



# Aboriginal Health and Climate in New South Wales

22 December 2020

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NOTE: This draft report presents preliminary findings of the literature review and consultations thus far. This work will be further developed over the coming months in consultation with selected agencies working with Aboriginal communities.

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# Executive Summary

The intensity and frequency of natural hazards in New South Wales (NSW) such as floods, heatwave, droughts and bushfires are projected to increase and this trend will continue due to climate change. There are many likely impacts on human health and wellbeing due to climate change. Some effects will be direct, such as heatstroke during heatwaves and premature deaths from heart disease among older adults. Other effects will be indirect such as changes in vector-borne diseases or crop production, impacts of communities displaced due to environmental change, and increased conflict over access to water. Groups who experience social and economic inequity including Aboriginal<sup>1</sup> peoples will be disproportionately affected by climate change. More Aboriginal peoples live in NSW than in any other Australian state or territory and improving Aboriginal health is a primary focus for the NSW health system. Understanding the impact of climate on the health and wellbeing of Aboriginal peoples is key to the development of adaptation strategies and responses to reduce these impacts under the influence of a changing climate.

This report summarises the results of a scoping study to describe the impacts of climate change on the health of Aboriginal peoples, and opportunities for adaptation. While climate change mitigation is recognised as an essential component of effectively addressing climate change, this report focusses on climate change adaptation. Further development of this work should include a combined focus on mutually reinforcing mitigation and adaptation actions to reduce the burden of Aboriginal ill health, boost community resilience, and lessen poverty and inequity.

NSW Aboriginal populations are currently more exposed to a range of climate hazards compared to the non-Aboriginal population, including longer heatwave duration, more rainfall variation and increased months in drought conditions. This disparity in exposure to climate hazards is predicted to increase due to climate change. The report identifies a wide range of climate-sensitive health conditions, as well as ecological and socioeconomic determinants of health that will exacerbate the impacts of climate related hazards on Aboriginal health.

While many reports identify Aboriginal populations will be disproportionately affected by climate change, few studies examined the details of these relationships using NSW data. Much of the evidence we describe in this report is based on studies in remote Australia and/or Aboriginal and Torres Strait Island populations living in areas outside of NSW and this context should be considered when generalising the findings of these reports to NSW. The lack of studies on climate change and health in urban Aboriginal populations is concerning given the large proportion of the total Aboriginal population living in urban or peri-urban environments that share similar health issues as those living in rural and remote areas (e.g. high rates of chronic disease and overcrowding). The available research focuses

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primarily on the direct impacts of climate on Aboriginal populations (e.g. increased heat, drought or other extreme weather events) with limited assessment of more indirect impacts such as social and emotional wellbeing, bushfires, ecosystem changes and food insecurity.

The health impacts of climate hazards on Aboriginal peoples in the near future will depend on the effectiveness of today's adaptation responses and those implemented in the next few years. Climate change will multiply the risk of existing Aboriginal health burdens so adaptation responses should primarily support and enhance existing health policies, measures and programs. The context for climate and health adaptation can vary regionally and responses should be locally relevant and culturally appropriate to Aboriginal peoples.

An overall objective of this project has been to acknowledge Aboriginal knowledge on climate and health developed over many thousands of years. We conducted targeted consultations with NSW Health and selected NSW state agencies and stakeholders on climate and health via informant interviews and an online workshop conducted in October 2020. These consultations were not as extensive as anticipated due to Covid-19 disruptions. Assessing the health risks of climate change for Aboriginal populations requires an holistic understanding of Aboriginal health, encompassing physical, social and emotional wellbeing, as well cultural dimensions that include environmental stewardship, connection to Country, cultural identity and spirituality.

The recognition that culture is an underlying determinant of good health is in line with the 'Closing the Gap' strategy which advocates for an Aboriginal and Torres Strait Islander-driven approach to health policy and program reform (2, 3). This strength-based approach is key to improving resilience to the impact of climate on Aboriginal health. Action is needed now to develop effective Aboriginal led adaptation responses to build resilience of Aboriginal populations to the current and future impacts of climate on health.

This scoping study is intended to inform follow up work on Aboriginal health and climate adaptation responses. The following recommendations are based on our literature review, consultation and climate hazard exposure mapping. Some recommendations include specific examples of actions that may result from further Aboriginal health and climate adaptation work. While our recommendations focus on health specific adaptation responses, many of these responses will require a whole of NSW government approach that includes a broad range of government and non-government stakeholders.

### *Health is everyone's business*

**Recommendation 1:** All NSW state government agencies identify their roles and responsibilities in supporting the health and wellbeing of Aboriginal peoples and include this explicitly in strategic planning and policy. This includes, but is not limited to, minimising the direct and indirect impacts of climate on health.

### *Future research*

**Recommendation 2:** NSW Health and NSW DPIE facilitate consultation with Aboriginal stakeholders to determine local priorities for participatory-based research in collaboration with Aboriginal stakeholders to understand the impacts of climate on Aboriginal health

and inform adaptation responses. This work should focus on urban as well as rural and remote settings and identify research areas that are sufficiently developed for priority translation into adaptation responses.

### *Development and implementation of adaptation responses*

**Recommendation 3:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders facilitate consultation with Aboriginal stakeholders to incorporate Aboriginal knowledge on climate and health into the development and implementation of Aboriginal led adaptation responses in urban and regional NSW.

### *Extreme weather events and emergency responses (e.g. heatwaves, floods and bushfires)*

**Recommendation 4:** Emergency management planning in NSW prioritise Aboriginal stakeholder consultation and representation in decision-making processes in all aspects of emergency management of climate related hazards including prevention, preparation, response and recovery arrangements, to address the needs of Aboriginal health in a culturally appropriate manner.

Addressing this recommendation will require consideration of the holistic view of Aboriginal health including Aboriginal traditional knowledge.

This recommendation includes issues such as:

- Culturally appropriate evacuation and communication procedures including evacuation centres
- Messaging around climate related health risks (e.g. heatwaves, floods, bushfires) be developed in consultation with Aboriginal stakeholders and communicated in culturally appropriate ways.
- NSW Health, together with Aboriginal primary health care providers and specialty networks address potential gaps in healthcare access (e.g. treatment for cardiovascular disease, respiratory disease, diabetes management, renal disease in remote areas) due to climate hazard disruptions.

### *Housing*

**Recommendation 5:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders facilitate an assessment of current guidelines and policy around Aboriginal housing to better support health, including regionally specific guidelines for Aboriginal housing, and consideration of ongoing maintenance and affordability for tenants.

This recommendation includes working with housing providers and communities to address issues such as:

- cooling in Aboriginal housing, including consideration of the maintenance and affordability of associated energy costs.
- ensuring the capacity to prepare, cook and store food in houses
- improving medication storage facilities and the feasibility of developing independent power sources for refrigeration.

## **Water**

**Recommendation 6:** NSW Health, NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities collaborate to identify priorities for data collection and research on water quality and water access for Aboriginal health and wellbeing including social and cultural practices.

**Recommendation 7:** NSW Health and NSW DPIE review risks from un-sewered regional towns and communities and from non-reticulated water supplies under a changing climate. Programs to upgrade these systems to ensure compliance with Australian drinking water guidelines and that sewerage services meet environmental standards should be prioritised, with a particular focus on Aboriginal health and wellbeing.

This recommendation includes issues such as:

- Water is central to the cultural, social and spiritual identity of Aboriginal peoples which in turn links to the holistic and whole-of-life view of Aboriginal health. 'Cultural flows' have been defined as water entitlements owned and managed by Aboriginal peoples to improve their spiritual, cultural, environmental, social and economic conditions. A national framework for cultural flows was released in the National Cultural Flow Research Project (4). A comprehensive assessment of the direct and indirect health benefits of cultural flows for river systems should be developed to support Aboriginal health and climate adaptation responses
- Provide culturally appropriate public health messaging for Aboriginal peoples around water contamination hazards including climate related hazards. For example, a body of water may hold cultural significance to Aboriginal peoples and in response to specific contamination events (i.e. deterioration of water quality driven by rainfall, floods, droughts or bushfires) public health advisories on restricting or discouraging use of a water body may be issued.

## **Vector borne disease**

**Recommendation 8:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities review vector borne disease risks for Aboriginal populations under a changing climate and recommend adaptation priorities.

This recommendation includes issues such as:

- Land management programs to minimise uncontrolled vector breeding habitats in Aboriginal communities
- Household related vector borne disease reservoirs and risk management, e.g. rainwater tanks, housing without screened doors/windows
- reviews of current regional-scale vector borne disease modelling to assess if the current surveillance programs address Aboriginal health risks, particularly in regions where changes in climate may facilitate the spread of vector borne disease in NSW.

## Air

**Recommendation 9:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities facilitate local assessments of current and future exposure and health risks from fire smoke, dust and aeroallergens in Aboriginal populations to develop adaptation responses including health messaging

This recommendation includes issues such as:

- Reviewing the health benefits/ impacts of incorporating traditional Aboriginal burning practices into bushfire management practices to improve fire management including related direct and indirect health benefits/ impacts (e.g. cultural and economic benefits)
- Improved messaging around air pollution and health risks (e.g. fire smoke, dust and allergens) in consultation with Aboriginal stakeholders for culturally appropriate communication to Aboriginal peoples.
- Land management programs to minimise the impacts of windblown dust in Aboriginal communities
- Household related indoor air exposure reduction options such as door and window seals to minimise ingress of outdoor air indoors during high fire smoke and/ or dust exposure events
- Socially and culturally appropriate clean air evacuation centres

## Food Security

**Recommendation 10:** NSW Health and NSW DPIE, in collaboration with relevant agencies and Aboriginal stakeholders, facilitate a review of food insecurity in Aboriginal populations for the development of adaptation responses, including the impacts of climate change and how Aboriginal communities experience food insecurity.

This recommendation includes issues such as:

- Working with local supermarkets and food suppliers to find mechanisms that support equitable food prices, especially for remote Aboriginal communities and for communities vulnerable to drought conditions where reliance on expensive store-bought fruits and vegetables is unavailable
- The provision of safe and palatable drinking water for Aboriginal communities, particularly during extreme weather events such as droughts and floods
- Working with Aboriginal communities to improve food preparation, cooking and storage methods and facilities, and consider the feasibility of developing independent power sources for refrigeration.
- Developing culturally appropriate public health advice to Aboriginal peoples on nutritional standards for food and encourage health eating and drinking (e.g. preferences for soft drinks). Children and young people can be targeted to reinforce early healthy eating habits.
- Consulting with Aboriginal stakeholders on the cultural dimensions of food gathering, producing own food, preparing and eating food in order to perpetuate knowledge, promote healthy traditional diets, as well as improving the social and emotional wellbeing of Aboriginal peoples



engaging in cultural practices whilst preparing for increased risks of pathogen proliferation in future warmer weather

- Consideration of commercial return from harvests of bush resources which contributes to the economic and social development for both urban and remote Aboriginal communities

# Acknowledgements

The authors of this report acknowledge and pay respect to the traditional Aboriginal custodians of the lands and waters of NSW and their continuing cultural, spiritual customs and practices, and pay respect to Elders, past, present and emerging.

We acknowledge the valuable contributions of officers from the following stakeholders towards a series of informant interviews and online workshop, which have informed the findings of this project report: NSW Health Environmental Health Branch, NSW Health Centre for Aboriginal Health, NSW Aboriginal Affairs, Aboriginal Health and Medical Research Council of NSW (AH&MRC), NSW Rural Doctors Network and Indigenous Allied Health Australia. We also thank Mr Jasper Garay from the University of Sydney for facilitating the online workshop.

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# Terms and Definitions\*

## **Aboriginal**

The term 'Aboriginal' describes the original peoples of Australia and their descendants. The term 'Torres Strait Islander peoples' describes the peoples and their descendants from Torres Strait Islands located to the north of mainland Australia. Aboriginal peoples are the original inhabitants of NSW. In this report, we use 'Aboriginal' in an inclusive way to refer to both Aboriginal and Torres Strait Islander peoples. In instances where we referenced studies outside of NSW, we use the term 'Aboriginal and Torres Strait Islander peoples', or 'Torres Strait Islander peoples' if the study is specific to the Torres Strait Islander peoples. We use the pluralised version, 'peoples', to emphasise and be inclusive of the diversity of Aboriginal cultures, identities, languages, knowledge, practices and beliefs (1).

## **Aboriginal health and wellbeing**

Aboriginal health means not just the physical well-being of an individual but refers to the social, emotional and cultural well-being of the whole Community in which each individual is able to achieve their full potential as a human being, thereby bringing about the total well-being of their Community. It is a whole-of-life view and includes the cyclical concept of life-death-life (5).

## **Adaptation**

The process of adjustment to actual or expected climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities (6).

## **Anthropogenic**

Caused or produced by human activities, generally relating to environmental pollution (6).

## **Climate change**

Climate change refers to a change in the state of the climate for an extended period, typically

decades or longer, due to natural variability or as a result of human activity (6).

## **Climate resilience**

The capacity of social, economic, environmental and governance systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning, transformation and enhanced resilience for future events (7).

## **Climate risk**

The potential for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure (8).

## **Climate variability**

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system, or to variations in natural (e.g. volcanic eruption) or anthropogenic (i.e. human-induced changes in composition of the atmosphere and land use change) external forcing (6).

## **Disadvantaged populations**

Sectors of a society that are marginalised, often because of low socioeconomic status, low income, lack of access to basic services such as health or education, lack of power, race, gender, religion, or poor access to communication technologies (6).

## **Discrete communities**

A discrete community is a geographic location, bounded by physical or legal boundaries, which

is inhabited or intended to be inhabited predominantly (i.e. greater than 50% of usual residents) by Aboriginal or Torres Strait Islander peoples, with housing or infrastructure (power, water, sewerage) that is managed on a community basis. Discrete communities have populations of (but not limited to) 50 or more Aboriginal and Torres Strait Islander people. Services such as schools, health clinics, shops and council depots are usually present (9).

### **Extreme weather event**

An extreme weather event is an event that is rare for a particular location and time of year. An extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations (6).

### **Hazard**

The potential occurrence of climate-related physical events or trend or their physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (6).

### **Social determinants of health**

The circumstances in which people are born, grow up, live, work and age, and the systems put in place to deal with illness. These circumstances are in turn shaped by a wider set of forces: economics, social policies and politics (10).

### **Vulnerability**

Vulnerability is the degree to which a system or system component is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (11). In the context of public health, a system component can be human populations.

In this report vulnerability is conceptualised in the context of public health with three components

(11, 12): a) exposure to climate hazards; 2) sensitivity or responsiveness to climate hazards; and 3) capacity to adapt.

The definitions of these components are as follow:

#### **a) Exposure**

The degree to which an inventory of elements comes into contact with climate hazards at a location. These elements could be populations, livelihoods, species, ecosystems, environmental functions, services, resources, infrastructure, economic, social or cultural assets in places and settings are adversely affected (6).

#### **b) Sensitivity**

The degree to which exposed systems, or in the context of public health, populations, are affected adversely or beneficially by climate variability or change (6).

#### **c) Adaptive capacity**

The ability of a system, in the context of public health, populations, to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope or respond to consequences (6). Further distinctions can be made between social or biophysical vulnerability:

**Social vulnerability:** arising due to social, economic, political or cultural processes (e.g. age, gender, ethnicity, health status, social class, unemployment status, population density, overcrowding, quality of the built environment, housing tenancy, land use, presence of support networks) (13, 14).

**Biophysical vulnerability:** arising due to biophysical processes (e.g. topography, environmental conditions, land cover) (15).

## **Social Housing**

Housing for people on low incomes or people in housing crisis, owned or managed by government or community housing providers. Rents are based on income (16). Social housing includes public, community and Aboriginal housing. Public housing generally refers to housing managed by government agencies while community housing is managed by non-government organisations.

\*see also: HHSI Node funded project report for more information: Ying Zhang, Lucie Rychetnik, Alexandra Barratt, Matilde Petersen. Developing an Australian Glossary on Health and Climate Change. 2020

# 1.0 Introduction

## 1.1 Climate change and Aboriginal health

The warming of our global climate has been unequivocally observed, with each of the last three decades experiencing successively warmer temperatures than any of the preceding decades since 1850 (6). Most of the observed increase in temperature is attributed to anthropogenic causes, whereby human activity releases heat trapping green-house gases chiefly composed of environmental pollutants into the atmosphere (6). In Australia, the mean surface air temperature has warmed by 1°C since 1910, leading to increased frequency and severity of heatwaves, bushfire weather and droughts (17).

Continued, unmitigated anthropogenic greenhouse gas emission will increase future global warming. Climate change will act as a risk multiplier that exacerbates threats to the environment and ecosystems (6). In turn, climate manifestations including worsening climate extremes and hazards, as well as degraded environmental systems, will directly or indirectly exacerbate a wide range of climate-related health risks (18). Health is impacted by the climate through three main pathways:

1. Primary and direct injury or death caused by weather extremes and climate hazards (e.g. heatwaves and floods).
2. Secondary and indirect harm (i.e. exacerbation of pre-existing chronic conditions) mediated by altered environmental and ecological systems (e.g. food yields, air or water quality or distribution of infectious disease-vectors).
3. Tertiary and indirect harm driven by primary and/or secondary pathways, where social and emotional wellbeing are disrupted (18, 19) (e.g. changes in water availability, population movements, disruptions of cultural practices).

These additional health risks to human populations require healthcare and emergency services to prepare and respond to climate change impacts (20).

Globally, Indigenous populations are identified as a group particularly susceptible to climate change and climate-related health risks. This is due to the close physical and cultural relationships of many Indigenous groups with the natural environment that is increasingly under threat, as well as existing disproportionate burden of ill health and social disadvantage (21, 22). In Australia, the life expectancy of Aboriginal and Torres Strait Islander peoples are 8 years less than that of non-Indigenous Australians, with the biggest contributors to the health gap being cardiovascular diseases, mental health conditions, respiratory diseases, cancer and diabetes (23). Aboriginal and Torres Strait Islander peoples also have lower levels of employment, income, education and quality of housing than non-Indigenous Australians (24). Accessing affordable health services is also more difficult for Aboriginal and Torres Strait Islander peoples, especially for those living in rural and remote areas (25). This inequity is compounded by structural and systemic discrimination of repeated governments towards Aboriginal and Torres Strait Islander cultures which are central to Aboriginal people's health and wellbeing (26).

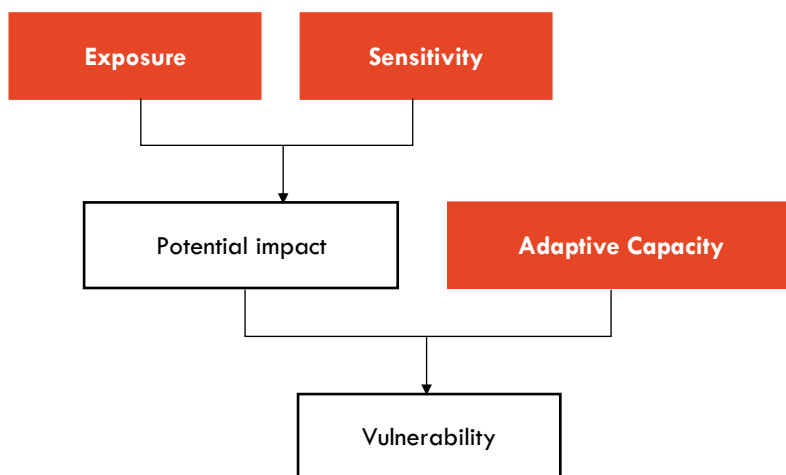
## 1.2 Indigenous perception of climate change

Despite the difficulties, Aboriginal and Torres Strait Islander peoples continue to survive, demonstrating profound adaptive capacities and resilience. Aboriginal and Torres Strait Islander cultures have developed a strong spiritual relationship with the climate and the land (27). Even though Aboriginal and Torres Strait Islander peoples do not have a specific term equivalent to 'climate change' in their own language, there is strong evidence to show the transmission of oral accounts around observed changes which is consistent with climate change literature (28). For example, traditional knowledge of weather and climate is exemplified by the recognition of subtle interacting climate related cycles such as six seasons by Aboriginal communities in south-west Kimberley, Kakadu National Park and central north Arnhem Land (29). These communities distinguished seasons by the direction of prevailing wind at different times of the year, by the intensity of rain or hot weather that precedes a monsoon season, the appearance of flowering and fruit ripening, or the fatness and behaviour of animals (29). As such, the Aboriginal and Torres Strait Islander communities across Australia are observing, via local accounts, modifications to their Country due to climate variations. Moreover, they are concerned that these observed changes are attributed to anthropogenic climate change and have articulated fear of various climate impacts, especially in relation to extreme heat, disease and poor housing quality (28).

## 1.3 Framing climate vulnerability

The post-colonisation era has brought drastic changes to the natural, social and cultural environments of Aboriginal and Torres Strait Islander peoples. These changes have exposed the population to an increasingly threatening natural environment and unfavourable living conditions, as well as a fundamentally compromised health and financial position to deal with the effects of climate change. These changes have imposed *vulnerability* on Aboriginal and Torres Strait Islander peoples. However, it is important to understand that many Aboriginal and Torres Strait Islander peoples do not consider themselves *vulnerable* (30). Aboriginal and Torres Strait Islander cultures have existed in the Australian continent for at least 50,000 years, adapting to a gradually changing natural environment prior to European colonisation (27) and are continuing to demonstrate profound resilience. In particular, Aboriginal and Torres Strait Islander peoples who have regained ownership of the land hold a deep spiritual connection to Country and exercise cultural responsibilities for maintaining that land (31, 32). Existing within those communities is a wealth of local ecological knowledge that can inform cultural practices – the very knowledge that may help overcome climate change adaptation challenges (29).

Therefore, the term *vulnerability* in the context of this report is used to describe the degree to which a population is susceptible to, or unable to cope with, the adverse effects of climate change, and this terminology is consistent with conventions in the international climate change literature (11). As a framework (see Figure 1), *vulnerability* is a function of **exposure** to climate-related risk; **sensitivity** or responsiveness to climate-related risk; and **capacity to adapt** to change (11, 12). Therefore, the term *vulnerable* in this report does not mean helplessness or weakness and should not be misinterpreted as a term that undermines the ability of Aboriginal and Torres Strait Islander peoples to determine what is important for themselves and to lead effective responses. The *vulnerability* framework in this report intends to help elucidate various environmental, socioeconomic and cultural factors that may contribute to health risks faced by Aboriginal and Torres Strait Islander peoples, as well as factors that may alleviate the risks of future threats due to climate change.



**Figure 1** Components of vulnerability (adapted from (12))

For the purposes of this report, the components of the vulnerability are defined as follows:

**Exposure:** The degree to which contact with a hazard occurs at a location. Hazards in the context of this report are climate related. Population exposure is influenced by time spent in the hazardous environment, activities and behaviours (e.g. older adults confinement to indoor environments during heatwaves).

