat-related health problems.

3. Heat stress resistance of buildings

AccuRate building energy simulation of a typical residential floor plan with different design scenarios
Results, impacts: threshold temperatures

<table>
<thead>
<tr>
<th>Temperature Threshold</th>
<th>Impact</th>
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<tbody>
<tr>
<td>32 °C</td>
<td>electricity consumption</td>
</tr>
<tr>
<td>30 °C</td>
<td>electricity peak demand</td>
</tr>
<tr>
<td>28-30 °C</td>
<td>water supply</td>
</tr>
<tr>
<td>28 °C</td>
<td>morbidity</td>
</tr>
</tbody>
</table>

- One fifth of water and electricity supply occur during heatwave days (6.61% of the year)

Heatwave days:

![Chart showing daily water demand and temperature graph]
Results, online survey on heat stress resilience

- The **health of one fifth** of the population was impacted by a medium heatwave.
- **Three quarters of dwellings** were reported having insufficient heat stress resistance.
- **Tenants** tended to have more health issues and live in less heat stress resistant homes.
- Homes with roof insulation had less health issues.
- >>>
  - Implement the **Energy Performance Certificate**
Results, online survey on heat stress resilience

• **Pre-existing health conditions** predicted higher vulnerability and they were oblivious of their vulnerability.

• In contrast, **older people adapt more** and live in more resistant homes.

• 6-9% of the population lives among poor housing conditions and suffers from **energy poverty**.
Results: AccuRate simulation

Homes with more stars can
• have higher cooling consumption
• have higher peak demand
• get overheated more
• than buildings with fewer stars

Total annual energy consumption (MJ)

- 2.6 stars traditional double brick
- 2.6 stars traditional brick veneer
- 6.2 stars cooling-dominant
- 6.2 stars heating-dominant
- 7.1 stars heating-dominant
- 7.2 stars cooling-dominant
- 8.0 stars cooling-dominant
- 8.0 stars 04 heating-dominant

Total energy unadjusted (MJ/m² year)
Cooling energy unadjusted (MJ/m² year)
Conclusion

• **To assess vulnerability** we have to consider energy poverty, adaptation capacity and the built environment

• **AC is not a final solution** >> impact of electricity and morbidity have to be managed together

• Built environment has a **triple positive impact** on resilience
  • Save energy
  • Increase adaptation
  • Decrease health issues

• **Holistic building design** is important to create energy efficient AND heat stress resistant homes
Thank you for your attention!

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CRC LCL research project webpage

PhD talk in the Science Show on the ABC RN, 2nd April, 2016,