Future Proofing Residential Development to Climate Change

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Are we locking in climate vulnerabilities for occupants of residential buildings with building controls based on historical climate records? If so, what adaptations are available to improve the resilience of residential development and protect the safety of our communities in a warming world?

Background

Nationally, it is estimated that 500,000 dwellings will be built over the next three years.[1] At the same time, Australia's climate is changing with average and extreme temperatures increasing and rainfall in the southeast declining; most notably in winter.[2] These climate changes impact our health and wellbeing, our energy and water infrastructure and supply, and should impact how we manage our built environment.

In 2014, it was observed that planning for demographic and population changes had failed to account for climate change related risks and hazards in Metropolitan Sydney.[3] Despite numerous heat events and resulting research, building controls still do not account for projected warming caused by climate change or the affect this will have on residential communities.[4] As a consent authority for residential development in Sydney's Eastern Beaches, Waverley Council designed a project to see if the residential buildings we approve today, will be safe in the hotter, dryer climate of the future. And if not – how can they be adapted to be more resilient to climate change.

Aim

The aim of the *Future Proofing Residential Development to Climate Change* research project was to model the performance of residential dwellings in Randwick, Woollahra and Waverley council areas against future climate projections to determine the effects of climate change on building performance and identify appropriate responses.

Method

Council officers selected five recently approved residential buildings (detached, attached, low-rise, mid-rise and high-rise) common to the Eastern Beaches (217 dwellings in total) that met NSW Building Sustainability Index (BASIX) requirements, and sought to review the performance of each building type against:

- Thermal comfort i.e. estimated heating and cooling loads (MJ per m^2 per year);
- Energy consumption and greenhouse emissions (kg CO_2 per person per year); and
- Water consumption (litres of water per person per year).

Each building type was then assessed for these criteria under three different climate scenarios:

- Present day 2020 (to serve as a Baseline Year)
- Near future change 2030 (average 2020–2039)
- Far future change 2070 (average 2060–2079)

It is worth noting that though the baseline year was 2020, the climate data in the current NatHERS software used to model the heating and cooling loads and energy consumption of dwellings is from predominantly last century (1970–2004). Similarly, BASIX uses climate data from pre-2004 to model estimated outdoor water consumption and the productivity of rainwater tanks.

Therefore, to undertake this research the historical data files were replaced with projected climate data for Eastern Suburbs Climate Zone 56, using high emissions scenarios. For NatHERS we used RCP8.5[5] data for 2030 and 2070 provided by CSIRO's Energy Division. For the BASIX tool we used NSW and ACT Regional Climate Model (NARCliM) A2 data for 2030 and 2070, provided by NSW Department of Planning, Infrastructure and Environment.

Through the modelling conducted by WSP, it was identified that although average temperature is projected to rise by only 1-2°C, the cumulative impact of hot/warm hours will drive significantly increased cooling loads. For Eastern Sydney Climate Zone by 2030, there will be almost an extra month of warm days per year over 25°C and by 2070, there will be an extra 2.5 months per year of warm weather compared to the Baseline year.[5]

Results

Under the future climate scenarios, there will be less energy required for heating and substantially more energy required to cool our homes. Despite a relatively mild coastal climate, all compliant dwellings in the Eastern Beaches failed regulated thermal comfort requirements for cooling by 2030, because cooling loads increased by 70% on average above the Baseline Year for all dwelling types. By 2070, cooling loads increased by 308% on average above the Baseline Year . Essentially, this project shows that dwellings approved today under existing NSW regulatory controls will be unsuitable for occupation by 2070, without extremely high levels of mechanical cooling. This raises important questions about affordability and equitable access to cooling for Sydney's vulnerable communities, not to mention looming peak electricity demand challenges as the climate warms and the frequency of extreme heat events increase. It also calls into question the feasibility of governments' net zero and resilience aspirations.

We next asked our building modellers to identify what treatments would enable the five BASIX buildings to reach thermal comfort compliance under 2030 and 2070 climate scenarios. Compliance Design Treatments included building fabric improvements (e.g. glazing performance, insulation, cross ventilation), shading improvements (e.g. eaves, awnings, venetian blinds, lighter coloured walls and roofs, reducing, removing or shading skylights), glazing area reductions, modelling of ceiling fans, and combined treatments (i.e. two or more treatments listed below).

	Baseline Year		2030		2070	
	Warm	Hot	Warm	Hot	Warm	Hot
Hours/year	1110	26	1323	28	2162	52
Days/year	125	5	150	6	200	9

Figure 1: Number of warm and hot days per year, Eastern Suburbs Baseline Year 2020, 2030 and 2070 (WSP, 2020)

Pleasingly, a range of existing design solutions enable the modelled buildings to meet the current thermal comfort compliance requirements in both 2030 and 2070.[6] To reach compliance in 2030, the modelled detached house required high performance single glazing, an increase in wall and roof insulation and the installation of a high-performance ventilated skylight. By 2070, the house also required high performance double glazing, a reduction in skylight area, light-coloured walls and roofs, openable windows in all rooms and ceiling fans in bedrooms and living areas to stay cool. These design modifications would deliver a dwelling that was thermally comfortable and safe to live in over its design life.

Discussion

With global temperatures projected to rise by 2.5°C in the next century, residential buildings and homes will need to withstand hotter temperatures, drier climates and more extreme weather events. Our project demonstrates that if projected climate data is incorporated into building controls, then designs will incorporate requisite building fabric improvements and increased ventilation; delivering homes that are built to stay cool over the lifetime of the dwelling.

As local government professionals, we want to ensure our communities are not forced to live in dwellings that are maladapted for the near future. Therefore, we are advocating for the use of future climate data to inform current planning tools. This will ensure that the houses built today are thermally comfortable and safe for occupants to live in well into the future. The BASIX tool is a State-wide policy while the NatHERS software is used nationally in the National Construction Code, and both are currently undergoing updates. As demonstrated by this project, adopting future climate data in both tools is a simple and available measure that can be implemented today, benefiting homes built across NSW and ultimately across the whole country. ■

Figure 2: The project team (left to right: Rachel O'Leary, Katie Fallowfield, Nick Asha and Suzanne Dunford) receive the Greater Sydney Planning 'Disruptor' Award for 2021 from Geoff Roberts AM.

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***Suzanne Dunford** has worked in climate change at both State and local government levels, and is passionate about harnessing social, regulatory and environmental systems to ensure a just transition to a climate adapted world.*

***Rachel O'Leary** is an environmental scientist who is passionate about providing safe, comfortable, and affordable housing for all people.*

Endnotes

1. https://hia.com.au/-/media/HIA-Website/Files/IndustryBusiness/Economic/fact-sheet/window-into-housing.ashx?la=en&hash=984BFC3393B3F2F997E099A71545B151044C2B50 Housing Institute of Australia (HIA), 2020, Window into Housing.
2. Australian Government 2020, *State of the Climate 2020*, Canberra.
3. State of NSW and Office of Environment & Heritage 2014, *Integrated Regional Vulnerability Assessment: Metropolitan Sydney*, vol. 1, p.9, Sydney.
4. March,A., Legacy,C., Warren-Myers,G., Nogueira de Moraes,L. 2021, *Bushfire and Natural Hazards CRC 2021 Heatwave and Building Codes in NSW: Issues and Prospects*, Sydney.
5. WSP 2020, *Future Proofing Residential Development to Climate Change Stage 1 Report*, Sydney.
6. WSP 2020, *Future Proofing Residential Development to Climate Change — Addendum — Adaptations to Residential Building Designs*, Sydney.