**Sensitivity:** the degree to which exposed systems, or in the context of public health, populations, are adversely or beneficially affected by climate variability or change. The definition of sensitivity builds from:

- The **biological ability** to cope (e.g. a higher likelihood of manifesting adverse effects to climate-related health risks is often seen in children, older adults and persons with pre-existing conditions, as well as those of particular ethnicity or gender).
- The **socioeconomic and institutional environment** that determines ability to cope (e.g. social class, employment status, population density, overcrowding, quality of the built environment, housing tenancy, land use, access to health care and support networks (13, 14))

**Adaptive capacity:** the ability of people and systems to adjust to actual and potential harm, to take advantage of opportunities, or to respond to consequences of climate-related threats.

## 1.4 Rationale and Purpose

Climate change will exacerbate the underlying health burden and social inequities experienced by Aboriginal and Torres Strait Islander peoples (33), impeding actions to close the health gap with non-Indigenous populations. Improving the health and wellbeing of Aboriginal peoples in New South Wales (NSW) where most Aboriginal peoples reside is a key focus for the NSW health system. It is therefore important to understand how the health and wellbeing of Aboriginal peoples are impacted by climate change; where exposed Aboriginal populations including discrete communities reside; and whether sufficient locally based services are provided to support these populations. A better understanding of



adaptation strategies and responses among Aboriginal populations and discrete communities in both urban and regional areas in NSW is also required.

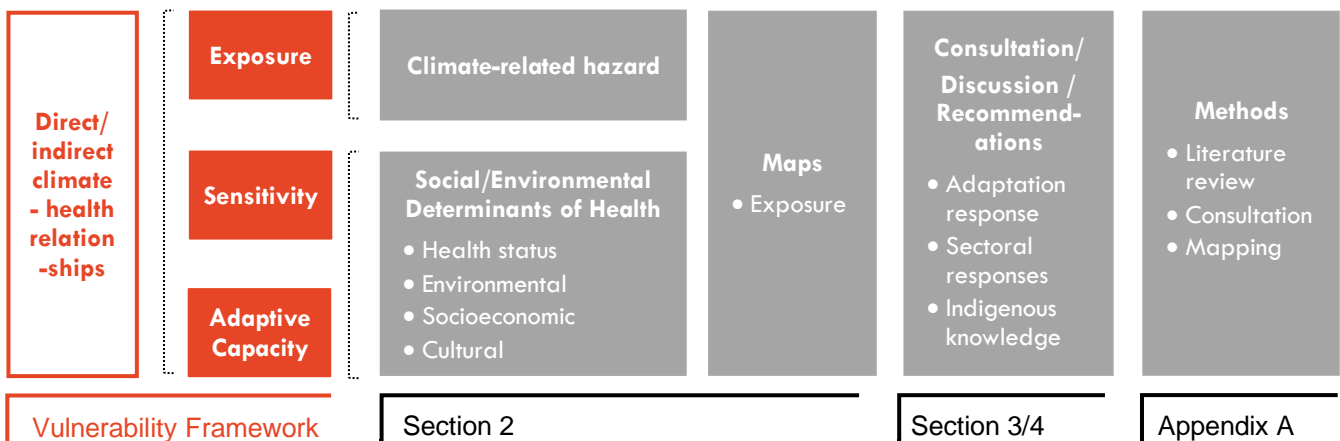
This report aims to:

1. Review existing evidence on the health impacts of climate change on Aboriginal populations in NSW and identify locally relevant climate-related health indicators (Section 2).
2. Identify Aboriginal populations and discrete communities in NSW at risk of climate-related health risks (Section 2).
3. Conduct preliminary consultation with NSW Health and selected NSW state agency stakeholders and collaborators on climate and health issues, and opportunities for adaptation responses including those based on Indigenous knowledge (Section 3).
4. Recommend directions in terms of adaptation responses, health service preparedness and future research (Section 4)

The report provides an overall summary of current understanding of the impacts of climate change on the health of Aboriginal peoples. An ongoing goal of this scoping study is to support the development of adaptation strategies in partnership with Aboriginal communities and organisations to deal with the effects of climate change on health. While mitigation is recognised as an essential component of effective adaptation this report focusses on climate change adaptation. Further development of this work should include a combined focus on mutually reinforcing mitigation and adaptation actions to reduce the burden of Aboriginal ill health, boost community resilience, and lessen poverty and inequity.

## 1.5 Structure of the report

The report describes the climate-related health risks due to selected climate-related hazards and population exposure to these hazards for Aboriginal peoples in NSW. Vulnerabilities to these hazards are outlined in terms of population exposures and sensitivities (Section 2). Selected climate related indicators are mapped to describe the exposure of Aboriginal populations to climate hazards (where data is publicly available) (Section 2). Results from targeted consultation with NSW Health and selected stakeholders are presented in Section 3. Recommendations for the development and implementation of Aboriginal-led adaptation responses to climate-related health risks are proposed in Section 4. Finally, methodologies applied in this report are described in more detail in Appendix A.



**Figure 2** Report section guide.

## 2.0 Climate exposure and Aboriginal Health

### 2.1 Climate trends in New South Wales

In Australia, the mean surface air temperature has warmed by 1°C since 1910, leading to the increased frequency and severity of heatwaves, fire weather and drought conditions (17). There has also been a decline in rainfall by 11% during the winter months in southeast Australia since the late 1990s, contributing to streamflow reduction and long-term climatic conditions such as the Millennium drought (17).

Climate change will continue into the future if higher ongoing release of greenhouse gases continues. In Australia, climate change will contribute to significant regional differences in temperature and rainfall across the continent (34). The NSW and ACT Regions Climate Modelling (NARClIM) project has produced climate change projections for the near (2020-39) and far (2060-79) future for NSW compared to the 1990 to 2009 baseline period, based on the IPCC Special Report on Emission Scenario (SRES) A2 (34).

Figure 3 summarises projected climate changes for NSW. The maximum and minimum temperatures in the near and far future are estimated to increase by 0.7°C and 2.1°C respectively (34). The number of hot days per year above 35°C will increase in inland NSW in the near future, with north-western NSW projected to experience 40 extra hot days (currently 60 days) in spring and summer. Heatwave events, defined by prolonged periods of excessive heat with respect to the usual temperatures experienced at a location, will also increase in frequency and duration across NSW (35). Extreme heat can change the probability of occurrence of other extreme events such as fire weather, which is expected to increase especially in western NSW in spring and summer (34). Spring rainfall is projected to decrease in inland and southern NSW in the near and far future and increase along the north coast; whilst autumn rainfall is projected to increase across NSW in the near and far future (34).

Climate variable		Near Future (2020 – 39)	Far Future (2060 – 79)
Maximum temperatures	NSW	↑ 0.4 – 1°C	↑ 1.8 – 2.6°C
Minimum temperatures	NSW	↑ 0.0 – 0.5°C	↑ 1.4 – 2.6°C
Number of hot days (maximum temperatures above 35°C) per year	NW NSW	↑ 10 – 20 days	↑ > 40 days
	Coastal NSW	↑ 5 – 10 days	↑ 10 – 20 days
Number of cold nights (minimum temperatures below 2°C) per year	NSW	↓ 10 – 20 days	↓ > 40 days
Frequency of heatwave events per year	NSW	↑ 1 – 1.5 events	↑ 2.5 – 4.5 events
Heatwave duration per year	NSW	↑ 1.5 – 3.5 days	↑ 2 – 11 days
Annual rainfall (% change)*	Spring	-18% to +11%	- 18% to -14%
	Summer	-13% to +12%	- 4% to + 35%
	Autumn	-11% to +48%	- 7% to +54%
	Winter	-16% to +4%	- 25% to +24%

**Figure 3** Projected change in climate for NSW in the near (2020 – 39) and far future (2060 – 79) compared to baseline period 1990 – 2009 (adapted from (34, 35)).

## 2.2 NSW Aboriginal population

In 2016, there were 798,365 Aboriginal and Torres Strait Islander peoples in Australia, representing 3.3% of the total Australian population (36). In NSW, Aboriginal population (265,685 peoples) accounts for one-third of the total Indigenous population in Australia and has the largest population compared to other states (36). The Aboriginal and Torres Strait Islander population is young, with 34% aged under 15 years and 4% aged over 65 years in 2016, as compared to 18% and 16% respectively for the non-Aboriginal population (37).

Of the Aboriginal populations in NSW, the largest proportions live in the Central and North coast region (32.5%) and the Sydney-Wollongong region inclusive of the Greater Metropolitan Region (30.7%) (37) (see Figure 4). By rurality defined by *major cities, regional or remote areas*, most Aboriginal peoples live in major cities (46%), however, Aboriginal peoples are more represented in regional and remote areas compared with non-Aboriginal NSW population (see Figure 5). Specifically, 50% and 3% of the total NSW Aboriginal population aged under 50 years live in regional and remote areas respectively, compared with 20% and 0.3% of total non-Aboriginal NSW population living in regional and remote areas respectively (36). This is slightly higher for those aged over 50, with 53% and 5% of Aboriginal peoples aged over 50 living in regional and remote areas, respectively, compared with 30% and 0.4% of non-Aboriginal people aged over 50. Finally, Aboriginal households are also highly represented in remote areas, accounting for 21% of all households in remote NSW (16).

Some Aboriginal peoples live within discrete communities of 10 to 1,000 people and within community-managed housing (9). Approximately 94% of the discrete communities are located in

remote areas of Australia. In NSW, there are 62 discrete Aboriginal communities with a combined population of 6,000, representing 6% of NSW Aboriginal population (38). Figure 6 shows the locations of discrete communities and Aboriginal populations in NSW by Estimated Represented Population (ERP)<sup>2</sup> at the Statistical Area 2 (SA2). Discrete Aboriginal populations of greater than 1,000 peoples tend to be in regional and remote areas in NSW. However, as remote and regional SA2s tend to be much larger than those across major cities, larger numbers of Aboriginal peoples in these SA2s do not necessarily suggest large communities, and populations in these areas may be quite dispersed. Appendix A further outlines our approaches to identifying Aboriginal communities and populations in NSW.

In terms of housing, about 20,000 Aboriginal families live in social housing in NSW provided by the Land and Housing Corporation, Aboriginal Housing Office and Aboriginal Community Housing Providers (16). However, Aboriginal peoples are also 14 times more likely to experience homelessness than non-Aboriginal people, further driving social and economic disadvantage (39). Homelessness refers not just to those rough sleeping, but also those living in improvised dwellings, in supported accommodation for the homeless or staying temporarily with other households (39). Despite representing only 3% of total NSW population, Aboriginal peoples make up to 8% of the total homelessness population in NSW and 30% of people accessing Specialist Homelessness Services (39).

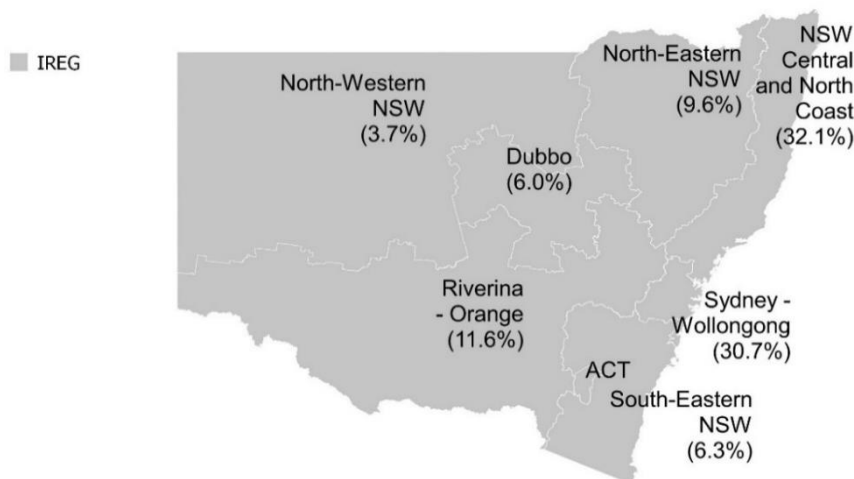
It is important to recognise that Aboriginal peoples have particular needs to uphold kinship responsibilities and connection to Country, which influence where and how they choose to live (16).

<sup>2</sup>ERPs are used to estimate the number of Aboriginal peoples in SA2s and are corrected for known biases in the counting of Aboriginal peoples in Australia.

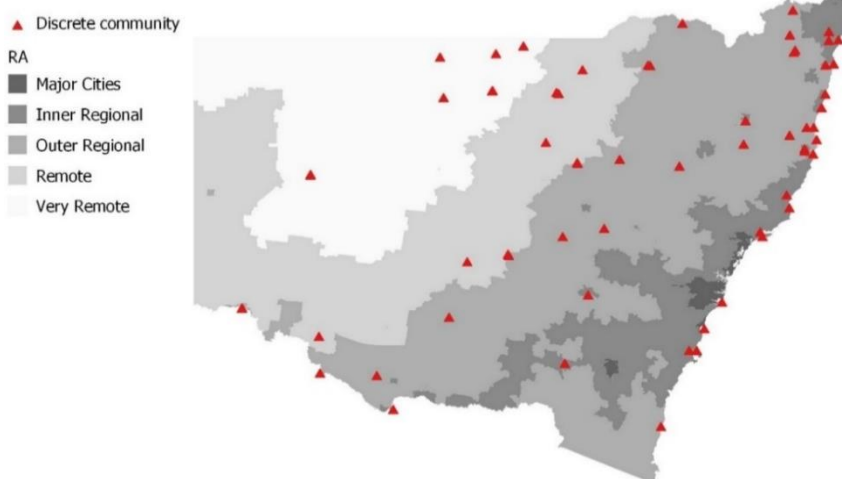
between urban, regional and remote locations for Aboriginal populations compared to non-Aboriginal populations from 2011 to 2016. The panels represent the percentage of the population who migrated from major cities, regional areas and remote areas in 2016 compared to where they lived in 2011. We found that the younger Aboriginal population (<30 years) are more likely to remain living in major cities, regional area and remote areas than migrate from these locations compared to the non-Aboriginal population. We see around twice the movement out of remote areas (1.8x, 34% vs 19%) among non-Aboriginal young

people than we do in Aboriginal young people. This trend is similar in older people although the proportions are smaller (1.75x, 14% vs 8%). In summary these results indicate Aboriginal peoples migrate less from regional and remote locations compared to the non-Aboriginal population, and are therefore likely to continue to be disproportionately impacted by climate change in these locations. This is also consistent with Aboriginal Connection to Country and reinforces the need for local climate adaptation responses that support Aboriginal peoples, particularly in regional and remote areas. (see for further explanation).

Indigenous Regions (% of total Aboriginal population in NSW)

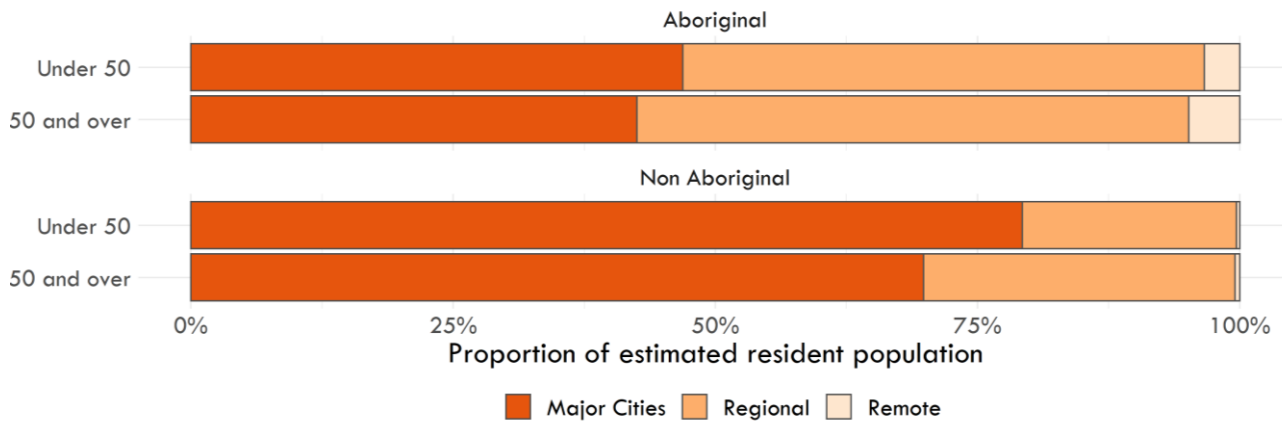


Remoteness Areas (RA)

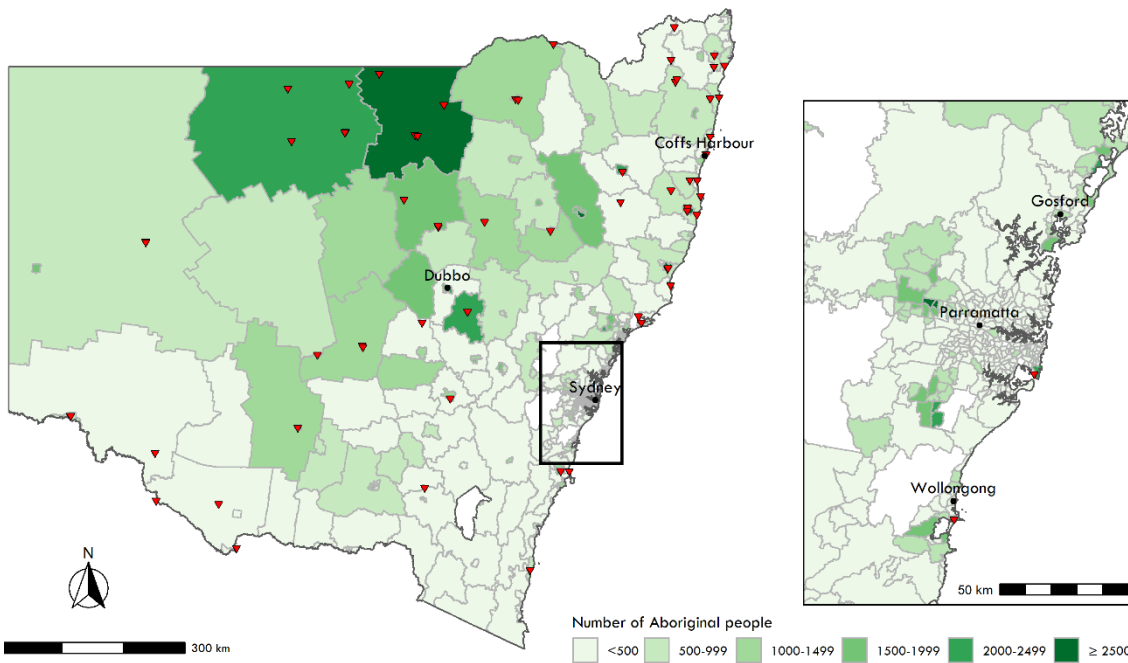


**Figure 4** Proportion of Aboriginal peoples in total Aboriginal population in NSW for each Indigenous Region (IREG)<sup>3</sup> in 2016 (top); and major cities, regional (inner and outer) and remote (remote and very remote) areas in NSW (bottom).

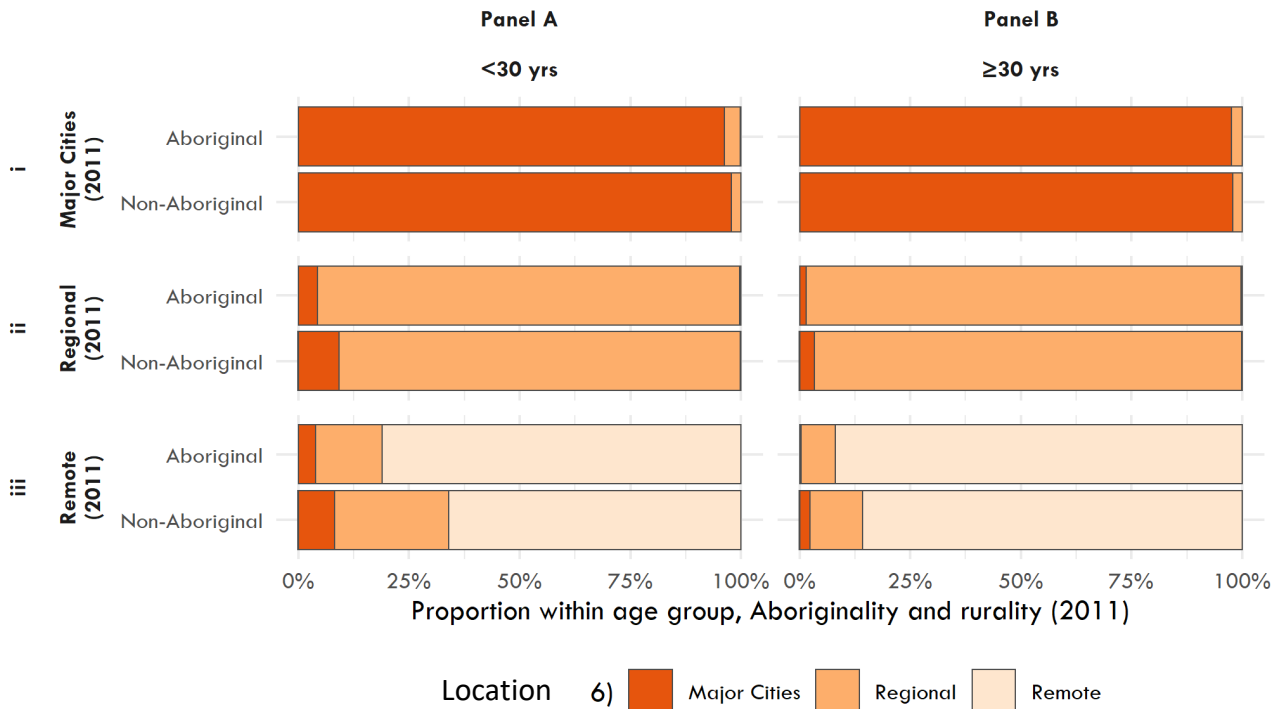
<sup>3</sup>Indigenous Regions are large geographical units based on the former Aboriginal and Torres Strait Islander Commission boundaries (40).



**Figure 5** Proportion of total Aboriginal and non-Aboriginal populations by rurality and age group, NSW



**Figure 6** Estimated number of Aboriginal peoples by Statistical Area 2 (SA2) in NSW and Greater Sydney Region, 2016. Triangle markers indicate discrete communities. A threshold SA2 ERP Aboriginal population of 1,000 or more (1000 people represents 0.4% of the total NSW Aboriginal population) to identify SA2 areas with >1,000 Aboriginal persons.



**Figure 7** Migration patterns of Aboriginal and non-Aboriginal populations from urban, regional and remote locations from 2011 to 2016. **Panel A** bar charts represent persons aged less than 30 years in 2016 stratified by Aboriginal and non-Aboriginal peoples who lived in i) major cities, ii) regional areas or iii) remote areas in 2011. **Panel B** bar charts represent persons aged more than 30 years in 2016 stratified by Aboriginal and non-Aboriginal peoples who lived in i) major cities, ii) regional areas or iii) remote areas in 2011.

