Managing heatwave impacts under climate change

Climate projections show (with high confidence) that Australia will experience more extreme heat events in the future as a result of climate change.

Key Points

Extreme heat events, or heatwaves, have killed more Australians in the past 200 years than any other climate hazard, and have caused major economic disruptions. Climate change will increase the exposure of Australian communities, buildings and infrastructure to longer and more intense heatwaves. Without effective adaptation, future climate change is very likely to increase the number of deaths and amount of economic disruption due to heatwaves.

Heatwaves cause multiple impacts – to people, the buildings they live in and the infrastructure and services they rely on (transport, electricity and heath services). They can have critical flow-on effects through increased bushfire risk. For city dwellers, these effects are exacerbated by the urban heat island effect.

There are significant opportunities to reduce the exposure of Australians and the Australian economy to climate change-enhanced heatwaves in four realms: personal/community (e.g. through education and targeted health care of the vulnerable), workplace (e.g. changes in working hours, contingencies for work stoppages), buildings and infrastructure (e.g. house design, building regulations and construction standards); and the public realm (e.g. increased shading in public spaces). Adaptation actions can be proactive, e.g. building resilience through consideration of extreme heat events in urban and regional planning, and reactive, e.g. door-knocking the elderly during the events themselves.

The interconnected nature of the problem demands integrated, holistic adaptation responses. Managing the policy responses to extreme heat events separately as health issues, emergency management issues or urban planning issues will be ineffective and could overlook critical interconnections such as the links between building more thermally-efficient houses, reducing peak energy demand for cooling, and electricity infrastructure planning.

NCCARF's evidence-based Policy Guidance Briefs address key challenges to effectively adapting Australia to a variable and changing climate. They provide high-level policy advice designed for use by policy makers at Commonwealth and State level. This Guidance Brief deals with the management of heatwaves, or 'extreme heat events', and their impacts on human health and infrastructure under climate change.

Extreme heat is defined as daytime maximum temperatures in excess of some threshold, often 35°C. Extreme heat events have been defined as occurring when there are at least 3 consecutive days in which the combined effects of excess heat and heat stress[1] are unusual with respect to the local climate (Nairn, 2012). During extreme heat events, persistently high temperatures pose serious risks to the health of individuals, as well as to infrastructure (Wang and McAllister, 2011).

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The climate context

Australia's climate is warming: annual mean temperatures have increased by 0.9°C since 1910, and the frequency of extreme (record) hot days has been more than double the frequency of extreme cold days during the past ten years (CSIRO and BOM, 2012).

In the future, extreme heat events are projected to occur more frequently and become more severe. By 2070, residents of Adelaide, Sydney and Melbourne can expect to experience at least twice as many very hot days, while residents of Darwin could find 35°C days occurring for up to two-thirds of the year (Table 1; Wang and McAllister, 2011).

Climate extremes are pushing new boundaries. This was demonstrated by the unprecedented 2009 heatwave in southeastern Australia (CSIRO and BoM, 2009) and the measurement of Australia's 'hottest day on record' on 7 January 2013 that was accompanied by forecasts of over 50°C in central Australia (Figure 1). This led the Bureau of Meteorology to add two new colours (deep purple and magenta) to temperature forecasts (ABC News, 9 January 2013).

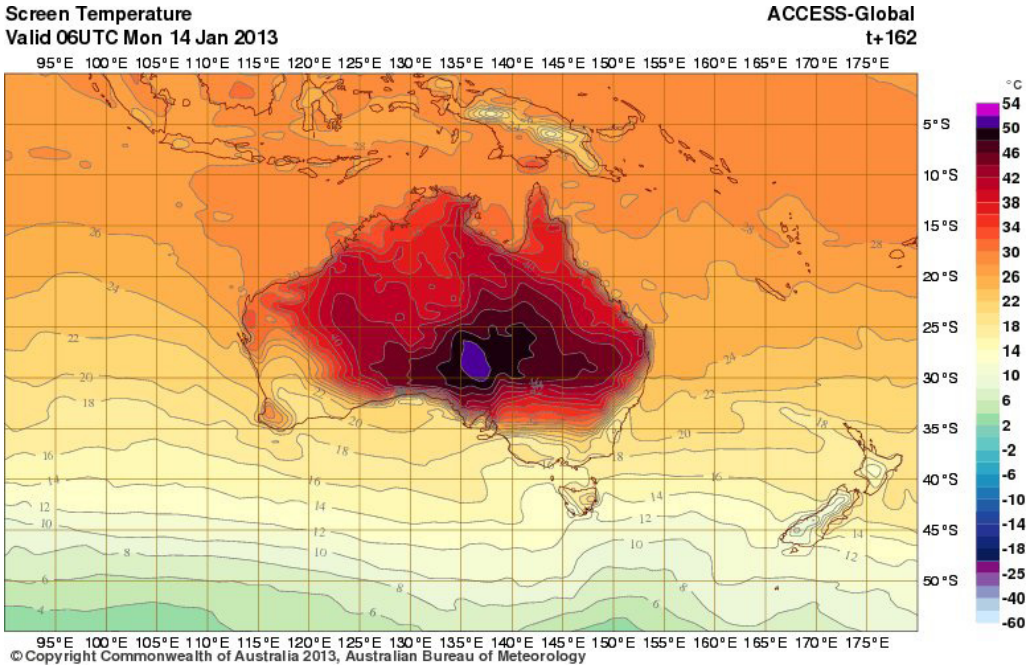

Figure 1: Forecast map for 8 January 2013 showing the addition of the expanded temperature range to 54°C, from the previous high of 50°C (Source: Bureau of Meteorology www.bom.gov.au)

[1] Heat stress is defined as a group of conditions (including heat stroke, exhaustion, cramps and fainting) that result from overexposure to and/or overexertion in excessive ambient temperatures.

2 Current effects, impacts and issues

Heatwaves have caused more deaths in Australia over the past 200 years than any other climate-related hazard (Coates, 1996). The effects of climate change-enhanced extreme heat will include widespread impacts on the health and comfort of individuals and communities and potentially overwhelming pressures on health and emergency services, electricity supplies and transport (QUT, 2010). Heatwaves can result in significant economic costs through lost productivity, for example through sickness and transport disruptions (Wang and McAllister, 2011).

Heatwaves have flow-on impacts through increased bushfire risk on extreme heat days. Urban heat island effects[2] can exacerbate heatwave impacts, making cities particularly high-risk places to be during very hot conditions (Bi et al., 2011).

The degree of vulnerability of individuals and communities to heatwaves is a function of factors such as age, pre-existing illnesses and medication, level of physical exertion, awareness of the risks, socio-economic factors, and the quality of housing and the urban environment (QUT, 2010). The level of preparedness, rate of event onset and its predictability, and the ability to moderate the impact (e.g. through mechanical cooling) all influence impact severity (QUT, 2010).

Numerous studies have associated high ambient temperatures with adverse health outcomes (Bi et al., 2011; Nitschke et al., 2011). These include, in increasing order of severity, dehydration, heat cramps, heat syncope (dizziness and fainting), heat exhaustion and heat stroke (Government of South Australia, 2010). While many Australians are acclimatised to hot summers, increased morbidity and mortality associated with extreme heat are regular occurrences and may become even greater risks in a warming climate.

Location	Present day	2030	2070 (low emissions)	2070 (high emissions)
Perth, WA	28	35	41	54
Darwin, NT	11	44	89	227
Alice Springs, NT	90	109	122	155
Cairns, QLD	3.8	6.6	12	44
Sydney, NSW	3.5	4.4	5.3	8.2
Melbourne, Vic	9.1	11.4	14	20
Hobart, Tas	1.4	1.7	1.8	2.4
Adelaide, SA	17	23	26	36

Table 1: Projected number of hot days (days over 35°C) by 2030 and 2070, for selected climate change scenarios (low or high emissions of greenhouse gases that drive the rate of climate change) and Australian locations. Source: www.climatechangeinaustralia.gov.au/documents/resources/Climate_change_poster.pdf