Figure 7 represents the migration of Aboriginal vs non-Aboriginal people, by age group and location in 2011. That is, each panel represents the remoteness structure of usual residence of each population in 2011, and how that changed in 2016. For example, Figure 7A.iii, shows that for Aboriginal peoples aged under 30 in 2016, who lived in a remote areas in 2011:

- 81% remained in remote areas in 2016
- 15% migrated to a regional area in 2016; and
- 4% migrated to major cities in 2016

Overall, Aboriginal peoples under 30 were 44% less likely to migrate from remote areas between 2011 and 2016 than non-Aboriginal people (19% vs 34%; OR = 0.56; see Figure 7A.iii), with a similar likelihood observed for those aged over 30, albeit with lower proportions (8% vs 14%; OR = 0.57; see Figure 7B.iii). Similarly, Aboriginal peoples under 30 were 49% less likely to migrate from regional areas between 2011 and 2016 (4.7% vs 9.3%; OR = 0.51; see Figure 7A.ii), with a similar likelihood in Aboriginal peoples over 30 (1.8% vs 3.4%; OR = 0.53; Figure 7B.ii).

## 2.3 Climate change: multiplying existing Aboriginal health disparities

Assessing the health risks of climate change for Aboriginal populations requires an understanding of what *health* means for Aboriginal peoples (2). The National Aboriginal Health Strategy (1989) describes the Indigenous concept of health as not only encompassing the physical wellbeing of an individual, but also the social, emotional and cultural wellbeing of the whole community in which each individual is able to achieve their full potential as a human being, thereby bringing about the total well-being of their Community (5). The term 'social and emotional wellbeing' also fits with the abovementioned holistic view of Aboriginal health, whereby mental health, spirituality, family, community and connection to Country are all important determinants (41).

Therefore, the determinants of health for Aboriginal peoples include behavioural, psychological, socioeconomic, environmental, and cultural factors (24). The responsiveness of health services that support Aboriginal communities and individuals is also an important determinant of health (24).

The following sections (Sections 2.3.1 – 2.3.3) outline the key issues and health disparities experienced by Aboriginal and Torres Strait Islander peoples, with a focus on Aboriginal peoples in NSW, that can potentially be exacerbated by climate change. Section 2.4 will further outline a range of climate-sensitive health risks that are important for Aboriginal health. For example, heatwaves can exacerbate underlying coronary, respiratory and diabetic conditions (42) amongst Aboriginal populations; or exacerbate existing mental health conditions including chronic stress, depression and health-damaging personal behaviour (43). Other extreme events floods, droughts, bushfires and dust storms could also exacerbate a range of

pre-existing health conditions prevalent amongst Aboriginal peoples.

### 2.3.1 Health, wellbeing and social disparities

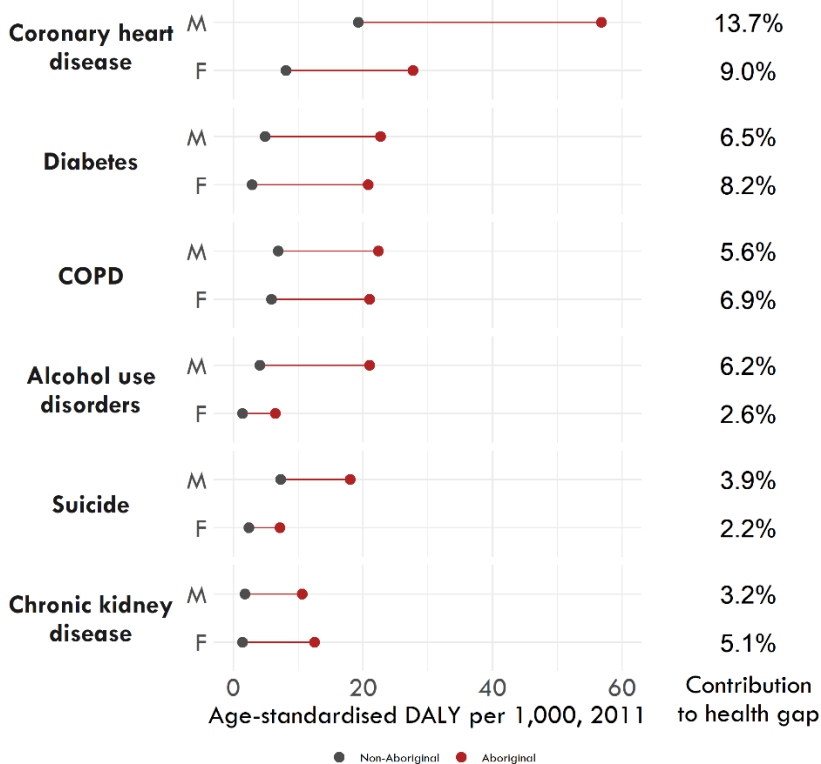
Health disparities between Aboriginal and Torres Strait Islander peoples and non-Indigenous Australians persists throughout Australia under successive governments. The Australian Government's 'Closing the Gap' strategy commenced in 2009 and aims to improve the health and wellbeing of Aboriginal and Torres Strait Islander peoples and achieve health equality within 25 years (44). Aboriginal and Torres Strait Islander peoples have disproportionately higher levels of mortality and morbidity than non-Indigenous Australians. Between 2015 - 2017, life expectancies of Aboriginal and Torres Strait Islander peoples were 72 years for males and 76 for females, respectively 9 and 8 years less than non-Indigenous peoples (3). Aboriginal children were 2.1 times more likely to die before the age of 5 than non-Indigenous children (3).

Aboriginal and Torres Strait Islander peoples experience greater disease burden across all key diseases categories than non-Indigenous Australians in 2011 (23). Chronic conditions including coronary heart disease (CHD) and diabetes accounted for 70% of the health gap (23). Chronic Obstructive Pulmonary Disorders (COPD), alcohol use disorder, chronic kidney disease and suicides were also key disease burdens (23). The leading causes of disease in Aboriginal children under the age of 5 were infectious diseases, blood and metabolic disorders and respiratory conditions such as asthma (23). Figure 8 summarises the leading diseases contributing to the health gap quantified by the Disability Adjusted Life Years

(DALY) rate difference between Aboriginal and non-Indigenous populations. Whilst NSW estimates were not available estimates for broader disease categories at the NSW level indicate similar significant gaps between Aboriginal and non-Aboriginal people in NSW. In most cases, NSW figures were similar to the national figures, due to the large proportion of Aboriginal peoples residing in NSW.

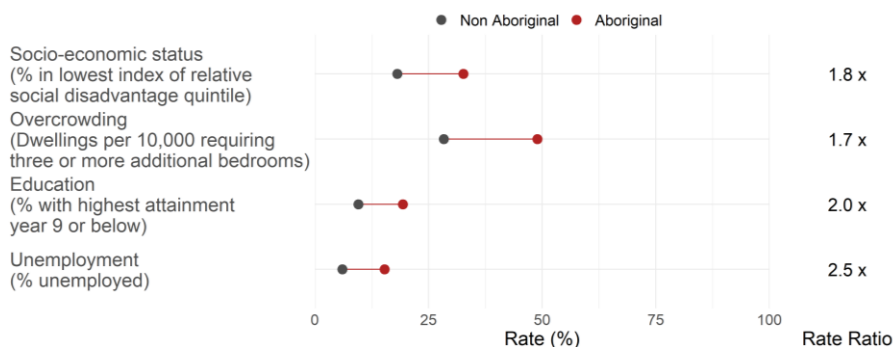
Behavioural factors also influence the health of Aboriginal and Torres Strait Islander people. In 2011, smoking was the leading behavioural risk factor and contributed to 23% of the health gap between Aboriginal and Torres Strait Islander and non-Indigenous populations (23). Smoking is associated with respiratory diseases, cancers, cardiovascular diseases and diabetes (23). Alcohol use is also a key risk factor, contributing to 8% of the health gap and an attributable burden to chronic liver diseases, liver cancer, suicide, self-inflicted injuries, homicide, intimate partner violence and alcohol use disorder (23). Finally, poor nutrition, encompassing dietary choices low in fruits, vegetables and fibre and food high in processed meat, cholesterol and sweetened beverages, contributed to over 15% of the health

**Leading diseases contributing to the health gap in Total Burden (age-standardised DALY rate) by Indigenous status and sex in Australia in 2011**



**Figure 8** Health gaps between Aboriginal and Torres Strait Islander and non-Indigenous populations due to Fatal or Non-Fatal Burden (DALY) by age in Australia in 2011.

Source: Australian Institute of Health and Welfare. Australian Burden of Disease Study: Impact and causes of illness and death in Aboriginal and Torres Strait Islander peoples 2011 (23).



**Figure 9** Social inequities between Aboriginal and non-Indigenous populations in NSW in 2011.



gap in 2011 (23). Cancer, cardiovascular diseases and diabetes are the major diseases linked with poor nutrition (23).

Both everyday stressors and major life events can impact on a person's social and emotional wellbeing. Importantly, past events can have ongoing impacts, including loss of Country, intergenerational trauma and historical policies (45). General disadvantages experienced by Aboriginal and Torres Strait Islander peoples in areas of education, employment and income also affect social and emotional wellbeing, which are linked with common stressors such as overcrowding, substance use disorders, violence, incarceration, high levels of family death, discrimination and racism (41). Inequalities relating to the social determinants of health such as education, employment, housing conditions and socioeconomic status, are summarised in Figure 9. These inequalities contribute substantially to the health disparities between Aboriginal and non-Aboriginal peoples (24).

An appreciation of the determinants of Aboriginal health, including the contributions of historical factors, education, employment, housing, environmental factors, social and cultural capital, and racism, is critically important to closing the health gap between Aboriginal and non-Aboriginal people (46).

### 2.3.2 Cultural determinants of health

There is an increasing realisation that reducing the Indigenous health gap compared to non-Indigenous Australians requires an understanding of the Indigenous concept of health (2). Aboriginal and Torres Strait Islander peoples embrace a holistic, ecologically focused approach to health that includes environmental stewardship, cultural identity, oral history and spirituality (10, 47). These key interconnected cultural determinants have recently been identified as *connection to Country; family,*

*kindship and community; Indigenous beliefs and knowledge; cultural expression and continuity; Indigenous language; and self-determination and leadership* (2).

#### **Connection to Country and access to land**

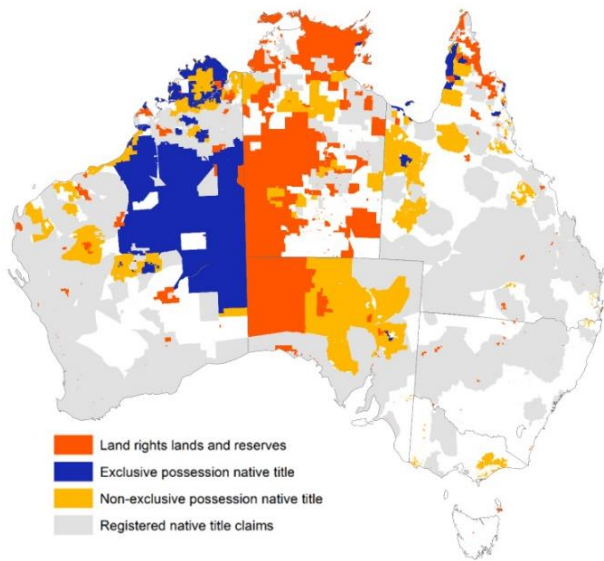
One of the most important Indigenous concepts of health is *connection to Country*, whereby being able to care for the land is a source of positive strength that confers good health and wellbeing. The 'Healthy Country, Healthy People' studies conducted in Arnhem Land showed that Aboriginal and Torres Strait Islander peoples who actively engaged in environmental and cultural activities in their traditional lands had lower rates of obesity, diabetes, kidney diseases and cardiovascular diseases (31, 48). This demonstrates that enabling Indigenous cultural practices within the community is a protective factor for health and wellbeing.

The ability to carry out Indigenous practices, such as fishing, hunting, gathering food, caring for country and visiting places of cultural significance, is affected by the legal status of the land or waterways. Nationally, 13% of land is granted to Aboriginal and Torres Strait Islander peoples represented by Local Aboriginal Land Councils (LALCs) under land rights legislations; whilst 23% of land is granted under the *Native Title Act 1993* (exclusive and non-exclusive possession) to Traditional Owners (49) (see Figure 10)

In NSW, only 0.3% of the land is granted under the *Native Title Act* because most of the state is subject to the state's land rights legislations as a form of compensation for the ongoing dispossession of Aboriginal peoples (50). In other jurisdictions, notably the NT, SA and WA, Aboriginal and Torres Strait people have higher rates of *Native Title* determinations and control over Traditional lands especially in remote regions. For Aboriginal peoples who reside in major cities and regional areas in NSW, sense of connection to Country remains important.

Connection to Country helps strengthen self-worth, cultural pride and sense of wellbeing even amongst displaced peoples (51).

However, institutional racism still persists, as reflected by the large number of unresolved land claims (37,000) to date in NSW, of which approximately 200 are more than 20 years old and 15,000 claims are more than 6 years old (52).



**Figure 10** Distribution of Lands Rights and Native Title in Australia June 2013

Source: The Australian Law Reform Commission (49)

### 2.3.3 Health services and Aboriginal health

Responsive health services that support Aboriginal communities and individuals are key to Aboriginal health and wellbeing. NSW Health operates targeted and mainstream programs and services for Aboriginal people in NSW. Aboriginal Community Controlled Health Services (ACCHS) are incorporated Aboriginal organisation initiated by and based in local Aboriginal communities. They deliver a holistic and culturally appropriate health service to the Aboriginal community. The Aboriginal and Torres Strait Islander Health Performance Framework 2017 provided insights on how health services are being utilised by Aboriginal

peoples compared with non-Aboriginal peoples in NSW (24). For example, effective chronic disease management is important given that chronic conditions are the leading cause of illness, disability and death among Aboriginal peoples (53). Between 2013 – 15, hospitalisations for Aboriginal peoples with chronic diseases that could have been ameliorated by early detection and treatment was 2.5 times the rate of non-Aboriginal peoples (24). In the same period, the rate of preventable hospitalisations was higher across all age groups for Aboriginal peoples compared to non-Aboriginal peoples (24). For mental health conditions, contacts for community mental health services for Aboriginal peoples were 5.4 times the rate of non-Aboriginal people in 2014, whilst the hospitalisation rate for mental health-related conditions rose by 46% in the period of 2004 – 14 for Aboriginal peoples, compared to 6% for non-Aboriginal people in NSW. (24).

The higher prevalence of chronic health conditions in Aboriginal populations results in higher demand for health care services to manage these chronic conditions, many of which are also climate-sensitive conditions (i.e. cardiovascular, respiratory, diabetes and mental health conditions). Climate change is expected to affect demand for healthcare services (e.g. floods and bushfires may interrupt routine chronic disease treatment services) and preventative health services (54). Climate change is also expected to affect the demand for emergency services (e.g. emergency department presentations for morbidities or mortalities caused by extreme heat, bushfire and floods).

It is important that Aboriginal populations are explicitly considered as a vulnerable subgroup in health services provision and emergency management response. Health policies, programs and services must be designed and delivered in culturally appropriate ways that take account of the socioeconomic disadvantage experienced by many Aboriginal people, and specifically

address potential barriers to access under climate change. Section 4 will provide further discussion on adapting Aboriginal health services and emergency management to climate change.

## 2.4 Climate hazards exposure mapping

This section describes the health effects of selected climate-related hazards under four themes based on key climatic conditions and related environmental impacts that have a range of downstream health consequences (direct or indirect) on Aboriginal populations in NSW. We selected these themes to describe key effects of climate on health identified from the literature and consultations. The selected climate-related hazards are:

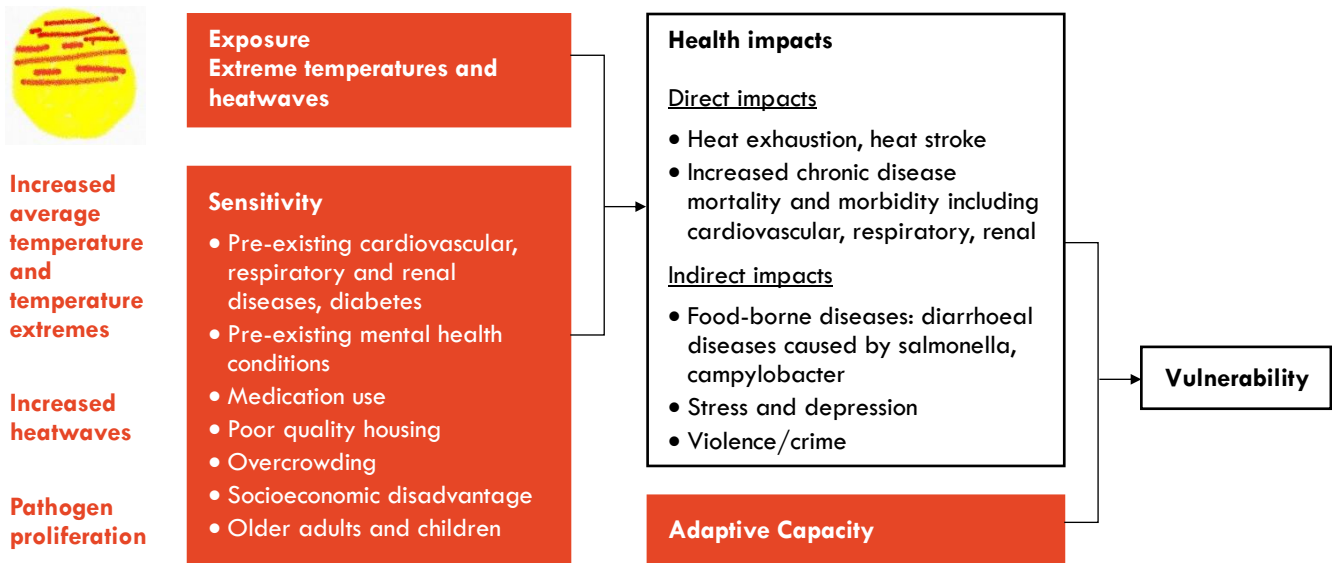
- Temperature and extreme heat,
- Extreme rainfall and floods,
- Droughts,
- Bushfires, air pollution and dust.

Vulnerabilities to these hazards are outlined in terms of population exposures and sensitivities.

Population exposure to each climate hazard is also mapped to illustrate the range of exposures experienced by NSW Aboriginal populations in the recent past and predicted near term and far term future exposures, compared to non-Aboriginal population. We used Statistical Area 1 (SA1) level Usual Resident Population (URPs)<sup>4</sup> data for Aboriginal and non-Aboriginal populations in NSW to compare the exposure of these population to the selected climate-related hazards in NSW. We also mapped discrete Aboriginal communities across NSW identified by various NSW Government programs and compiled by the NSW Health Environmental Health Branch. The list has been validated by on-site/ field visits and mapping using the G-NAF (Geocoded National Address File), a trusted index of Australian address information. G-NAF contains the state, suburb, street, number and coordinate reference (or “geocode”) for street addresses in Australia. G-NAF does not contain any personal information or details relating to an individual or business (ref: <https://geoscape.com.au/wp-content/uploads/2020/09/Unpacking-GNAF-.pdf>). We also mapped the Australian Bureau of Statistics’ Australian Indigenous geographical classification (55). More detail on the data and methods is included in Appendix A.

<sup>4</sup>Usual Resident Population (URPs) are known to undercount Aboriginal peoples, only proportions are given for these estimates, aggregated to the state level.

## 2.4.1 Temperature and Extreme heat



**Figure 11** Vulnerability to heat exposure, sensitivity factors and health impacts

### Climate hazard

NSW experienced the warmest year on record in 2019 in terms of the mean temperature (1.95°C above the long-term 1961–90 mean) and the minimum and maximum temperatures (2.13°C and 1.34°C above their respective long-term means) (56). Since 2013, the annual mean temperature for each year in Australia is amongst the ten warmest on record (56).

The shift to a warmer climate is accompanied by more extreme temperature events, commonly referred to as heatwaves. Heatwaves are broadly defined as a period of at least three consecutive days of unusually hot temperatures with respect to the specific locations' usual temperatures (35). Whilst there is no consensus on the definition of heatwaves, the Bureau of Meteorology (BoM) uses the Excess Heat Factor (EHF) index to identify and characterise heatwaves based on their intensity, duration and frequency and timing (57, 58). Since 1911, heatwaves have increased in intensity, duration, frequency and spatial extent in NSW (56). The warming in Australia is attributable to increasing greenhouse effect (59).

### Health impacts

When the environmental temperature is greater than the core body temperature, heat exhaustion and more serious heat stroke can occur if the human body cannot eliminate heat by sweat production and increased cardiac output (60). From 1844 to 2010, extreme heat events in Australia have caused more than the combined total of deaths from all other natural hazards (61). The deaths were primarily due to heat stroke or heat-sensitive pre-existing illnesses (e.g. cardiovascular, respiratory, renal diseases), with the greatest number of deaths occurring during summers in NSW and Victoria (61).

Increasing temperatures are associated with increased food-borne gastrointestinal (GI) diseases worldwide (62). In Australia, *norovirus*, *rotavirus*, *Giardia*, *Cryptosporidium*, *Escherichia coli*, *Campylobacter* and *Salmonella* are common causes of GI infections which have different responses to temperature (63). A year-long national study in 2001 showed that for every 1°C increase in maximum temperature there was a 2.5% increase in GI infections, which was

substantial given that GI disease has a very high health burden in the population (63). In areas, where facilities for preparing food and storage can be deficient, Aboriginal communities may experience higher rates of *Salmonella* infections in a warming climate (63).

Finally, effects of high temperatures on increased frequencies of crime, domestic violence and aggression are often overlooked. The heat hypothesis suggests that high temperatures increase aggressive behaviour, and as temperatures become comfortably warmer, more people are outdoors with greater social opportunities for crime (64). A recent study from NSW using crime data between 2006 – 2016 shows that rates of assaults (including domestic violence) and thefts (including break-ins, car thefts and stealing) are higher during summer than winter; and as temperature increases incidents of aggressive crime also increase (65).

## **Sensitivities**

### **Age**

Older adults have reduced heat tolerance due to differences in body composition, underlying cardiovascular, respiratory and renal conditions, as well as social isolation and dependencies on others to support adaptive behaviours (60, 66). Young children are also susceptible due to their inability to meet cardiac output in extreme heat conditions (60). It has been suggested that heat-related illnesses among Aboriginal children are often unreported (50). During high environmental temperatures, malnourished children are at risk of heat-related illness and death. Severely malnourished children may have abnormal hypothalamic thermoregulatory function (i.e. body temperature and water balance regulation) as a result of excessive fluid loss (67).

### ***Underlying cardiovascular, respiratory, renal conditions***

The thermoregulatory physiological and circulatory adjustments necessary for the body to cope with extreme heat can place stress on the cardiovascular, respiratory and renal systems, exacerbating underlying conditions such as coronary heart disease (CHD), respiratory diseases and renal diseases (42). People with diabetes are also sensitive to heat stress, as they are prone to dehydration due to diuresis (68). Diabetics are more likely overweight with an increased mass to surface area ratio that reduces the ability of the body to lose heat (68). Studies in Australian cities have found increases in all-cause (69), cardiovascular, respiratory and diabetes mortality were associated with heatwaves (70, 71). Total hospital admissions for heat-related injuries and dehydration (70), coronary heart disease (CHD) and renal disease were also increase during heatwaves in Australian cities (42, 71, 72).