3 Future effects, impacts and issues

Health and infrastructure risks from heatwaves will increase in the future in the absence of effective adaptation measures. The number of extreme hot days is predicted to increase over the next 20 to 40 years in all Australian capital cities (Table 1; Loughnan et al., 2013). The Garnaut Review projected that annual net temperature-related deaths (taking into account fewer deaths in warmer winters and more deaths in hotter summers) for their unmitigated climate change scenario would increase by 1,250 deaths in 2070, and 8,628 deaths in 2100, nationally (Bi et al., 2011). The greatest negative impacts were projected for Queensland, Northern Territory and Western Australia (Bambrick et al. 2008; cited in Bi 2011). These projected increases in heat-related mortality and associated morbidity will place pressure on emergency and health services, an effect already seen, for example, during the 2009 heatwave in Victoria (QUT, 2010).

As the population grows and urban areas expand, increasing numbers of people will be exposed to second-order risks such as photochemical smog, bushfires and breakdowns of transmission and supply-chain networks (QUT, 2010). The interconnected nature of Australian urban systems results in high sensitivity to extreme heat (Guan et al., 2012). Disruption of transport and/or energy supply networks has potential repercussions for the ability of communities to access essential supplies and/or regulate their exposure to high temperatures through the use of technologies such as air conditioning. Understanding differential exposure, sensitivity and adaptive capacity of infrastructure, supply chains and social systems will be imperative in developing effective adaptive responses to extreme heat risk.

Different heat thresholds associated with negative health outcomes have been found for individual cities around Australia depending, for example, on the degree of acclimatisation in the population. These thresholds, beyond which risks of mortality and morbidity rise sharply, have helped in setting extreme heat warning triggers.

[2] The high thermal mass of buildings, structures that restrict airflow and surfaces that radiate stored heat lead to urban temperatures higher than those in the surrounding countryside.

4 Adaptation: what this means for managing heatwaves

There are significant opportunities to reduce the vulnerability of Australians and the Australian economy to climate change-enhanced heatwaves through adaptation. For example, Saman et al., (2013) show that a combined approach of behaviour change, dwelling modification and improved air conditioner selection can readily adapt Australian households to the impact of heatwaves, reducing the risk of heat-related deaths and high household energy costs.

Adaptation action can be considered under four headings, depending on the goals of those actions: first, to reduce exposure, second, to reduce vulnerability, third, to enhance adaptive capacity and, fourth, to improve responses during and after a heatwave (Loughnan et al., 2013; Wang and McAllister, 2011):

Adaptation to reduce exposure:

- Goal: to achieve 'cool cities' by reducing the intensity of urban heat islands.

  Possible actions: planning urban areas with regard to comfort of public areas through plantings, shading, and free airflow; providing public cool areas and amenities such as swimming pools; and mainstreaming consideration of heatwaves into urban planning at Local Government level and in individual development proposals.

- Goal: to increase the resilience of infrastructure to heat-related failures through upgraded engineering design standards.

  Possible actions: uprating building and infrastructure design standards to allow for more severe heatwaves, e.g. through incorporating passive cooling and 'cool rooms' in new-build houses, and designing and building critical infrastructure to operate under severe heatwave conditions.

Adaptation to reduce sensitivity:

- Goal: to ensure that service operation will be robust during heatwaves and will not compromise the safety of vulnerable groups.

  Possible actions:

  - Improving maintenance programs (and their timing) for essential services (e.g. power, transport) to enhance system resilience.
  - Using fewer heat-sensitive materials and components in key infrastructure.
  - Retrofitting older housing stock to withstand extreme heat events, e.g. through installation of shading and insulation.
  - Modeling electricity demand under more severe and more frequent heatwaves and planning to meet the expected demand.
  - Taking an integrated (across agencies) approach to the management of peak demand loading on the electricity grid during extreme heat events.

Adaptation to enhance adaptive capacity:

- Goal: to ensure that all individuals, communities and institutions are prepared for the impacts of more severe and more frequent heatwaves.