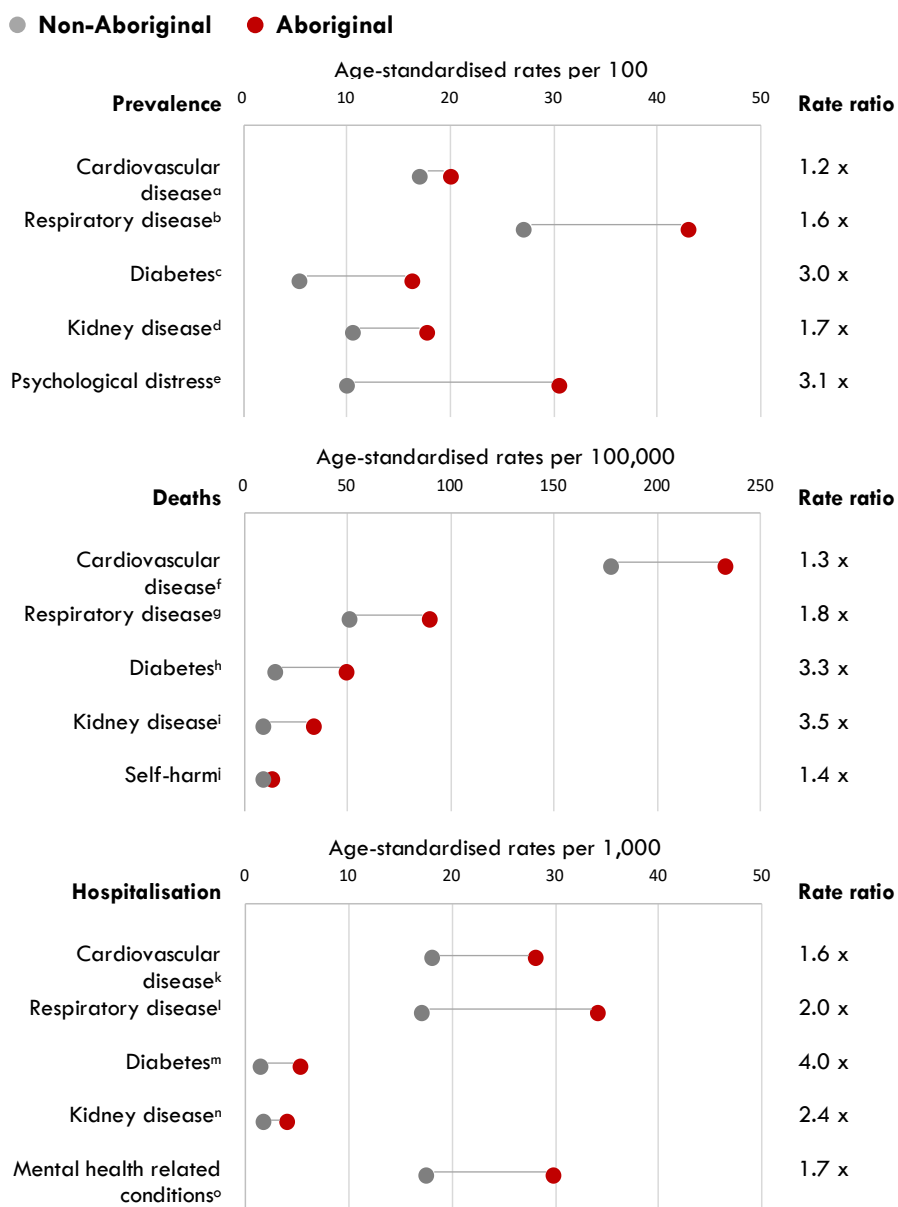
Aboriginal and Torres Strait Islander peoples are expected to be more sensitive to the projected increase in extreme temperatures under climate change, due to the higher rates of cardiovascular, respiratory and renal disease as compared to the non-Indigenous population (see Figure 12) (47, 73). In a study that observed the effect of extreme temperatures on hospital admissions during 1992 – 2011 in the Northern Territories (NT), cardiovascular hospital admission rates for Aboriginal and Torres Strait Islander peoples were higher for females aged < 65 in very hot days and for all aged > 65 in cold conditions when compared to the non-Indigenous counterparts (74). Remote Aboriginal communities and inhabitants that are older adults with underlying conditions will be more vulnerable to heat stress due to limited access to health care facilities (47).

## Underlying mental health conditions

Elevated temperatures may also exacerbate existing mental health conditions, including chronic stress, depression and health-damaging personal behaviour compounded by lethargy and an inability to function due to oppressively hot conditions (43). People with poor mental health or older adults are also less likely to undertake adaptive behaviours to manage temperature extremes such as increased fluid intake, and are more dependent on the support of others, increasing the risk of heat-related morbidity and mortality (75). Medications used to treat mental health conditions also increase sensitivities to heat as they tend to alter the body's ability to thermoregulate (75). An epidemiological study from Adelaide found positive associations between heatwaves with hospital admissions for mental health conditions such as dementia, depression, anxiety and senility (43).

The Aboriginal and Torres Strait Islander population is expected to be more sensitive to the projected increase in extreme temperatures due to their higher rates of mental health conditions as compared to the non-Indigenous population (see Figure 12). In

## Comparing Aboriginal and non-Aboriginal age-standardised rates in NSW



**Figure 12** Health gap for selected heat related conditions in NSW Aboriginal and non-Aboriginal populations.

- a. Cardiovascular disease lasted for > 6 months 2012-13 (Age-std rate per 100)
- b. Respiratory disease lasted for > 6 months 2012-13 (Age-std rate per 100)
- c. Persons >18 diagnosed with diabetes 2012-13 (Age-std rate per 100)
- d. Persons >18 diagnosed with kidney disease 2012-13 (Age-std rate per 100)
- e. Persons >18 with high levels of psychological distress 2012-13 (Age-std rate per 100)
- f. Death by cardiovascular diseases 2011-15 (Age-std rate per 100,000)
- g. Death by respiratory diseases 2011-15 (Age-std rate per 100,000)
- h. Death by diabetes 2011-15 (Age-std rate per 100,000)
- i. Incidence of end-stage kidney disease (Age-std rate per 100,000)
- j. Death by intentional self-harm 2011-15 (Age-std rate per 100,000)
- k. Hospitalisation by cardiovascular diseases 2013-15 (Age-std rate per 1,000)
- l. Hospitalisation by respiratory diseases 2013-15 (Age-std rate per 1,000)
- m. Hospitalisation by diabetes in adults aged >65 2013-15 (Age-std rate per 1,000)
- n. Hospitalisation by kidney diseases 2013-15 (Age-std rate per 1,000)
- o. Hospitalisation by mental health related conditions 2013-15 (Age-std rate per 1,000)

Source: Australian Institute of Health and Welfare. Aboriginal and Torres Strait Islander Health Performance Framework (HPF) report 2017 (24).

2011, suicide and self-inflicted injuries, anxiety and alcohol use disorder were amongst the top five health burdens for the Aboriginal and Torres Strait Islander population (23).

### Domestic violence and crime

While obtaining data on the true extent of family and domestic violence is difficult, violence occurring within the family, against both women and children, is prevalent in the general population as well as the Aboriginal population. On the basis of crimes reported to the police, Aboriginal women are almost 40 times more likely to be victims of spousal violence than non-Aboriginal women (67).

### Housing and social environments

In urban NSW, physical housing problems are most prevalent in social housing, which is the dominant tenure type amongst the Aboriginal population (76). Inadequate housing is a key contributor to the health gap between Aboriginal and Torres Strait Islander and non-Indigenous population and is an indicator of social disadvantage (53). summarises disparities between Aboriginal and non-Aboriginal peoples housing environment and homeownership in NSW. Housing characteristics such as building materials, home insulation, cooling and air-conditioning play an important role in protecting inhabitants from extreme heat exposure (77). However, Aboriginal housing in NSW generally lacks adequate passive and active thermal regulation, which puts older adults, the young people and those with underlying conditions more at risk from extreme temperature events (67) (78).

### Comparing Aboriginal and non-Aboriginal populations (%) in NSW

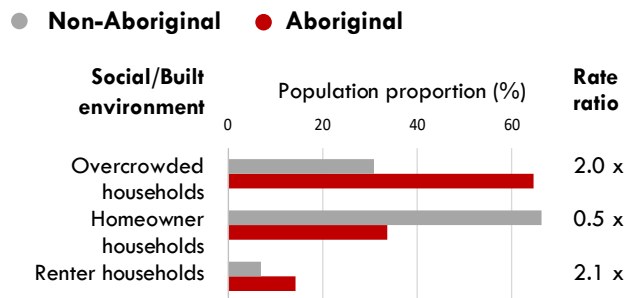


Figure 13 Disparities between Aboriginal and non-Aboriginal peoples housing environment and homeownership in NSW (2014-15).

The Aboriginal Housing Office (AHO) have developed an Air Conditioning Policy to provide cooling for Aboriginal social housing in areas with high temperatures. According to this policy’s guidelines, housing eligible for air conditioning are those located within the Isotherm 33 boundary where average January temperatures are 33-36 degrees (79). This temperature boundary covers most of far west and north west NSW and is illustrated in Figure 14. This policy is a promising adaptation strategy to increasing periods of extreme heat. It would be useful to assess the progress in eligible households having air conditioning installed, the health benefits of the program and issues around ongoing operations such as maintenance and affordability.

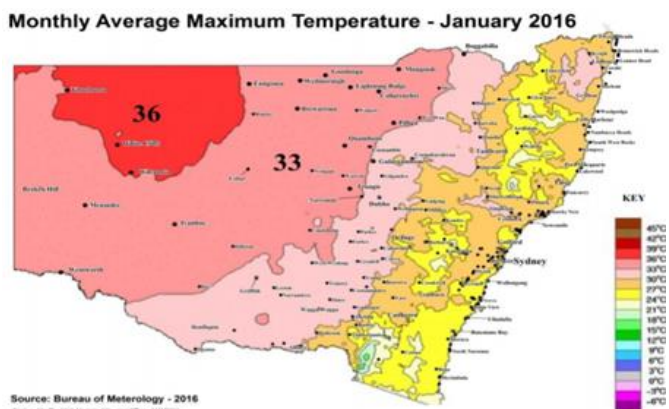


Figure 14 January 2016 Monthly average maximum temperature isotherm for NSW – Isotherm 33-36 used to define eligibility (79)

Source: Aboriginal Housing Office



Cultural factors and extended family networks influence the ways Aboriginal peoples occupy their households and plays a role in the increased rates of overcrowding seen in housing in Aboriginal communities (80). A 2014 study in NSW found significantly more Aboriginal peoples (14%) lived in overcrowded households compared to non-Aboriginal peoples (7%) (24). Overcrowding not only exacerbates environmental temperatures, it puts excess pressure on 'health hardware', leading to poor hygiene and the exacerbation of close contact infectious disease transmission, chronic conditions and stress (53, 81). In urban NSW, cumulative housing disadvantages, including overcrowding, plumbing issues, inability to keep warm, presence of vermin, mould and damp, were shown to associate with recurrent GIs amongst Aboriginal children (82).

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#### Case Study: Public\* Housing in Mildura

A recent study conducted in Mildura on the Victorian border with NSW, assessed the impacts of extreme heat for those living in public housing (83). While this study was not specifically targeting Aboriginal peoples, it illustrates the importance of community consultation to understand the links between extreme heat, health and public housing. The qualitative study was conducted by a research team at The University of Sydney in partnership with community members and Mallee Family Care, a local organisation advocating for vulnerable residents in the Mallee Region of Victoria. The research was driven by community members to understand and respond to the community-identified issue of inadequate cooling for public housing residents. The Victorian State policy regarding minimum standards for cooling in public housing had not been revised since 1997, despite the significant increases in severity, duration and frequency of extreme heat events in Mildura.

In the initial stages of the study, several 'community champions' were selected to help with the planning and recruitment phases of the study. They helped harness local knowledge, and advise on proposed study methodologies. The study recruitment process was strengthened by their liaison with community members to explain the benefits and importance of the study.

Current and past public housing tenants were recruited, as well as service providers including schoolteachers, social workers, and drug and alcohol workers. Both Aboriginal and non-Aboriginal public housing residents participated in the study.

The study used focus groups and one-on-one interviews to explore participants' lived experiences. Participants could attend more than one focus group and some of the quieter participants became more confident to tell their stories over multiple sessions. Overall, the participants were very happy to share their experiences and the success of the study data collection process can be attributed to the community-driven nature of the study.

Residents and service providers linked inadequate home cooling or lack of access to public cooling areas to not being able to sleep, resulting in mood changes and being less able to cope with daily stressors. Common themes included the exacerbation of pre-existing chronic conditions (including mental health conditions and those requiring medications), social isolation, nutritional concerns from not cooking in the heat, concern for the safety of Elders and other vulnerable groups, worsened attention and performance at school, and increased violence and antisocial behaviour in the community (many of which were described as stemming from lack of sleep and roaming the streets at night to escape their hot homes).

The study recommended urgent amendments to the 1997 legislation to better safeguard the

health and wellbeing of public housing residents by adapting to the current and future conditions of increasing periods of extreme heat in the Mallee region of Victoria. The 2020/21 Victorian State Budget, announced \$112 million to upgrade cooling, heating and hot water in 35,000 social housing properties (84). This recent announcement will improve adaptation and health responses for public housing residents. This case study demonstrates the valuable influence of community consultation in responding to local issues driven by climate change. It will be important to conduct follow up work on the maintenance and affordability of operating the upgraded heating and cooling for lower income public housing tenants.

### **Exposure maps**

NSW climate data was obtained from the Australian Bureau of Meteorology Australian Water Availability Project (85) to estimate population exposures to extreme heat and prolonged heatwaves, detailing both average daily temperature and the length of extreme heat events across NSW. Both the total number of annual days with a temperature of 35 degrees Celsius or higher, and periods of prolonged extreme heat (that is, heatwaves) were calculated and annual averages were obtained for all NSW at a resolution of 25km by 25km over 1990 to 2019 period. These data were then population-weighted using the 2016 Australian Bureau of Statistics Population grid (86), and categorised according to severity. Finally, population proportions were calculated by summing the number of Aboriginal and non-Aboriginal peoples residing in SA1s in each exposure category. Extreme health and heatwave projection estimates were obtained for NSW from The NSW and ACT Regional Climate Modelling (NARClIM) Project (87) and population exposures were estimated at the SA1

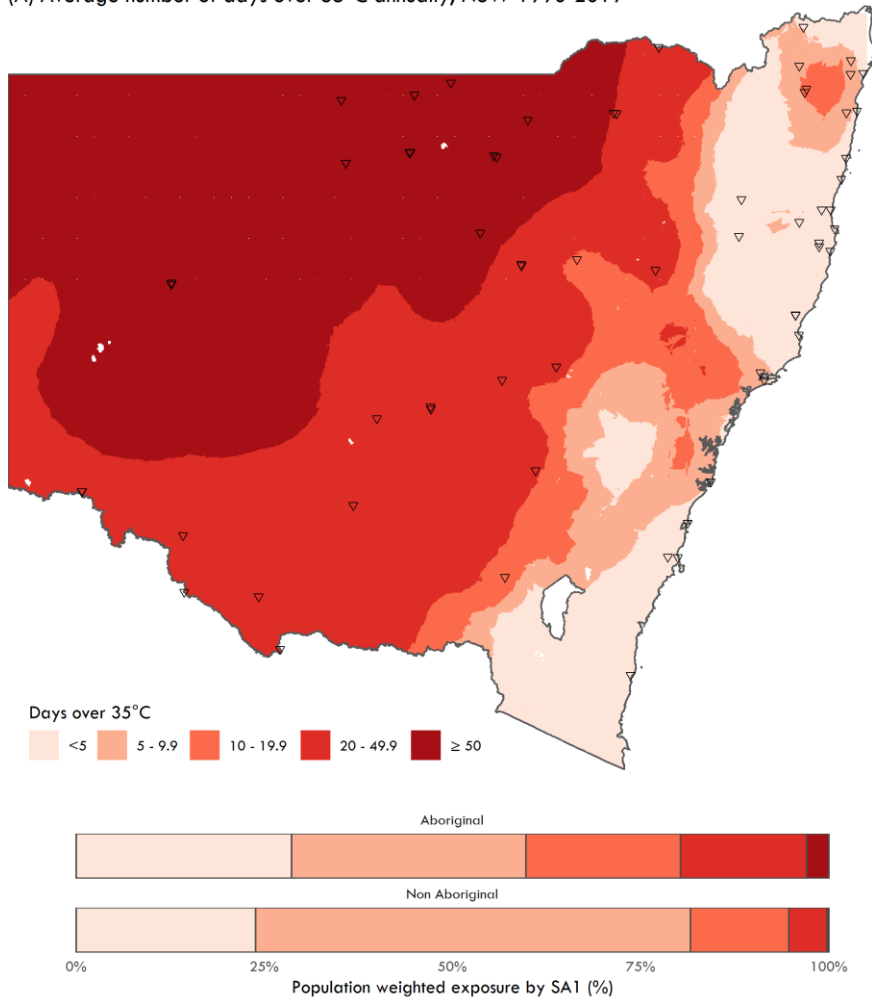
level using a similar approach as described above. Results are summarised in Figure 15, with histograms indicating differences in proportions of Aboriginal and non-Aboriginal peoples exposed to that indicator.

We see that, across NSW, Aboriginal peoples live in areas subject to longer heat waves and more days over 35 degrees (Figure 15A and B). Specifically, 27% of Aboriginal peoples currently reside in areas with mean heatwaves lengths of 7 or greater days, compared with 9% of non-Aboriginal peoples (Figure 15A), and 20% of Aboriginal peoples live in areas with an average of 20 or more days over 35°C annually, compared with 5% of the non-Aboriginal population of NSW (Figure 15B).

Projecting forward in the near and far future, the frequencies (2.5 – 4.5 extra events) and durations (2 – 11 extra days) of heatwaves are expected to increase significantly in NSW (35) Figure 16 shows that around 32% of Aboriginal peoples currently live in areas with projections of five or more additional days over 35 degrees Celsius annually for the period of 2020-2039, compared with 12% of non-Aboriginal peoples.

# Heat

(A) Average number of days over 35°C annually, NSW 1990-2019



(B) Average heatwave duration in days, NSW 1990-2019

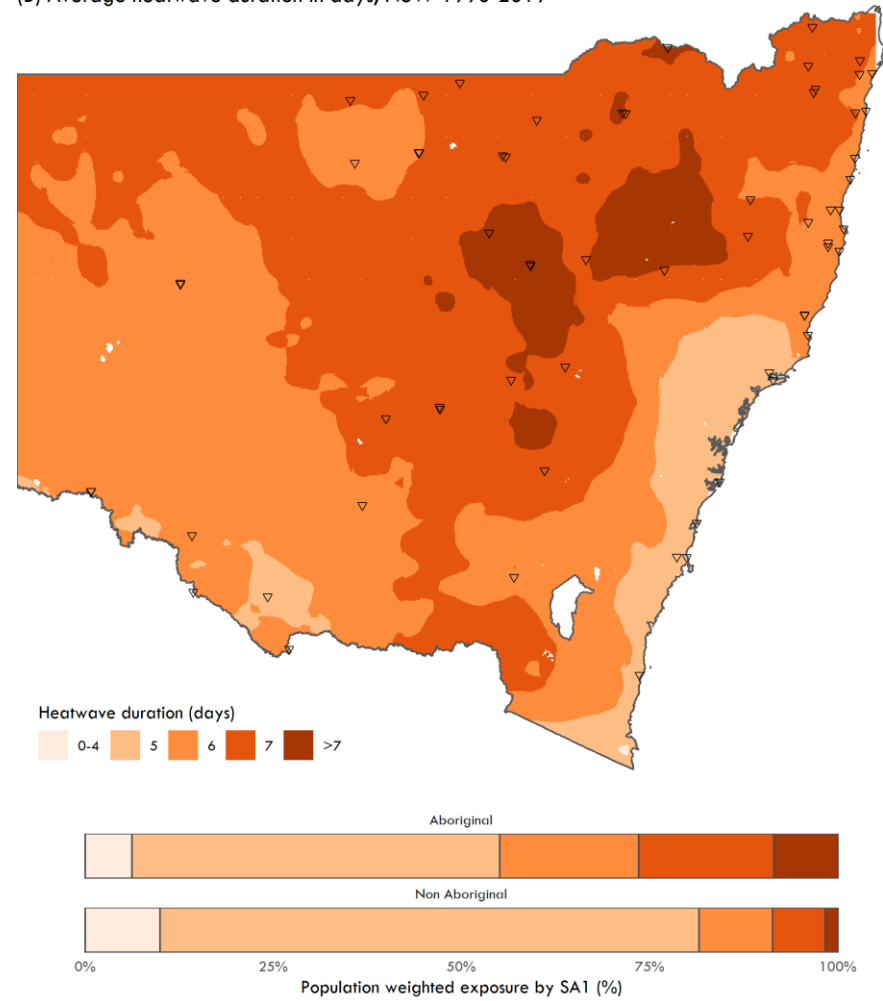
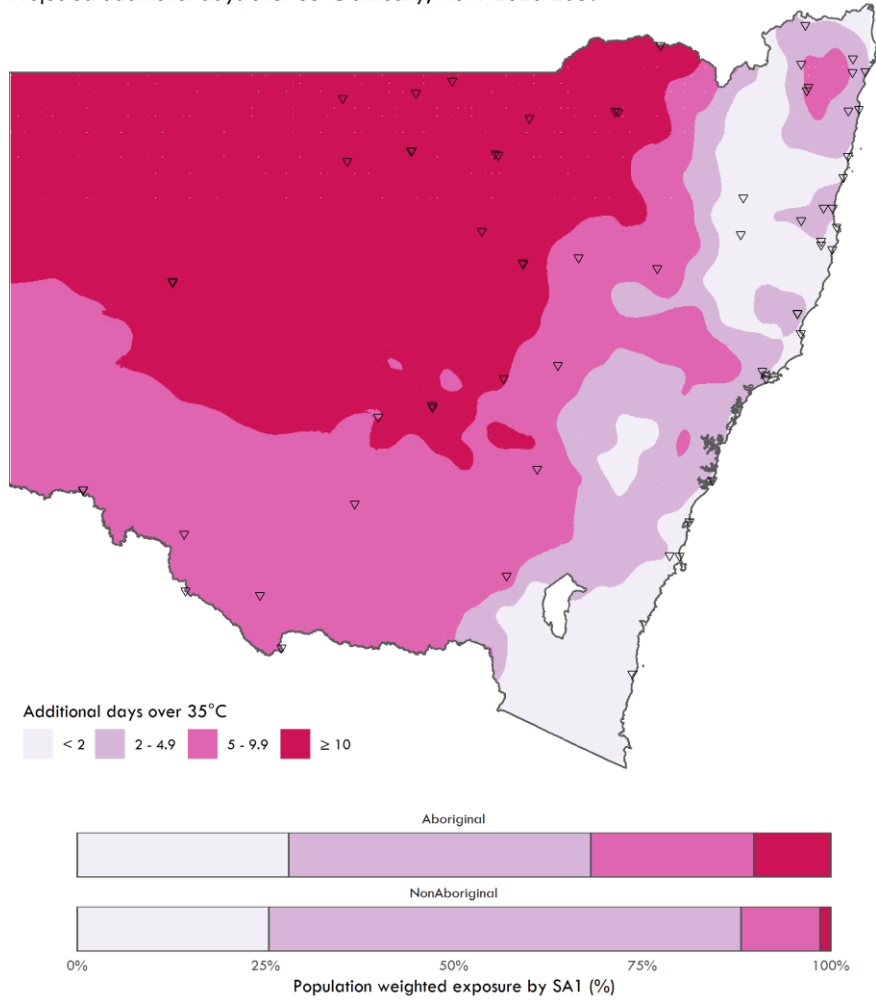


Figure 15 Current maps and population exposures of heat indicators.

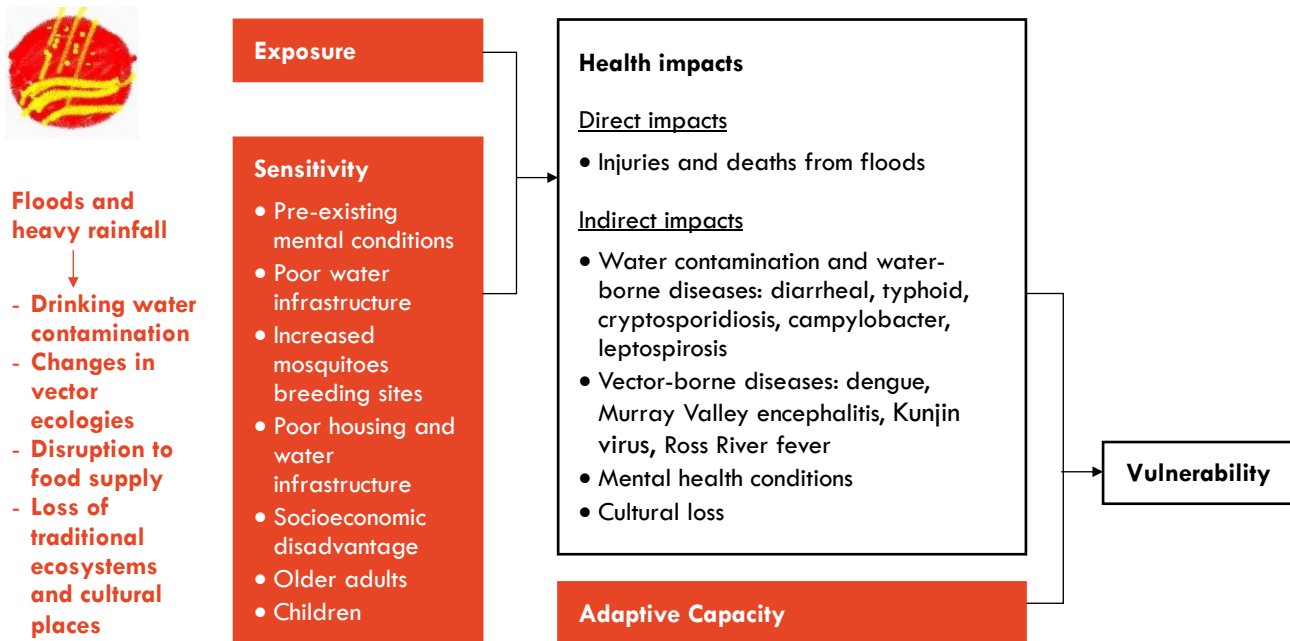
# Heat

Projected additional days over 35°C annually, NSW 2020-2039



**Figure 16** Projected map and population exposure of heat exposure.

## 2.4.2 Extreme rainfall and floods



**Figure 17** Vulnerability to rainfall variability, sensitivity factors and health impacts

### Climate hazard

Australia's rainfall is naturally highly variable year-to-year, decade-to-decade, as well as across the continent (59). In the last 20 years, there has been a shift towards wetter conditions in northern Australia and drier conditions in southwestern and south eastern Australia in comparison to the entire rainfall record since 1900 (17). Since 1970, rainfall extremes also became more intense, indicated by the increase in proportions of Australia's landmass receiving greater than 90% of annual rainfall due to heavy one-day events (59). Extreme rainfall variabilities can lead to floods and droughts (see Section 2.4.3). For example, the Millennium Drought occurred in NSW between 1996 – 2010 was followed by record rainfalls during 2010 – 2012. Increasing interannual rainfall variabilities have been observed since 1950 in Australia (34).

Whilst attributing increasing rainfall variabilities to climate change is difficult, studies have suggested that sea surface warming contributed to 20% of the rainfall anomalies in south eastern

Australia since the 1990s (59). As temperature warms the atmosphere can hold more moisture, thereby increasing the potential for extreme rainfall and the risk of flooding (59). In the near and far future, the mean springtime rainfall in the inland regions and the southern part of NSW is projected to decrease, whilst the mean rainfall in the coastal north will increase (34). In autumn, the mean rainfall across NSW is projected to increase in the near and far future (34). Extreme rain events and floods are expected to increase in frequency and magnitude (88).

### Health impacts

The direct health impact of floods in terms of death by drowning, most notably associated with vehicle crossings over flood-impacted areas, was 1,859 between 1900 and 2015 in Australia (89). Floods can further impair access to health services, resulting in the exacerbation of health problems among flood affected communities (90). Floods are the second most hazardous natural disaster after heatwaves in Australia, with Queensland (QLD) and NSW bearing the highest numbers of fatalities (61).

Flood events also cause indirect health impacts mediated by water damages to the natural and built environment (90). Flood waters can damage sewage systems, contaminate local surface and ground water supplies with pathogens (e.g. *Escherichia coli*, *Vibrio cholerae*, *Cryptosporidium*, *Giardia*), and cause water-borne GI infections and diarrhoeal diseases (90).

Increases in rainfall or flooding in conjunction with warmer temperatures, or following droughts whereby the 're-wetting' of the environment occurs (91), can promote breeding conditions for mosquitos and vector-borne diseases (92). Epidemic dengue, currently limited to QLD, could expand southwards towards NSW (93); whilst Ross River and Barmah Forest viruses, currently endemic across much of Australia, could expand in their geographic niches especially in the tropical north (94).

Flood events could also impact social and emotional wellbeing. Floods can inflict physical injuries, personal losses, food supply disruptions, social disruption and economic hardships that can in turn lead to the development or exacerbation of mental health conditions (90). In March 2017, Australia's second most destructive cyclone (Debbie) caused devastating floods in northern NSW. A recent study suggests that as the intensity of exposure to floods increases, the likelihood of developing mental distress also increases (95).

## **Sensitivities**

### **Age**

Aboriginal children living in remote areas will likely be more sensitive to extreme rainfall and flood events, as these events affect environmental systems and exacerbate childhood susceptibilities to respiratory, gastrointestinal, skin, and eye and ear infections (96, 97). In NSW, respiratory and GI conditions were the leading causes of avoidable hospitalisation amongst Aboriginal children (98). Aboriginal children's risk of avoidable hospitalisation is

greater than non-Indigenous children across in NSW, and tend to be higher in remote and socioeconomically disadvantaged areas (98).

### **Access to safe water and perception of drinking water**

Insufficient access to clean water (e.g. due to broken taps and showers) to practice personal hygiene, and dysfunctional sewerage systems (e.g. broken toilets) for removing waste, especially in remote Aboriginal populations, are important risk factors for respiratory and infectious conditions (96, 97). In 2014, Aboriginal households in NSW are still without working facilities for washing people (3%), clothes and bedding (7%), preparing food (8%) as well as sewage disposal (4%) (24).

Access to clean drinking water is fundamental to good health. Improvements in access to safe reticulated water supplies for Aboriginal communities in NSW have been implemented through the NSW Communities Water and Sewerage Program established in 2008 (99). In 2015 this program reported more than 99% microbiological and chemical compliance with the Australian Drinking Water Guidelines in NSW Aboriginal communities (100).

However, less is known about the exposure of Aboriginal communities to non-reticulated water sources such as rivers, rainwater tanks and ground water, which can be prone to microbiological and chemical contaminations. In WA, due to lack of access to safe water, the use of underground water contaminated by nitrates and uranium was suspected to contribute to the disproportionately higher cases of chronic kidney diseases amongst Aboriginal adults (101).

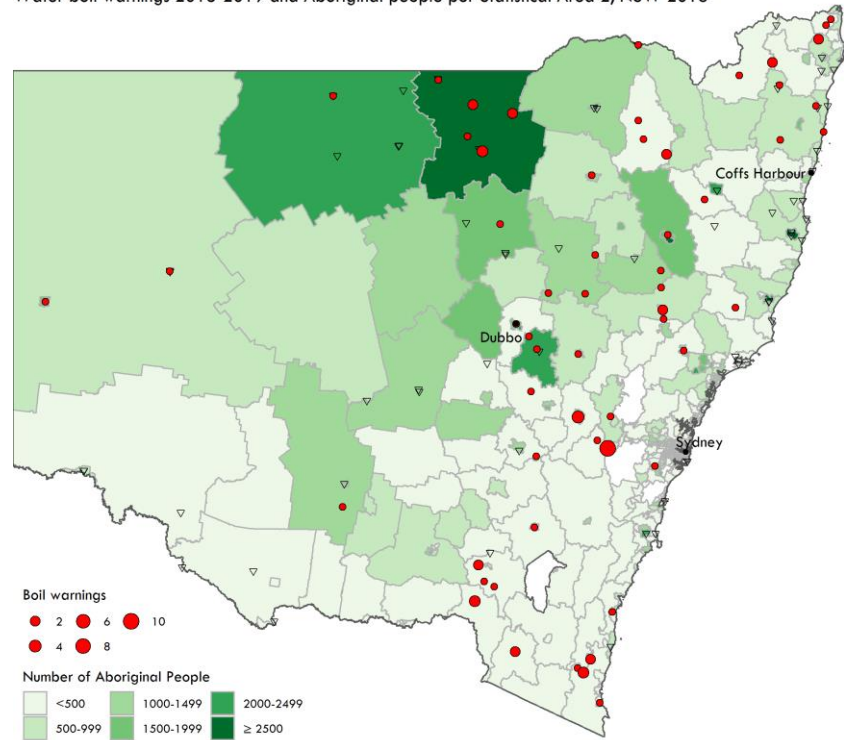
In NSW, even though the supply of safe town water is generally achieved, a case study at the community of Walhallow demonstrated that **negative perception** of the taste and hardness of town water resulted in its rejection (102). Instead, untreated rainwater, even though more

likely to be contaminated with *E.coli*, was more culturally accepted (102). This is also reflective of a general lack of trust by Aboriginal peoples in government interventions (103).

In addition, alerts are often issued by the government, advising tap water be boiled before drinking due to bacterial contamination (104). Figure 18 shows that boil water alerts occur more frequently in rural and remote areas, where higher numbers of Aboriginal peoples live. Such boil water alerts, combined with a historical mistrust of government interventions, may serve to strengthen already negative perceptions of government supplied drinking water.

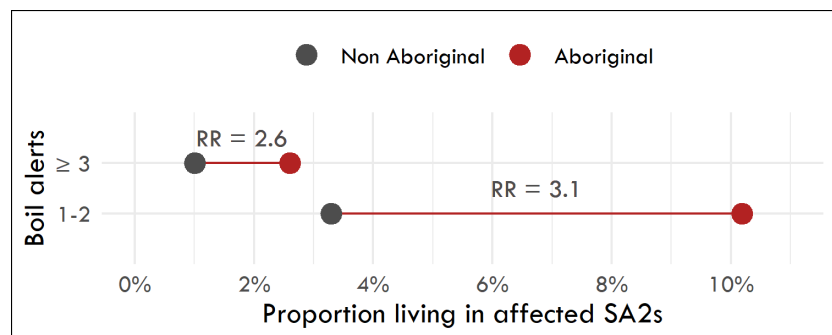
While boil water alerts only affect a small proportion of the population of NSW, with only 4% of the population living in affected SA2s, Aboriginal peoples disproportionately live in these SA2s. Specifically, 13% of Aboriginal peoples live in SA2s where there have been boil water warnings since 2013. Aboriginal peoples are 2.6 times more likely to live in SA2s with greater than 3 alerts in since 2013 than non-Indigenous peoples (see Figure 19).

Water boil warnings 2013-2019 and Aboriginal people per Statistical Area 2, NSW 2016



**Figure 18** Boil water alerts for NSW, 2013-2020 and estimated resident populations of Aboriginal peoples by Statistical Area 2, 2016

Source: NSW Health Drinking water quality and incidents (104)



**Figure 19** Proportion of Aboriginal and non-Aboriginal peoples by Statistical Area 2 (SA2) affected by boil water alerts, 2013-2020, with risk ratios (RRs) indicated.

### **Underlying socioeconomic disadvantage**

Aboriginal and Torres Strait Islander peoples fared worse in terms of education, employment, housing conditions and relative disadvantage as compared to the non-Indigenous population (see Figure 9) (24). Social disadvantage have been shown to be associated with the population's higher exposure to flood events and lower capacities to cope with them (105). In March 2017, cyclone Debbie caused devastating floods in northern NSW, a region with a higher proportion of Aboriginal peoples than the state average (95). A survey following the floods found that Aboriginal peoples were more likely to report flood damage to homes than non-Indigenous people (95). Given that Aboriginal peoples have higher rates of psychological morbidities (23), flood events may exacerbate these conditions to cause higher risks for post-traumatic stress, anxiety and depression.

### **Potential increase in mosquito breeding sites**

The expansion of vector ecologies due to climate change is difficult to predict, as it is also influenced by human climate adaptation activities such as the installation of rainwater tanks, which can inadvertently extend the geographical range of mosquito breeding sites. Other human activities conducive to the spread of vector borne infections include travel and habitation patterns (106).

### **Exposure map**

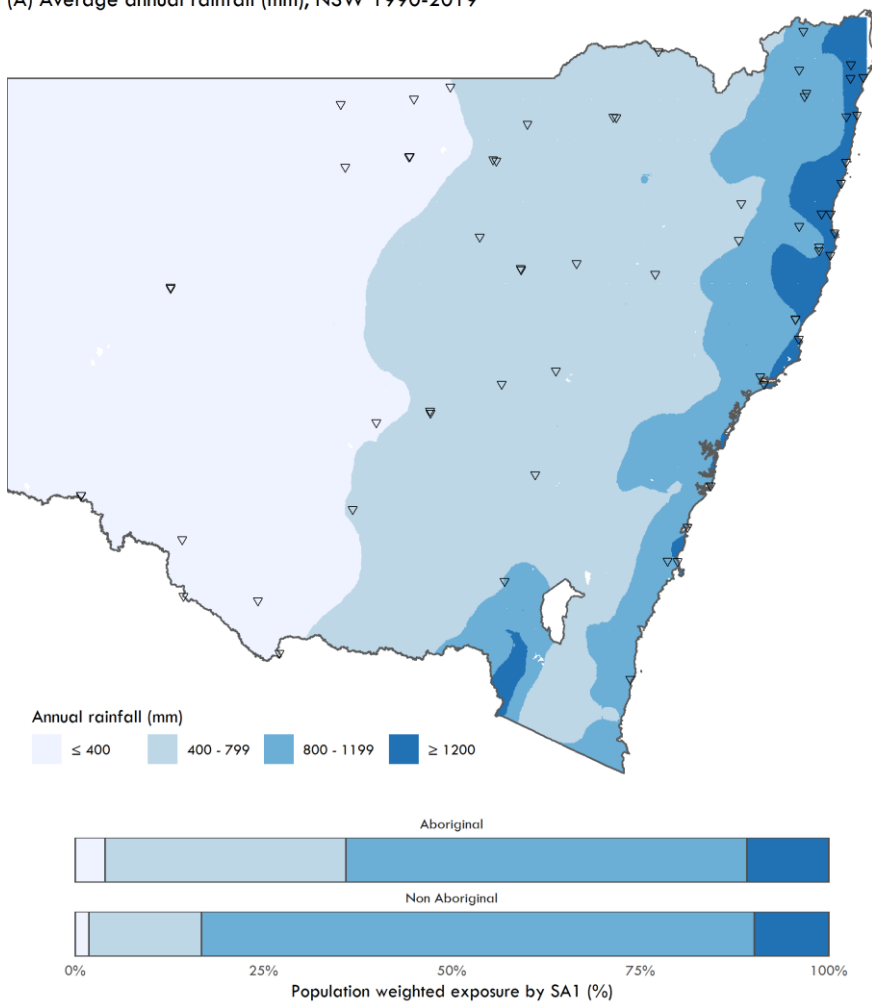
Similar to the extreme heat indicators, rainfall variability and average rainfall estimates were obtained for NSW from the Australian Water Availability Project (85), and population weighted estimates of exposure at the SA1 level were calculated. The level of exposure in each SA1 was categorised, and total proportions of Aboriginal and non-Aboriginal peoples were calculated in each exposure category at the state level. These results are shown in Figure 20

There are considerable differences in rainfall exposure between Aboriginal and non-Aboriginal populations. Specifically, a greater proportion of Aboriginal peoples live in areas with low rainfall, with 33% living in areas with annual average rainfall of 800mm or less, compared with 20% of the non-Aboriginal population (Panel A). More Aboriginal peoples also live in areas with considerably more rainfall variability, with 13% of the total Aboriginal population living in areas with Moderate to very high rainfall variability, compared with 3% of the total non-Aboriginal population (Panel B).

Additionally, more Aboriginal peoples in NSW live in areas with higher projections of change in rainfall from 2020-2039. Twelve percent of Aboriginal peoples in NSW live in areas with projected decreases in annual rainfall of greater than 1%, compared with 6% of non-Aboriginal peoples in NSW. Similarly, just under a third of Aboriginal peoples (31%) live in areas with projected increases in rainfall of 2% or greater, compared with 23% of non-Aboriginal peoples (Figure 21A). This suggests that rainfall variability is projected to increase in areas with high proportions of Aboriginal peoples. While slightly more Aboriginal peoples lived in areas with a high number of annual flood days between 2015 and 2019 (12% vs 10%), Aboriginal peoples were also more likely live in areas that experienced no flood days between 2015 and 2019 (46% vs 20%; Figure 21B)



(A) Average annual rainfall (mm), NSW 1990-2019



(B) Average rainfall variation, NSW 1990-2019

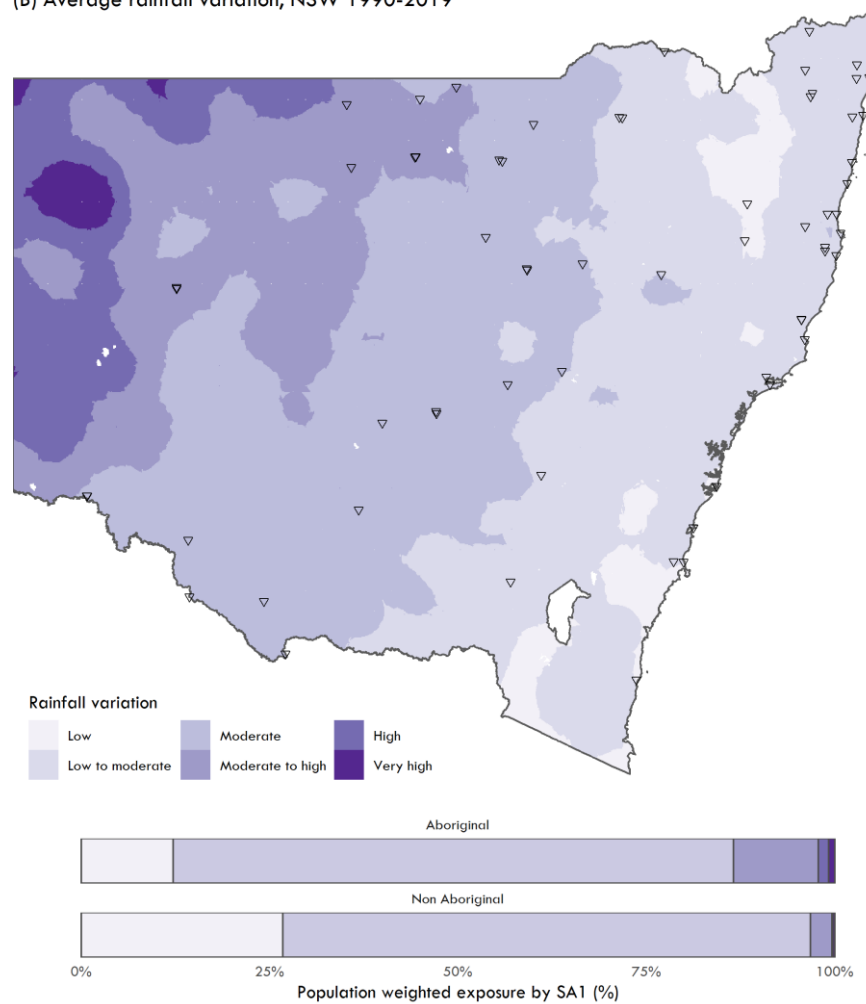
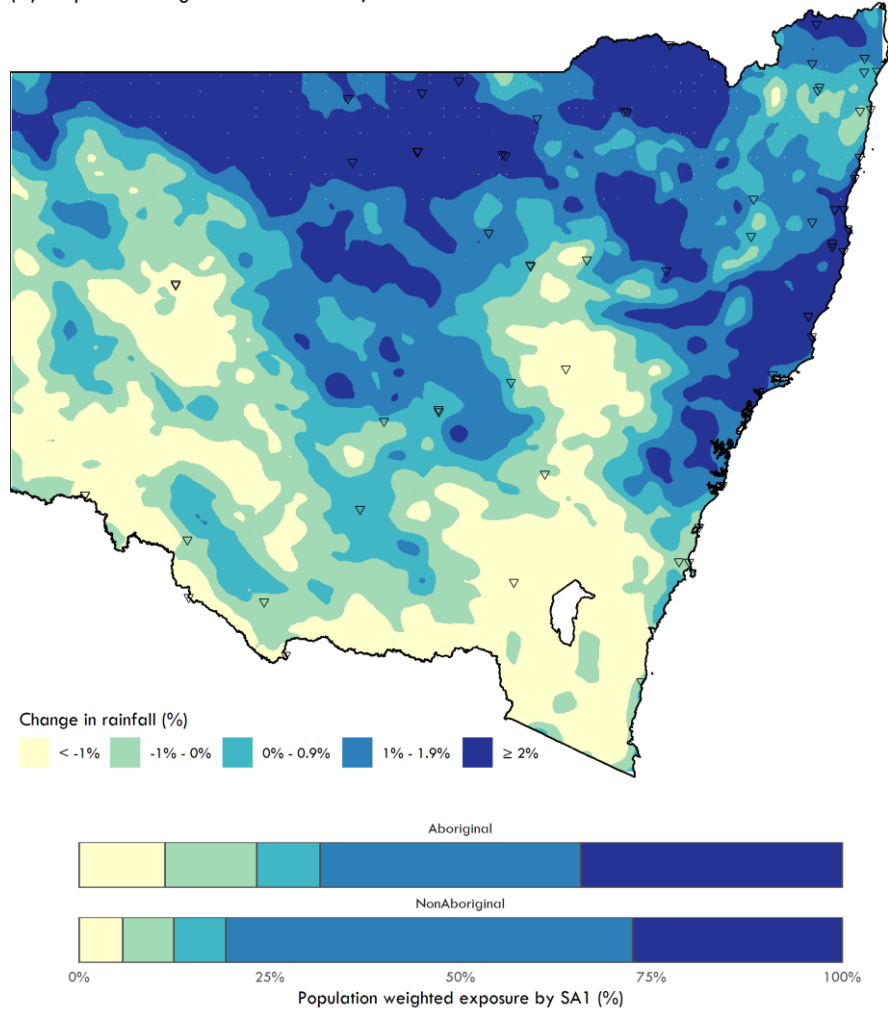