  Possible actions:

  - Encouraging behavioural changes to reduce the risk of heat stress.
  - Understanding and communicating the nature and location of high-risk areas.
  - Developing early warning systems.
  - Building health care systems that support vulnerable members of the community during heatwaves (an existing example of good practice is Telecross REDi. http://www.redcross.org.au/telecross-redi.aspx) including the elderly, frail, housebound, mentally ill, those taking certain medications, and new arrivals to Australia.
  - Establishing consistent and location-specific threshold temperature criteria for activating and escalating coordinated agency responses in the lead-up to and during a heatwave. This will ensure simple, transparent across-agency triggers for heatwave alerts, and for declaration of an emergency.

Adaptation: what this means for managing heatwaves ... continued

Adaptation for impact/post impact response:

- Goal: to ensure that agencies, communities and individuals manage their heatwave responses from a position of awareness about the likely increasing severity of heatwaves, and in the light of best practice.

  Possible actions:

  - Enhancing health systems from primary care through to hospital emergency departments to ensure consistent, coordinated health responses to heatwaves.
  - Developing integrated heatwave emergency response plans that foster adaptability through collaboration across agencies and scales.
  - Maintaining monitoring and evaluation systems on the impacts of, and responses to, heatwaves across the country to improve future responses and inform best practice forward planning.

5

Policy implications

The interconnected nature of the problem demands integrated, holistic adaptation responses. Managing the policy responses to extreme heat events as simply health issues, emergency management issues or urban planning issues will be ineffective and could overlook critical interconnections, for example the link between building more thermally-efficient houses, reducing peak energy demand for cooling, and electricity infrastructure planning. Policy actions can be divided into four realms: personal/community, workplace, buildings and infrastructure; and the public realm.

Personal/Community

- Ensure coordinated information and outreach activities to vulnerable community members to encourage adaptive behaviour to reduce the risk of heat stress.
- Enhance early warning and care systems to ensure that vulnerable members of the community are effectively warned, and cared for, during heatwaves. This will require coordinated policy response among all levels of government responsible for different aspects of health care and community service provision from primary health care, in-community care, aged care facilities and hospitals.

Workplace

- Allow for changing work hours during heatwaves in workplace agreements and business planning.
- Investigate strategies such as income insurance, contract conditions and temperature threshold specification that will enable work stoppages during long periods of extreme hot weather.

Buildings and Infrastructure

- Integrate considerations of heatwaves into urban and regional policies and plans to ensure multi-scale responses ranging from regional planning through to individual development applications and construction of infrastructure. This should include consideration of the interconnected nature of heatwave impacts, including the flow-on effects to essential services/supplies and transport networks, and implications for other hazards such as photochemical smog and bushfires.
- Ensure that consideration of extreme heat is integrated into appropriate regulations, standards and guidelines for new building development and critical infrastructure. This will require a coordinated approach at all levels of government to ensure consistency between national standards and codes (such as the Building Code of Australia and Nationwide House Energy Rating Scheme), state/territory planning standards and implementation by local governments.

Public Realm

- Enhance policy frameworks to plan and manage urban heat island effects to encourage active steps to reduce the heat island effect in the development and redevelopment of urban spaces, including planning for public open spaces.

Underpinning effective adaptation policy is the need for monitoring and evaluation to develop a strong, well-coordinated evidence base. The ongoing lessons, including examples of best practice, from managing the increasing number and intensity of heatwaves must be learned and absorbed into planning and response actions.

Approach

The policy guidance provided in this brief was developed based on a workshop held in Adelaide, South Australia. The workshop was attended by local government (City of Port Adelaide, Adelaide City Council) and state government representatives from the Departments of Health and Premier and Cabinet, South Australia; representatives from the Urban Renewal Authority; Huade Guan (Flinders University); Deborah Black (University of Sydney); Wasim Saman (University of South Australia); Robert Kay (Adaptive Futures) and NCCARF staff.

NCCARF's research programs have delivered over 140 reports on climate change adaptation, many of which address the topics of the Policy Guidance Briefs. For more information, see: www.nccarf.edu.au

NCCARF is producing a portfolio of twelve Policy Guidance Briefs in 2012–13 on critical climate change adaptation topics. For a complete list of available Policy Guidance Briefs, please go to: www.nccarf.edu.au/publications/policy-guidance-briefs

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