Figure 20 Current maps and population exposure of rainfall indicators, NSW

(A) Projected change in annual rainfall, NSW 2020-2039



(B) Flood days, 2015-2019

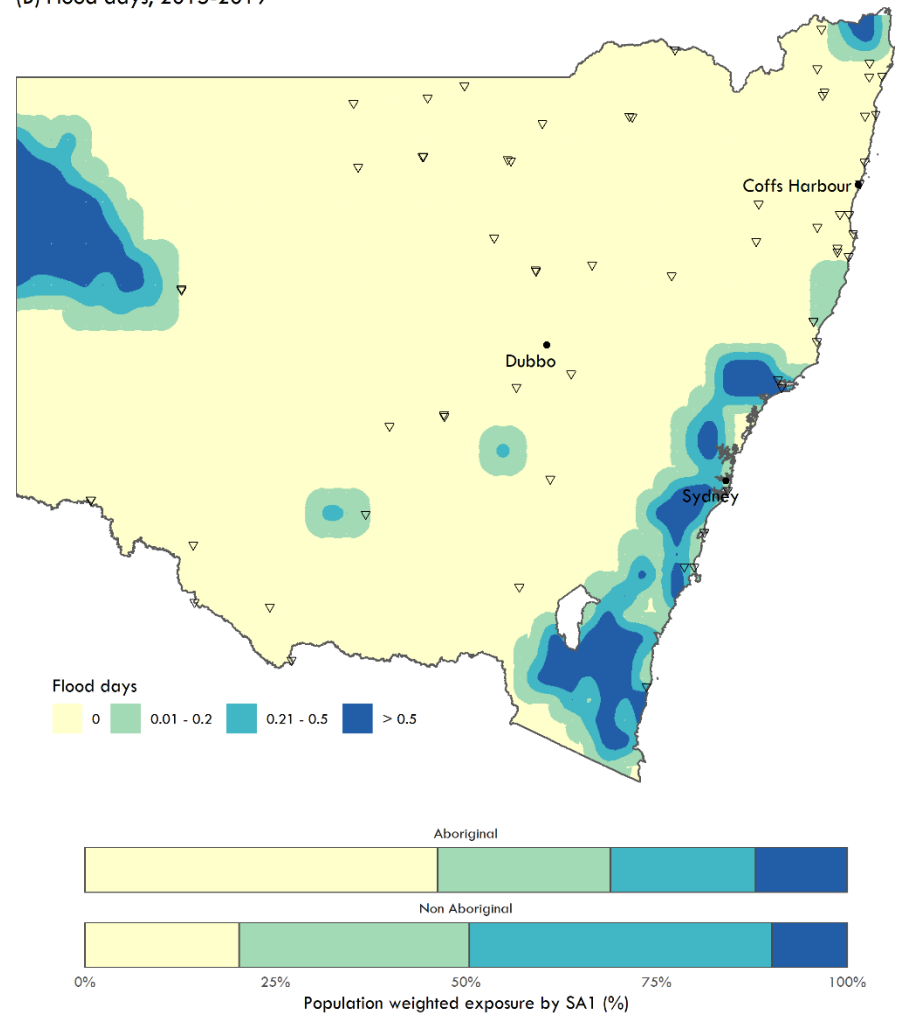
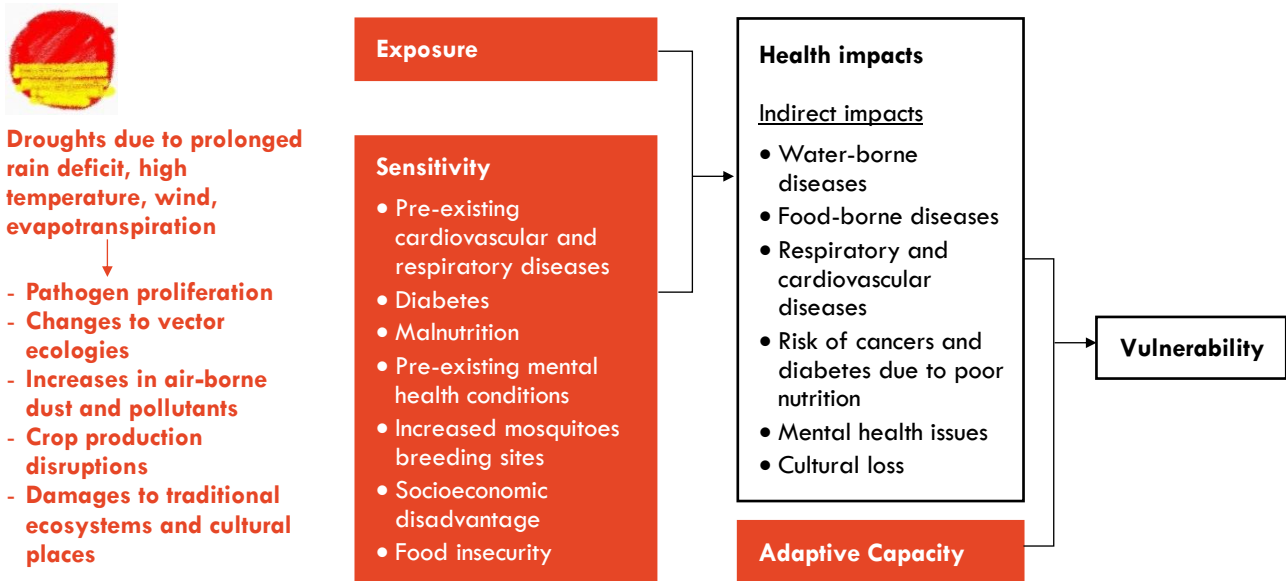


Figure 21 Projection map and population exposure of rainfall indicators, NSW

## 2.4.3 Droughts



**Figure 22** Vulnerability to drought exposure, sensitivity factors and health impacts

### Climate hazard

Australia is the driest inhabited continent on Earth and a drying trend was observed in the southeast (WA) and southwest (encompassing VIC and NSW) of Australia in recent decades (17). Between 1999 – 2018, there was a 11% decline of Winter-Spring rainfall in Australia's southeast compared to the 1900 – 1998 period (17). In 2019, NSW received the lowest average rainfall on record, whilst the Murray-Darling Basin (MDB) received the second lowest surface runoff on record (56). The Northern Basin storage levels were lower than at any point during the Millennium Drought (2001–2009) that affected much of southern Australia (56).

Whilst droughts are generally caused by prolonged rain deficits, atmospheric temperatures also influence droughts by evaporating water from the land and causing transpiration of water from plants to the atmosphere (evapotranspiration) (107). Climate change influences these atmospheric variables linked to droughts, however, due to their complexities, the representations of droughts in

climate models are highly uncertain (107). In Australia, the BoM used a standardised precipitation index (SPI) based solely on rainfall to predict an increase of up to 20% in the proportion of time spent in drought in southern Australia by 2090 (59). This is consistent with the projected decrease in the Winter-Spring rainfall in the same region.

Drought conditions also contribute to fire weather (confluence of low moisture content in vegetation, strong wind and ignition source) and airborne dust (108). The health impacts of these environmental effects will be discussed in Section 2.4.4.

### Health impacts

The health impacts of droughts are mostly indirect and difficult to estimate, as droughts are slow-onset climate events that affect several environmental and human systems (108).

Droughts can increase **water-borne diseases** and **diseases associated with pollutants** by concentrating microbiological or chemical contaminants in reduced surface or ground water

(109). Droughts can exacerbate **respiratory and cardiovascular diseases** by increasing airborne dust in dry soil or by promoting fire weather that leads to bushfires and bushfire smoke (110) (see Section 2.4.4). Drought can also lead to more **vector-borne disease** outbreaks by triggering abnormal precipitation changes and increasing mosquito habitats and numbers (91) (see Section 2.4.2).

Droughts can also reduce food productivity and food security. During the Millennium Drought, reduction in cereals, rice and meat production led to their significant price increase and a global shortage in cereal (111). A long-term health impact of food insecurity is malnutrition due to the reduced nutritional diversity, sufficiency as well as affordability of foods (112).

Exposure to drought and food insecurity is also linked with reduced livelihoods from the agricultural industry, reduced household income, reduced ability to purchase nutritious food and these factors contribute to increasing psychological distress among those affected (113). Aboriginal peoples who lost work to the pastoralism sector due to the prolonged drought in QLD during the 2000s reported an increase in social problems and a decline in mental wellbeing (114). A study in NSW found that Aboriginal peoples were more vulnerable to experiencing worsened social and psychological effects from drought than other rural populations, including solastalgia (i.e. distress caused by environmental change) increase in self-harm suicide, substance use disorder and decreased ability to buy basic items such as food (115).

## **Sensitivities**

### **Food insecurity**

Climate change alters ecosystems and in turn the life cycles of animals and plants. In this context, food insecurity is an emerging issue of concern especially for regional and remote Aboriginal

communities who relies on the timely arrival of bush tucker species or river fish to supplement their diet (28). The definition of food insecurity encompasses poorer food access, food availability and food utilisation (116). The prevalence of food insecurity in the general population of NSW was 3% in 2012 (117), but disproportionately affects Aboriginal and Torres Strait Islander people, where 22% of the population nationally experienced unaffordability (118). Those that lived in remote areas (31%) were more likely to experience food insecurity compared to those lived in non-remote areas (20%) (118).

Vulnerability to food insecurity is embedded in the physical, social and economic processes that allow for sufficient and safe access to nutritious food (119). Aboriginal and Torres Strait Islander peoples are likely more sensitive to having poorer food access, poorer food availability and poorer food utilisation than non-Indigenous people (116).

---

### **Case Study: Walgett**

Lack of food access refers to not having sufficient financial and other resources to obtain nutritious food. A recent survey comparing food prices in regional Walgett Local Government Area (LGA) and a Sydney metro suburb found that nutritious foods were pricier in regional Walgett (120), where 29% of LGA's population was Aboriginal. Since Aboriginal peoples have **lower levels of employment and income** (24), higher food prices make it more difficult for them to achieve healthy diets.

The quantity and quality of nutritious food consumed by Aboriginal peoples in Walgett were found to be generally poor, where Westernised diets of processed foods and sugary drinks were preferred, and higher levels of sodium were found in local drinking water (120). Exacerbating issues of food access and availability is **dispossession and the blocking of Indigenous access to Traditional land and**

### **rivers for farming, food-gathering and hunting.**

Aboriginal peoples were impeded from supplementing their diet with nutritious plant foods, seeds, fruits and nuts (121). When the local rivers dried up, residents in Walgett relied on packed water donations (120). In 2011, 10% of the Indigenous disease burden was dominated by cancers, cardiovascular diseases and diabetes, where diets high in processed meat and sugar, and low in fruits, whole grains and vegetables were contributing factors (23).

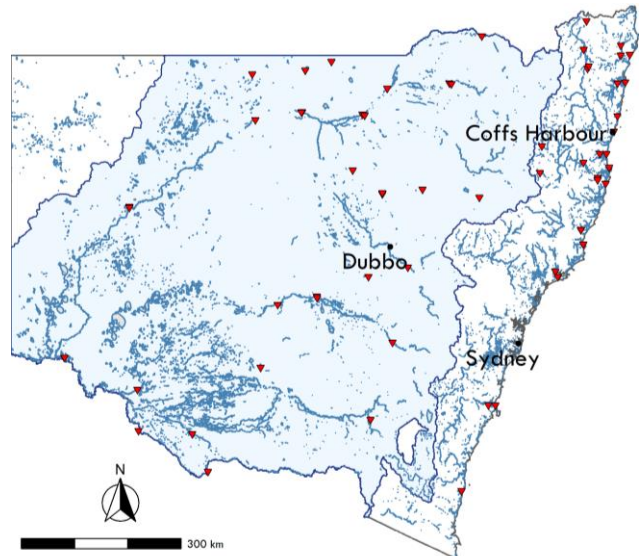
The inability to appropriately use food was also recognised in Walgett (120), where there was limited access to functional housing hardware such as stove top, bench space, sink and refrigerator that enable hygienic food preparation, cooking and storage. Altogether, food insecurity is exacerbated by the underlying social disadvantages experienced by Aboriginal peoples, including **lower income, education, employment, housing conditions and relative socio-economic disadvantage** (116)

### **Cultural loss**

Exposure to drought and food insecurity among Aboriginal peoples not only have biophysical impacts, but also cultural consequences. As described in Section 2.3, connection to Country is a protective factor for Indigenous health and wellbeing, especially for those living in remote and very remote areas.

In Australia, the Murray-Darling Basin (MDB) (see Figure 23) is home to up to 40 Indigenous Nations which makes up 15% of the total Aboriginal and Torres Strait Islander population (122). These Indigenous groups share a vision for the Basin that is a healthy, living river with natural flows and cycles (drying and flooding) that sustain communities, hunting, fishing and ceremony (122). However, the MDB also supports 45% of Australia's agricultural output, 40% of all Australian farms and provides drinking water to over 3 million people living

inside and outside of the Basin (123). It is widely acknowledged that extensive manipulation of rivers through the construction of dams and weirs and over extraction of water have resulted in the reversal of natural flow cycles (122).



**Figure 23** The Murray Darling Basin in NSW indicated in light blue. Triangle markers indicate discrete Aboriginal communities. Darker blue indicates watercourse areas and lakes. The MDB makes up 75% of NSW's landmass.

Climate change is expected to impact water availability in the MDB. In 2018, the MDB experienced the hottest year on record and was the driest that it has been since 2006 (124). Studies have projected an 11% decline of water volume by 2030 due to severe droughts and temperature increases exacerbated by climate change. The consequence on the MDB is further reduction in streamflow which will adversely affect the hydrology of the river, species survival, agribusinesses and communities on the river system. For Aboriginal land owners, these consequences are already felt as a form of contemporary dispossession of their Country (122). Climate change may already have driven the non-Aboriginal people from their farms to urban centres, leaving Aboriginal peoples bearing the brunt of the impacts of climate change whilst facing further risks of involuntary relocation (122).

In 2012, the Murray-Darling Basin Plan recommended the immediate action of recovering water back to the Basin from existing water sharing arrangements to buffer the Basin system from stress under climate change, along with provisions for traditional owners to exercise some water rights (125, 126). For Aboriginal communities, the intention of restoring the health of the river is conducive to improving health and wellbeing. However, success also predicates on the genuine recognition of Indigenous rights and interests including better access to land and water to practice caring for Country.

### **Exposure map**

Drought exposure was calculated using the Standard Precipitation Index with a six month rolling sum of rainfall between 1990 and 2019 (127). The average number of months in drought annually was compared between the years 1990 to 2005 and 2006 and 2019 and the results are illustrated in Figure 22. This revealed that Aboriginal peoples were more likely to live in areas with increased months in drought between 2006 and 2019, compared with the 1990-2005 period. Specifically, almost 20% of Aboriginal peoples (18.6%) lived in areas with greater than 0.5 additional months in drought annually, compared with 5% of non-Aboriginal peoples. Overall, 44% of Aboriginal peoples lived in areas that saw an *increase* in drought months annually, compared with 20% of non-Aboriginal peoples.

Additional months in drought, 1990-2005 vs 2006-2019

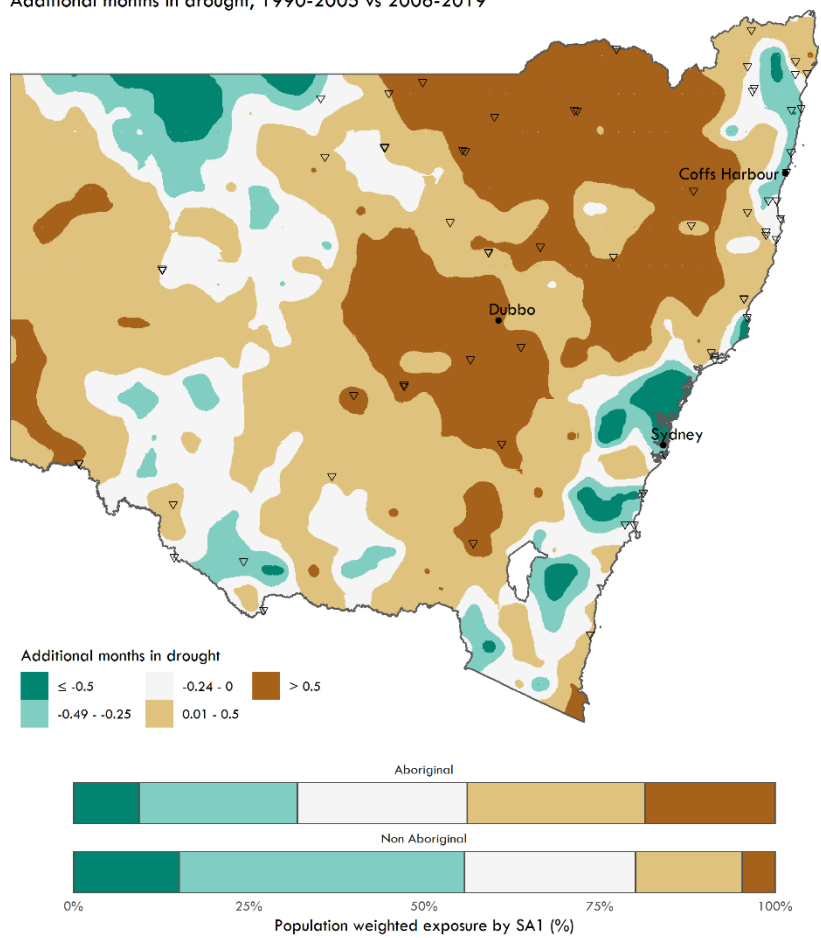
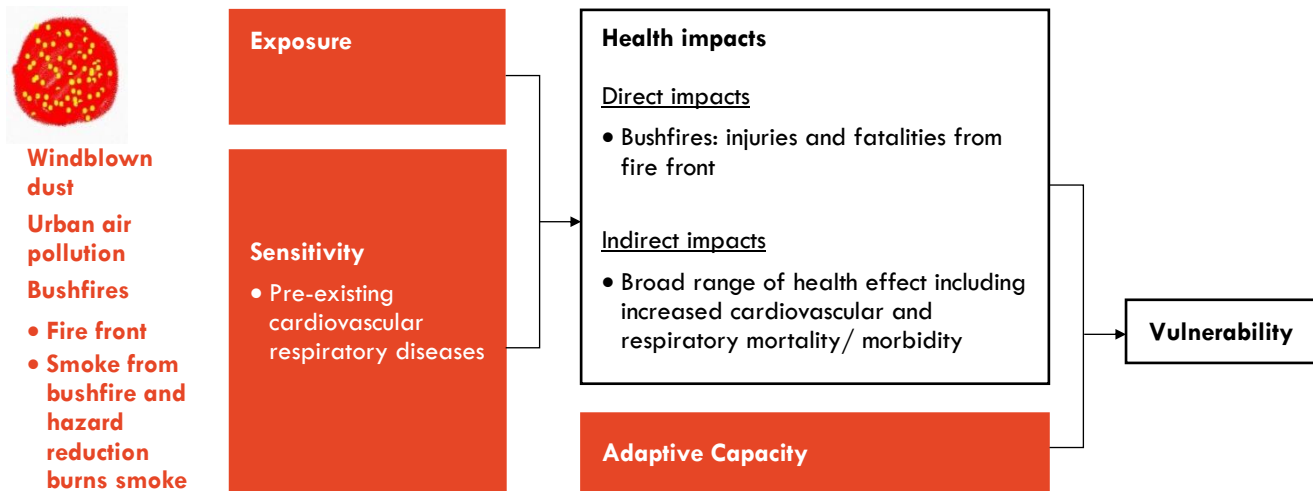


Figure 24 Current and projected maps and population exposures of drought indicators

## 2.4.4 Bushfires, air pollution and dust



**Figure 25** Vulnerability to air pollution, sensitivity factors and health impacts

### Climate Hazard

Bushfires are an inherent feature of the ecology of Australian landscapes and climate change is likely to exacerbate the trend of longer fire seasons with more extreme fire weather leading to fires that are historically unusually frequent, severe and, in some cases, economically destructive (128, 129). Air quality will also be impacted by the increasing frequency and severity of bushfires as well as fire risk management strategies such as hazard reduction fires. Windblown dust (geogenic) and the output of allergenic pollens are also expected to have an increasing impact on air quality under climate change (130). Drought conditions contribute to fire weather (i.e. confluence of extended drought conditions, low moisture vegetation as a source for fuel, strong wind and ignition source (131)) and airborne dust (108).

### **Bushfires**

Bushfires are one of the most frequent natural hazards experienced in Australia. Between 1973 and 2010, major bushfire events increased significantly in the centre, south and east of Australia including the forest regions of south-eastern Australia (132). The summer bushfires of

2019/20, unprecedented in their scale and intensity, burned 17 million hectares of land around the country (133).

The severity of fire weather is related to the confluence of extended drought conditions, low moisture content in vegetation (fuel), strong wind and ignition source (131). These parameters are tracked by the Forest Fire Danger Index (FFDI) in Australia (134). Anthropogenic climate change increased the risk of fire weather as severe as the 2019/20 bushfires by 30% (135). North-western NSW is projected to experience increases in average and severe fire weather during spring and summer in the near future (34). In recent decades, the shift towards a more severe fire regime has led to more catastrophic ‘pyrocumulus fire storms’ (132).

### **Air Quality**

Air is a complex mix of gasses and fine particulates and particulate matter in the air is a common measure of air quality. Particulate Matter (PM) include includes fine particles from sea salt, desert dust, fire smoke, as well as emissions from transport, industry and agriculture. PM concentrations vary across Australia, reflecting the various natural and



anthropogenic (human made) contributors. Domestic wood-heating is a major source of air pollution in Australia, including PM<sub>2.5</sub> (particles less than 2.5 µm). Proportionately, more households in regional areas use wood heaters than metropolitan Australia. Dust storms originating from Central Australia frequently cause high particulate pollution at many sites in NSW, both inland and along the coast(136).

The NSW government air pollution monitoring stations provide robust estimate of air pollution exposure in the Sydney greater metropolitan area, however, regional towns often have limited or no air pollution monitoring, resulting in potential misperceptions about the magnitude of air pollution and the importance of the associated health burden.

### **Health impacts**

Bushfires have both direct and indirect impacts on the health and wellbeing of individuals and communities in the short and long term. Direct health impacts can be life threatening and include burns, asphyxiation and injuries requiring long term medical treatment. Bushfires are the fourth most hazardous natural disaster in term of loss of life after heatwaves, cyclones and floods since 1844 (61), killing approximately 900 Australians (137, 138). Natural disasters, including bushfires also exacerbate chronic conditions, such as respiratory disease, cardiovascular disease and diabetes, and can have short and long-term effects on mental health and wellbeing. Experiencing disasters such as bushfires can also affect a person's mental health—even if they are not directly impacted (139).

Smoke inhalation is an indirect health impact of bushfires. Particulate Matter (PM) from fire smoke can penetrate deep into the lungs and cause respiratory and cardiovascular morbidity and mortality (140, 141). The impact of PM on health has been most extensively studied in urban settings, where PM are emitted from

various sources including vehicles and industrial processes. While air pollution in Australia is generally low by international standards smoke from bushfires and prescribed burns (a bushfire control strategy) can cause daily exceedances of PM air quality guidelines by several orders of magnitude in urban and regional areas (142).

During the 2007 NSW bushfires, PM travelled long distances to affect coastal cities, resulting in an increase in hospital admissions for asthma, Chronic Obstructive Pulmonary Disease (COPD) and ischemic heart disease (143, 144). During the 3 month-long 2019/20 summer bushfires, 28 days recorded hazardous levels of PM<sub>2.5</sub> in Sydney. Bushfire PM<sub>2.5</sub> was estimated to have contributed to excess deaths (219 cases), asthma presentations (1305) and cardiovascular (577) and respiratory (1015) hospitalisations in NSW (145).

### **Sensitivities**

#### ***Age and underlying health conditions***

Older adults with underlying cardiovascular and respiratory illnesses are particularly sensitive to PM-related health effects (146). Studies from Darwin showed that Aboriginal peoples maybe more susceptible to bushfire PM than non-Aboriginal peoples, where respiratory hospital admissions in the fire seasons of 1996 – 2005 were greater for Aboriginal than non-Aboriginal population (147, 148).

In NSW, 7% or 5 million hectares of land on the eastern seaboard were burnt during the summer bushfires of 2019/20(149). Of the total Aboriginal population living in NSW and VIC, greater than 25% lived in fire-affected areas, of which 36% were Aboriginal children aged less than 15 (150). This is of concern, as children tend to receive higher doses of PM per body weight are particularly sensitive to PM-related health effects (146).

People with pre-existing respiratory conditions

like asthma, chronic obstructive airways disease (COAD) or emphysema can experience worsening symptoms due short term increases in dust concentration. Long term exposure to high concentrations of dust can reduce lung function in and exacerbate disorders like chronic bronchitis and heart and lung conditions.

As described in Section 2.4.1, Aboriginal peoples have higher rates of cardiovascular and respiratory mortality and morbidity. Air pollution increases related to climate change may amplify these existing health disparities experienced by Aboriginal peoples.

### **Exposure maps**

Bushfire vulnerability was estimated using the McArthur Forest Fire Danger Index (FFDI), a composite measure of the area's drought factor, daily maximum temperature, daily afternoon humidity and windspeed (134). Higher values of FFDI indicate a higher likelihood of fires starting and spreading, with values between 25 and 49 indicating very high danger, and values of 50 or over indicating severe fire danger. Notably, the FFDI measures the degree to which a fire may be suppressed once started and relates more to the likelihood of property damage as opposed to damage to forest or vegetation. Thus, values are calculated for areas irrespective of vegetation density.

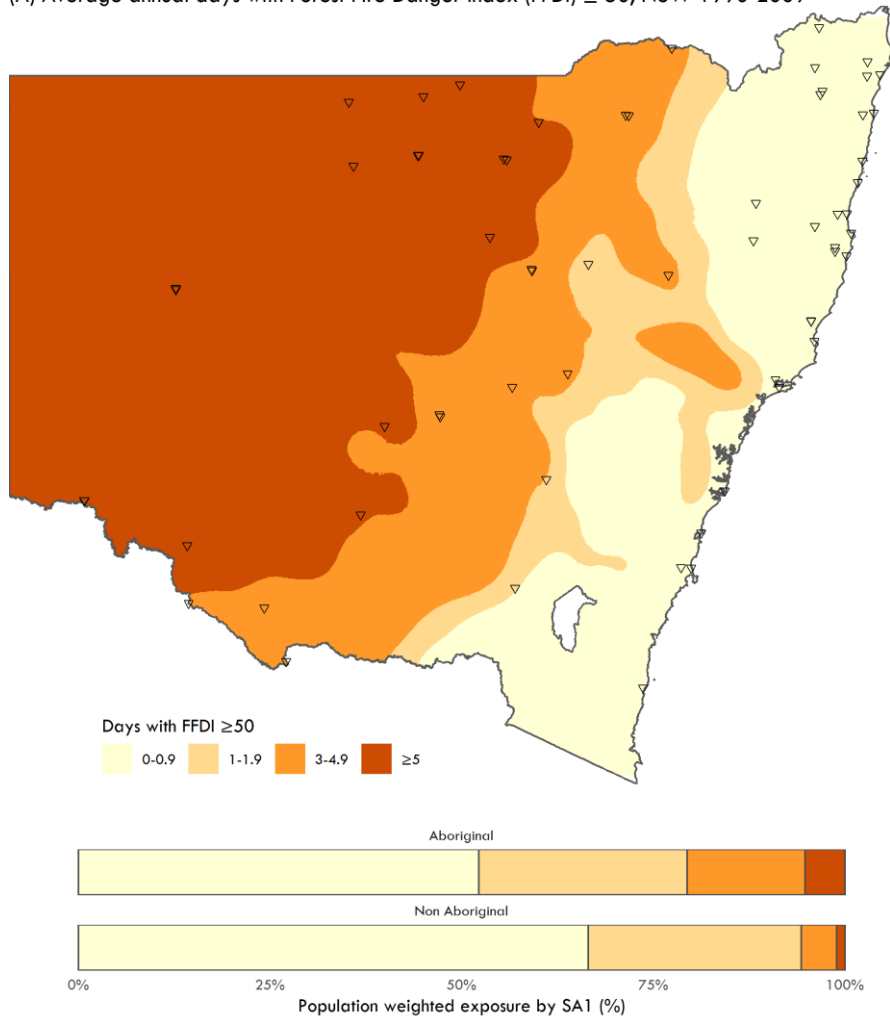
From Figure 24A, we can see that Aboriginal peoples disproportionately live in areas with a higher average number of days with an FFDI exceeding 50. Specifically, almost half (48%) of Aboriginal peoples live in areas at least one day exceeding 50 per year, and 5% live in areas with five or greater days per year with an FFDI exceeding 50. Comparatively, 33% of non-Aboriginal peoples in areas with one or more days exceeding 50 on the FFDI, and only 1% of non-Aboriginal people live in areas with five or greater days exceeding 50 on the FFDI.

In the near-future, 2020-2039, areas with the highest projections for additional annual days exceeding 50 on the FFDI also have higher proportions of Aboriginal peoples living in them, as can be seen in Figure 24B. Specifically, 22% of Aboriginal peoples live in areas with 0.25 or greater additional days per year projected above 50 on the FFDI, compared with 7% of non-Aboriginal people. Additionally, 2% of Aboriginal peoples live in areas with one or more additional projected annual days exceeding 50 on the FFDI, compared with 0.4% of non-Aboriginal people.

Figure 25 shows that Aboriginal peoples were more likely to live in areas with lower PM<sub>2.5</sub> concentrations, indicating cleaner air. Specifically, 31% of Aboriginal peoples lived in SA1s with a PM<sub>2.5</sub> concentration greater than 6 µg/m<sup>3</sup>, compared with 57% of non-Aboriginal peoples. This is due to greater proportions of Aboriginal peoples living outside of cities. Nonetheless, higher rates of underlying health conditions as well as increased sensitivity in Aboriginal peoples suggests that Aboriginal are disproportionately vulnerable to the adverse effects of bushfire smoke.

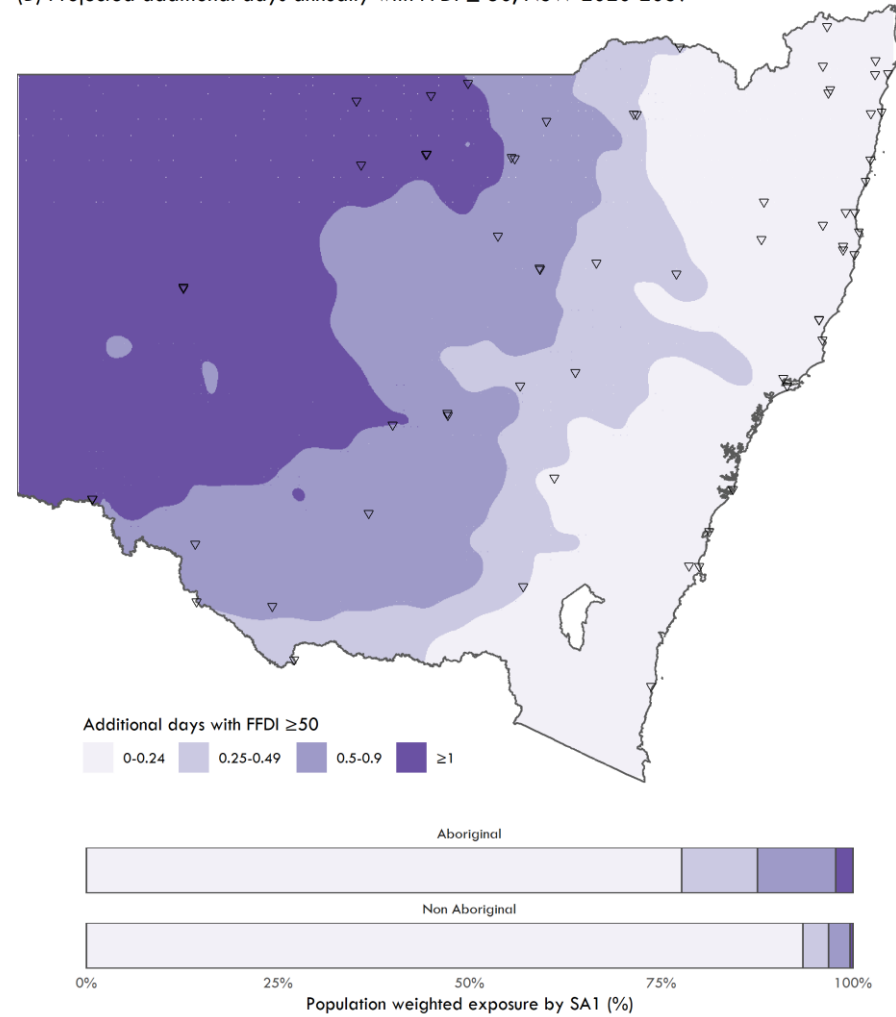
Recent Past

(A) Average annual days with Forest Fire Danger Index (FFDI)  $\geq 50$ , NSW 1990-2009



Projected

(B) Projected additional days annually with FFDI  $\geq 50$ , NSW 2020-2039



**Figure 26** Forest Fire Danger Index for NSW for current period (1990-2009) and near-future projections (2020-2039)

Annual average surface PM2.5 concentration

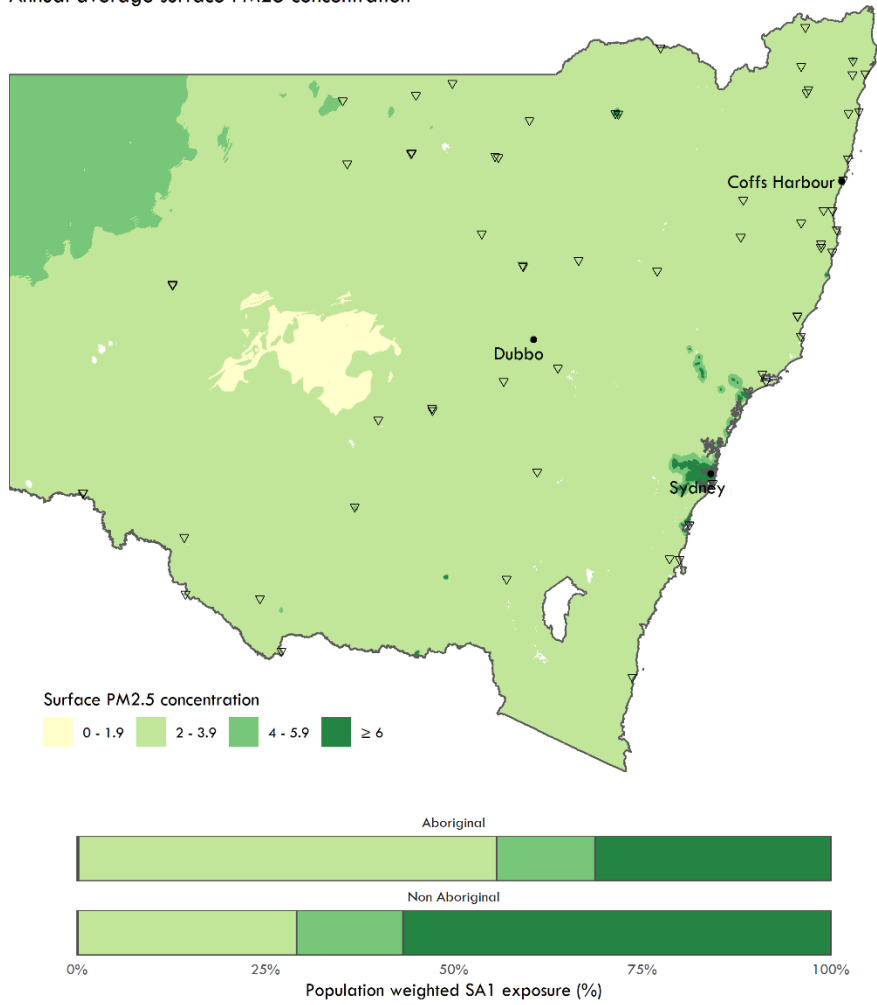


Figure 27 Current population exposures to PM<sub>2.5</sub>

## 2.5 Case study of northwestern NSW

To illustrate the specific exposures of Aboriginal peoples in NSW, particularly those who reside in rural areas, an illustrative case study was prepared. The central north-western area of NSW including the Bourke-Cobar-Coonamble and Dubbo SA3s and the Nyngan-Warren and Walgett-Lightning Ridge SA2s, was chosen for analysis. This area contains 14 discrete Aboriginal communities as well as a substantial proportion of Aboriginal peoples living in non-discrete communities. In total, Aboriginal peoples comprise over 18% of the total population residing across this central north-western region. While this area accounts for around 1.3% of Australia's total population, around 7.8% of Aboriginal peoples in NSW reside across the region. Sociodemographic indicators are outlined in Figure 28.

SA1s with higher proportions of Aboriginal peoples tend to have higher social disadvantage (category 1 is the lowest SES category), with many of these SA1s in the most disadvantaged quintile (Figure 28C). In addition, the SA2 of Bourke, which contains one of the highest numbers of Aboriginal peoples across NSW (see

Figure 6) also contains a relatively high number of overcrowded houses, with approximately 8 dwellings per 1,000 requiring three or more additional bedrooms to adequately house all usual residents (Figure 28D).

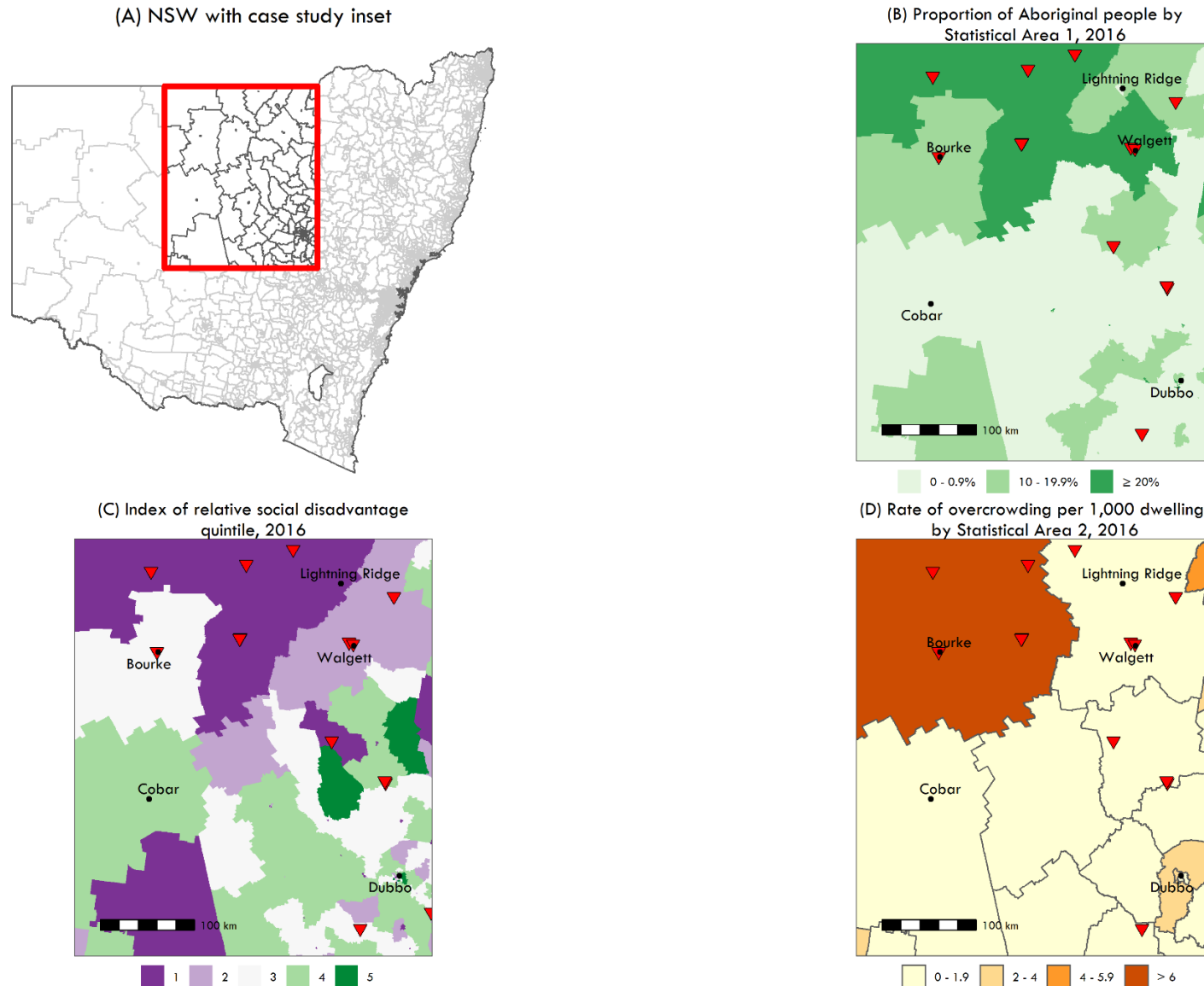
Across the selected region all areas have at least 30 days over 35°C annually, on average, with some areas experiencing greater than 90 days per year over 35°C (Figure 29A). Similarly, heat wave duration is much longer than in other areas of the state, with heat waves lasting a *minimum* of six days, with some areas experiencing heat waves of

eight days in length on average (Figure 29B). In addition, almost all of the region is projected to receive at least ten additional days over 35°C annually between 2020 and 2039, with fourteen or more additional days projected in some areas (Figure 29C).

This is also a particularly dry area, with the vast majority of the region experiencing less than 500mm of rain per year (Figure 29D), and around half the area experiencing moderate to high rainfall variability (Figure 29E). Rainfall is projected to increase in many areas (Figure 29F), suggesting potential flood risk to Aboriginal communities living in this region, many of whom are reliant upon the Murray-Darling basin as an ongoing source of water and food. Changes to this water source are likely to disrupt the already limited access of Aboriginal peoples to traditional land and rivers for food-gathering, hunting and cultural practices.

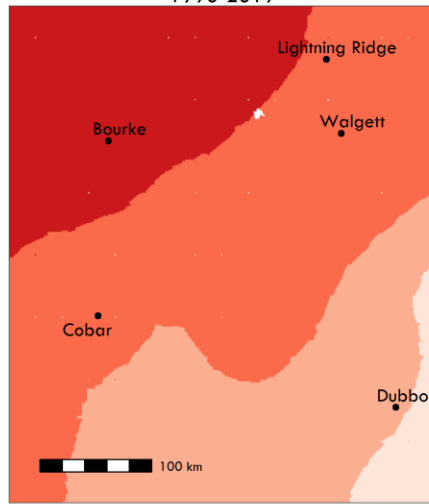
Any adverse effects of climate change on this region of the Murray-Darling basin, and more broadly, are likely to be disproportionately borne by Aboriginal peoples residing in areas who rely on these water sources. Such effects will exacerbate already limited food security, and related physical and mental health conditions discussed above. This has been explored above in relation to the Walgett Shire, and issues are likely to be exacerbated across the entire region. While access and proactive engagement with Aboriginal communities are central focus points of the Western NSW Local Health District's Aboriginal health strategy for 2018-2023 (151), increases in extreme weather conditions are likely to impact healthcare access to these areas. The increased disruptions to physical access to health services in these regions due to climate change must therefore be considered alongside the increased demand

for health services these changes are likely to bring.



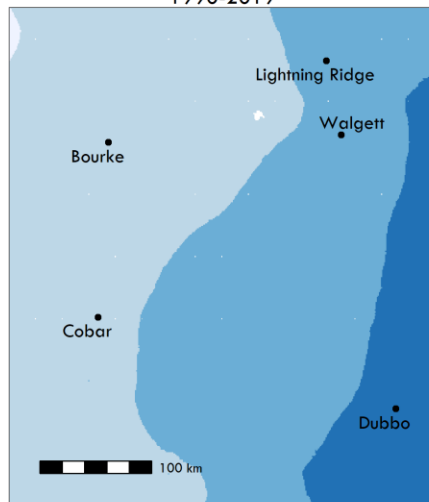
**Figure 28** Illustrative case study of central north-western remote NSW with sociodemographic exposure indicators visualised. Points in Panels B, C and D indicate discrete Aboriginal communities. NB: Overcrowding is operationalised as dwellings which require three or more additional bedrooms to adequately house the people usually residing there; Panel C, category 1 is the lowest SES category.

(A) Average number of days over 35°C annually, 1990-2019



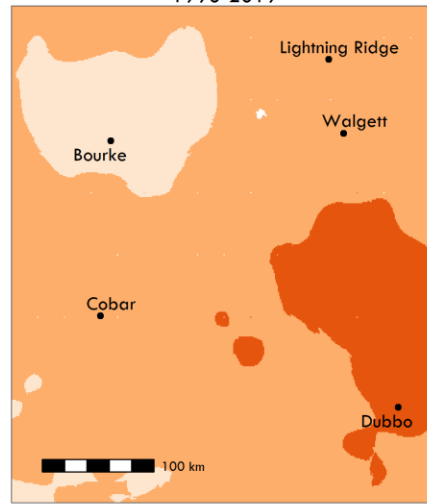
< 25   30 - 49.9   50 - 69.9   70 - 89.9

(D) Average annual rainfall (mm), 1990-2019



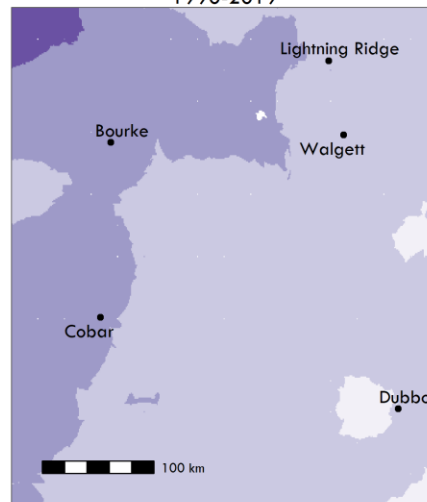
200 - 299   300 - 399   400 - 499   ≥ 500

(B) Average heat wave duration (days), 1990-2019



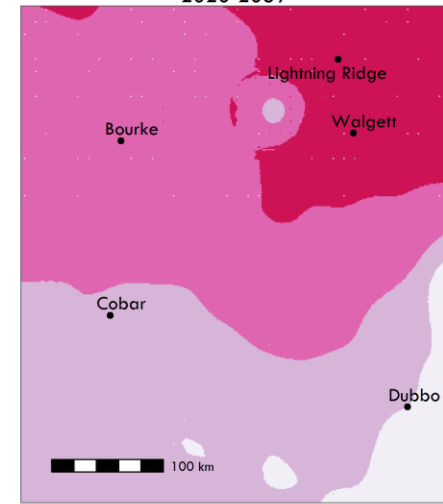
6   7   8

(E) Annual rainfall variability, 1990-2019



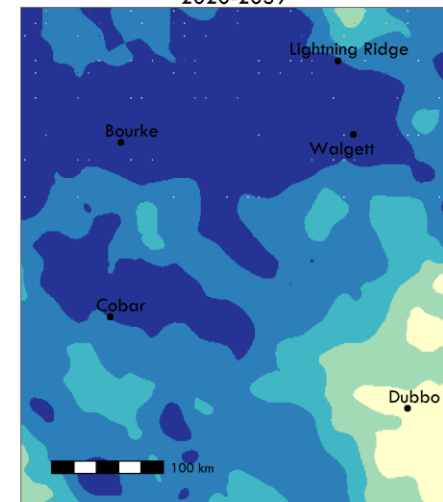
Low to moderate   Moderate   Moderate to high   High

(C) Projected additional days over 35°C annually, 2020-2039



< 10   10 - 11.9   12 - 13.9   ≥ 14

(F) Projected change in annual rainfall (%), 2020-2039



< -1%   -1% - 0%   0% - 0.9%   1% - 1.9%   ≥ 2%

**Figure 29** Illustrative case study of central north-western remote NSW with environmental exposure indicators visualised



## 3.0 Stakeholder consultations summary of findings

Our stakeholder consultation process was restricted due to COVID-19 disruptions with a reduced range of consultations conducted primarily via phone and online meetings and workshops. The aims of the consultation were to obtain a broader range of input on:

- the environmental, economic, social and cultural impacts of climate on health and wellbeing of Aboriginal peoples;
- climate and health adaptation responses including those based on Indigenous knowledge;
- priorities for future work on climate and Aboriginal health.

The consultations occurred in two parts and focussed on targeted agencies / groups with a formal role in Aboriginal Health. The first part of the consultation was a series of targeted key informant interviews conducted during May and June 2020. The second part of the consultation process was a two-hour online workshop conducted on 28 October 2020 to obtain further stakeholder input and discuss the main finding of the draft project report.

Officers from the following agencies participated in the consultation process:

- NSW Health - Environmental Health Branch
- NSW Health - Centre for Aboriginal Health
- NSW Aboriginal Affairs
- Aboriginal Health and Medical Research Council (AH&MRC) of NSW
- NSW Rural Doctors Network
- Indigenous Allied Health Australia

The findings from the informant interviews and the online workshop are summarised in the following sections. The main climate and Aboriginal health hazards highlighted by stakeholders include heat, water, extreme weather events and food insecurity.

While the focus of the discussions was on climate and health risks and adaption actions and opportunities, there was also discussion of climate mitigation opportunities and Aboriginal communities as the two issues of adaption and mitigation are closely linked. For example, the announcement of a hydro energy generation plan for west Kempsey where the local Aboriginal community is working with state Government development of this renewable energy options. (See <https://www.abc.net.au/news/2020-10-12/new-hydro-power-project-to-be-fast-tracked-in-northern-nsw/12753306> )

The consultation noted the Adapt NSW Integrated Regional Vulnerability Assessments (IRVA) conducted by NSW DPIE to identify potential threats and response options to support community to prepare for climate change. The process used local knowledge to identify potential threats and response options to help communities prepare for climate change. Background climate change, socio-economic and sector information was compiled, and sector focused workshops conducted to assess the specific effects of climate change on regional systems, and the capacity to adapt. (132) These regional assessments are available from Adapt NSW web site via the following link:

<https://climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Regional-vulnerability-and-assessment>.

For example, the North Coast report identifies pilot projects on “transition pathways” for resilient communities. One of the pilot projects was *Sharing knowledge: Aboriginal and Torres Strait Islander communities - Co-design with Aboriginal and Torres Strait Islander communities to share knowledge around climate change and community resilience*. The project report also identified a need to further involve Aboriginal communities in co-design, partnerships and knowledge exchange for decision-making processes, such as through the OCHRE Plan (NSW Aboriginal Affairs). These Adapt NSW regional vulnerability assessment reports will be useful resource materials for the proposed second stage of this Aboriginal Health and Climate project that focusses on the development and implementation of Aboriginal Health focussed climate adaptation responses.

A recent assessment of five Indigenous Protected Areas (IPAs) in regional and remote Australia demonstrate the social and cultural co-benefits of Indigenous land management initiatives was also noted. (see <https://www.socialventures.com.au/sva-quarterly/healthy-country-healthy-people/>) The Minyurni IPA project supported Bandjalang people’s re-engagement with culture and language through country. Bandjalang Traditional Owners land and fire management work saw the restoration of native plants and animals previously considered lost (152).

### 3.1 Heat and Aboriginal health

Aboriginal populations have higher rates of hospitalisation overall, including for heat sensitive conditions compared to non-Aboriginal populations. Increasing climate change related trends in higher temperatures will further exacerbate this gap for hospital admissions, including Emergency Departments presentations, and place additional pressure on front line services including Aboriginal Medical Services. It was noted that in many locations, particularly in Western NSW, the frequency of extreme heat events – heatwaves - is increasing and the utility of defining a heatwave in these locations compared to the more usual and frequent extremely high temperatures seems unclear. (heatwaves are covered in the Extreme Weather Events / Emergency Management section below)

Much of the discussions around the impacts of heat on Aboriginal health focused on housing-related issues. For example:

- It was noted that some Aboriginal housing organisations provide heating and cooling while others did not.
- The importance of air conditioning to cool houses was highlighted. The NSW Aboriginal Land Council Housing Limited (NHL) was established in 2019 (<https://nswalhousing.org.au/>) and it may be possible to work with these groups along with NSW social housing providers such as the NSW Aboriginal Housing Office to define appropriate housing standards for cooling and heating of homes. It is not clear what currently policies are applicable or implanted in relation to this issue.
- It was also recognised that increased use of air conditioning in homes could further stretch limited resources of tenants to cover the additional costs of increased usage. Examples of Aboriginal specific messaging and support services were identified that could be further

developed, e.g. <https://www.dhhs.vic.gov.au/covid-19-aboriginal-energy-affordability-doc>

- The potential for the installation of solar panels on houses to offset the costs of increased air conditioning use was discussed, including work by the NSW Aboriginal Housing Office (see: <https://www.aho.nsw.gov.au/read-our-story/our-executive-team>).
- The health impacts of power outages during heatwaves was also noted, including indirect health risks such as compromised medication cool storage, particularly in rural and remote communities.
- The continuing need for housing agencies to build collaborations with Aboriginal peoples around providing housing that is fit for purpose was highlighted. NSW Health has taken a lead in this for more than 20 year and consideration should be given to NSW Health taking a lead role in advocacy and research on this issue (153).

The social impacts of extreme heat were also discussed, including concerns around increased crime/ violence during these periods.

## 3.2 Water and Aboriginal health

The centrality of water to the cultural, social and spiritual identify of Aboriginal peoples which in turn links to the holistic and whole-of-life view of Aboriginal health was highlighted. ‘Cultural flows’ have been defined as water entitlements owned and managed by Aboriginal peoples to improve their spiritual, cultural, environmental, social and economic conditions. The importance of access to water in lakes and rivers for cultural, social, and spiritual purposes to support the health and wellbeing of both individuals and communities was highlighted in our consultation. Aboriginal peoples have reported feeling ‘desperate’ when the land is very dry and a general feeling of disconnectedness (e.g. no fishing means not only less food, but also no social outing and no physical activity). Access to water for irrigation, environmental flows and cultural flows is contested. While cultural flows have not yet been granted for the Murray–Darling Basin river system a national framework for cultural flows was released in 2018 (4).

Concerns were raised about current water and sewerage infrastructure in NSW Aboriginal communities, as well as in regional NSW more broadly. Climate change will place increased pressure on safe drinking water supply due to likely reduced raw water access that will affect some regions. These concerns included:

- Local water utilities (mostly Local Government) have responsibility for supplying safe drinking water in rural areas. Ageing water treatment infrastructure combined with limited financial resources of some local councils raises concerns about their capacity to maintain and improves these services to required standards, and this task is likely to become more complex under climate change.
- Reduced raw water availability will put additional pressures on already stretched water treatment systems and personnel
- Higher temperatures and reduced water flows leads to increased algal blooms and affected water may not be suitable for drinking, recreation and agricultural use. These issues are likely to increase under climate change in some NSW regions.
- The extensive damage to natural landscapes caused by bushfires can results in increase

runoff and nutrient loads affecting river catchments and drinking water quality. Another example of water-ways pollution due to bushfires was the suspension of oyster farm harvesting in the NSW South coast in January 2020, see

<https://www.goodfood.com.au/eat-out/news/south-coast-oyster-harvests-suspended-due-to-bushfires-20200110-h1kyk0>

- Concerns were raised about potential drinking water quality issues from supplementary water sources that can have unintended health consequences such as rainwater tanks (e.g. ongoing maintenance to ensure drinking water quality) and roof top solar water distillation (e.g. lack of fluoridation).
- It was also noted that bore water can sometimes be used as a supplementary water source that can be unpalatable and result in increased use of unhealthy substitutes such as soft drinks. A scheme aimed at improving oral health and reducing obesity in Aboriginal and Torres Strait Islander communities was highlighted in discussions. The program provided a dedicated oral health aide, teeth brushing program and filtered chilled water fountains in schools and public parks targeting several communities across the state.

It was noted that NSW Health supports programs around safe drinking water in regional NSW, and the NSW Aboriginal communities water and sewerage program (99). NSW Health acknowledges the importance of supporting regional utilities to provide safe drinking water, especially those with limited engineering expertise and financial capacity. A recent paper by authors from NSW Health acknowledged that continued engagement and support will be necessary to ensure implementation of such programs by all utilities, private suppliers and water carters (154).

The role of climate change in food insecurity was discussed including:

- Unusual seasonal changes linked to climate change have been observed among Aboriginal communities. For example, gathering time of emu eggs in Walgett has changed
- The potential important role of primary health care providers as health educators was discussed. For example, Aboriginal Medical Services could have an important role in programs to promote increased fruit and vegetable intake by Aboriginal populations.
- The lack of affordability of nutritious food in some rural and remote communities was also highlighted, see <https://www.croakey.org/the-cost-of-eating-well-in-australias-remote-indigenous-communities/>

### 3.3 Extreme weather events / Emergency management (heatwaves, floods, bushfires)

There was discussion around the newly established lead disaster management agency for NSW - Resilience NSW. The NSW State Emergency Management Plan (EMPLAN) outlines agreed roles and responsibilities of NSW agencies have responsibilities and functions in disaster response and recovery. It was highlighted that emergency management plans relating to climate hazards need to provide detail on how local Aboriginal health is supported in culturally appropriate ways, with input from local Aboriginal peoples.

The recent catastrophic bushfires during the summer of 2019/20 were discussed by several participants and a wide range of fire related issues were raised including:

- The opportunity for traditional Aboriginal burning practices to be implemented for improved fire management, as well as building Aboriginal culture and employment. For example, Aboriginal peoples' involvement with local rural fire service to develop traditional burning practices and building community resilience. See: [https://www.youtube.com/watch?v=RM72NtXyLs&feature=emb\\_title](https://www.youtube.com/watch?v=RM72NtXyLs&feature=emb_title)
- Examples were also provided of Aboriginal fire management practices being developed as greenhouse gas emissions abatement programs. See: <https://nailsma.org.au/programs/economic-development-and-employment/carbon-fire-management>
- Bushfires increasing food insecurity among Aboriginal peoples as wildlife and plant as well as supporting ecosystems are destroyed and damaged by fires.
- Concerns were also raised that bushfire evacuation plans did not sufficiently support the needs of Aboriginal groups. There were reports of racism being experienced by Aboriginal peoples seeking refuge at bushfire evacuation centres during the bushfire response in early 2020. There was limited access to medications, food and essential medical treatments such as, dialysis. Protective eye equipment requested by Elders during the 2020 fires not being available as the it did not meet emergency management funding criteria.
- The possibility of collaborations with the AH&MRC around Aboriginal health and emergency management was discussed. For example: the partnership between GSK, AH&MRC and NSW Health to distribute Ventolin to bushfire smoke affected Aboriginal communities during the 2020 bushfires (see <https://www.ahmrc.org.au/partnership-between-gsk-ahmrc-nsw-health-ventolin-distribution-bushfire-smoke/>)

The drought conditions that contribute to increased bushfire risk also have a range of indirect impact on Aboriginal health and well-being via indirect economic impacts. The high proportion of Aboriginal peoples engaged in seasonal labouring work (e.g agricultural and livestock farming) was discussed with the drought severely affecting this casual workforce in regional and remote areas (155).

While the effects of dust storms and fire smoke on physical health, particularly for those with pre-existing chronic conditions are well accepted, concerns were expressed about the unrecognised mental health impacts from the recent dust storms/fire smoke pollution, potentially due to people feeling trapped in their houses.

It was also highlighted that many Aboriginal communities are located close to rivers and so are extremely susceptible to floods. For example, the Aboriginal community of Cabbage Tree Island on the North Coast of NSW was evacuated during floods in 2008 [<https://www.abc.net.au/news/2008-01-07/ses-evacuates-cabbage-tree-island-residents/1004410>]. Improved health messaging and preparedness for these communities was discussed, and a Queensland government example of health messaging provided (see [https://www.qld.gov.au/data/assets/pdf\\_file/0027/54882/flood-atsi.pdf](https://www.qld.gov.au/data/assets/pdf_file/0027/54882/flood-atsi.pdf))

### 3.4 Climate and Aboriginal health adaptation capacity building

The importance of improved capacity building including education programs around climate and health risks and opportunities for adaption was a general theme throughout the consultation process. This education and capacity building was required not only within the health sector but

also in other sectors not directly involved in health services or public health, such as public housing providers. The importance of staff training in Aboriginal cultural competency was also highlighted. Aboriginal organisations also need to build capacity around the broad range of climate and health risks faced by local communities, and mechanisms to address these issues.

Specific examples of this capacity building included:

- Building an understanding of the eco-social and cultural determinants of Aboriginal health and the role of agencies not directly involved in health services delivery and public health
- Developing communication, education and training initiatives that inform and build capacity across the health and wellbeing workforce, policymakers and the wider community.
- Improved messaging around the impacts of climate on Aboriginal health
- Front line health staff including primary health care – one option may be to incorporate Aboriginal health and climate issues into Aboriginal cultural training across NSW Health

## 4.0 Discussion & Recommendations

The mean surface air temperature of Australia has warmed by 1°C since 1910, leading to the increased frequency and severity of heatwaves, fire weather and drought conditions (11). Rainfall has declined by 11% during the winter months in southeast Australia since the late 1990s, contributing to streamflow reduction and long-term climatic conditions such as the Millennium drought. In NSW the maximum and minimum temperatures in the near future (2020-39) and far future (2060-79) are estimated to increase by 0.7°C and 2.1°C respectively (27). In the near future the number of hot days per year above 35°C will increase in inland NSW, with north-western NSW projected to experience 40 extra hot days (currently 60 days) in spring and summer. Heatwave events will also increase in frequency and duration across NSW (28). Extreme heat can change the probability of occurrence of other extreme events such as fire weather, which is expected to increase, especially in western NSW in spring and summer (27). Spring rainfall is projected to decrease in south-western NSW and increase along the north coast; whilst autumn rainfall is projected to increase across NSW in the near and far future (27).

This report demonstrates how NSW Aboriginal populations are more exposed to a range of climate hazards compared to the non-Aboriginal population, including longer heatwave duration, more rainfall variation and increased months in drought conditions. This disparity in exposure to climate hazards is generally predicted to increase due to climate change. The report also identifies a wide range of climate-sensitive health risks and ecological and socioeconomic determinants of health that exacerbate the impacts of climate related hazards on Aboriginal health. These health impacts can occur through direct exposure pathways caused by extreme weather events including heatwaves, floods and bushfires, as well as indirect exposure pathways mediated by altered environmental or ecological systems including water, air, disease vectors and food yields. This report describes climate vulnerability as a function of **exposure** to climate-related risks, **sensitivity** to those health risks and, **capacity to adapt** to existing or potential climate-related risks. While mitigation is recognized as an essential component of effective adaptation this report focusses on climate change adaptation. Further development of this work should include a combined focus on mutually reinforcing mitigation and adaptation actions to reduce the burden of Aboriginal ill health, boost community resilience, and lessen poverty and inequity.

There is an increasing realisation that reducing the Indigenous health gap compared to non-Indigenous Australians requires an understanding of the Indigenous concept of health (2). Aboriginal and Torres Strait Islander peoples embrace a holistic, ecologically focused approach to health that includes environmental stewardship, cultural identity, oral history and spirituality (10, 47). These key interconnected cultural determinants have recently been identified as *connection to Country; family, kinship and community; Indigenous beliefs and knowledge; cultural expression and continuity; Indigenous language; and self-determination and leadership* (2).

The extent to which Aboriginal peoples will experience climate-sensitive health risks in the future will depend on the effectiveness of adaptation responses of today. Given that climate change is a risk multiplier of existing Aboriginal health burdens, adaptation responses to reduce climate and health risks should further support and enhance existing health policies, measures and programs.

Where applicable, adaptation responses should build on health promoting actions already underway and be informed by Aboriginal knowledge. The large proportion of the total Aboriginal population living in urban or peri-urban environments share similar vulnerabilities as those living in rural and remote areas (e.g. high rates of chronic disease, overcrowding). The context for adaptation can vary regionally throughout NSW and also between urban and regional Aboriginal populations and responses should be locally relevant and culturally appropriate to all Aboriginal peoples.

This report mapped selected climate related hazards to highlight the associated risk to Aboriginal health and inform adaption responses. This exposure mapping should be further developed to include a broader assessment of the risks of climate change on Aboriginal health and wellbeing, including the health and wellbeing impacts and benefits of climate adaption responses. Climate adaptation responses need to be guided by robust research, surveillance and evaluation including a focus on building the capacity of Aboriginal communities and organisations via participatory-based research defined in collaboration with Aboriginal stakeholders. Our report highlights the need to engage with Aboriginal health stakeholders to develop Aboriginal led climate adaptation responses. Our stakeholder engagement highlighted the need to develop communication, education and training initiatives to build capacity around the impacts of climate change on Aboriginal health within the health sector, government agencies and the broader community.

The *NSW Climate Change Policy Framework* (156) makes provisions for the health sector under the policy direction 'to reduce climate change impacts on health and wellbeing'. The aim is to improve community resilience by anticipating their increased need for health and emergency services in the face of climate change, and supporting communities that are more vulnerable to climate-related health risks (156). The *Framework* aims to embed climate change mitigation and adaptation considerations across government operation and co-ordinate cross-agency interactions. This framework needs to facilitate Aboriginal led innovations and resilient responses to manage climate risks to Aboriginal health and wellbeing. These responses will require all levels of government and stakeholders to work collaboratively, harness opportunities to protect the health and wellbeing of present and future Aboriginal generations, and realise economic, social and cultural co-benefits through climate change adaptation and mitigation action.

The *NSW State Health Plan Towards 2021* (46) aligns existing policies, plans and programs, including the *NSW Aboriginal Health Plan 2013-2023* (157) that aims to close the health gap between Aboriginal and non-Aboriginal peoples (44). The *NSW Aboriginal Health Plan* was developed by the NSW Ministry of Health (MoH) in partnership with the Aboriginal Health and Medical Research Council of NSW (AH&MRC) and focuses on changing the health system to meet the needs of Aboriginal peoples in a culturally competent way. At the local level, the AH&MRC works with Aboriginal Community Controlled Health Services (ACCHSs) and Local Health Districts (LDHs) to facilitate a coordinated approach to local actions.

The recently developed health and wellbeing climate adaption strategy for the Queensland government identified principles to underpin climate and health adaption measures including (8): avoiding and managing risk; collaboration with and engagement of all affected stakeholders; responses must be equitable, evidence-based, inclusive and responsive to change; responses must recognise social vulnerability and build on existing strengths to increase resilience. Social vulnerability in this context means society's ability and capacity to prepare for, cope with and



recover from events or impacts related to climate change. It differs between individuals, communities and varies spatially and in time. The Queensland strategy also defines priority climate adaptation and health measures (8) including: capacity building; research, data and evaluation; education and communication; and policy, regulation and legislation.

### ***Aboriginal-led climate and health adaptation responses***

Aboriginal cultures have existed for more than 50,000 years and have developed a strong spiritual relationship with the climate and the land (27). The Aboriginal peoples have been adapting to a gradually changing natural environment prior to European colonisation, including the melting of continental icesheets 15,000 years ago (158). A wealth of local environmental and ecological knowledge still exists within the communities that are informing cultural practices (29). Given that Aboriginal and Torres Strait Islander cultures integrate the relationship between natural and human systems as a concept of health whereby any imbalance confers poor health (48), climate change will pose significant health risks.

### ***Health is everyone's business***

The following recommendations are based on our literature review, consultation and climate hazard exposure mapping and primarily identify directions for further work. For some of the recommendations we provide specific examples of actions that may result from further Aboriginal health and climate adaptation work. While our recommendations focus on health specific adaptation responses, many of these responses will require a whole of NSW government approach that includes a broad range of agencies, including NSW Health and the Aboriginal community health sector.

**Recommendation 1:** All NSW state government agencies identify their roles and responsibilities in supporting the health and wellbeing of Aboriginal peoples and include this explicitly in strategic planning and policy. This includes, but is not limited to, minimising the direct and indirect impacts of climate on health.

### ***Future research***

**Recommendation 2:** NSW Health and NSW DPIE facilitate consultation with Aboriginal stakeholders to determine local priorities for participatory-based research in collaboration with Aboriginal stakeholders to understand the impacts of climate on Aboriginal health and inform adaptation responses. This work should focus on urban as well as rural and remote settings and identify research areas that are sufficiently developed for priority translation into adaptation responses.

### ***Development and implementation of adaptation responses***

**Recommendation 3:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders facilitate consultation with Aboriginal stakeholders to incorporate Aboriginal knowledge on climate and health into the development and implementation of Aboriginal led adaptation responses in urban and regional NSW.

### **Extreme weather events and emergency responses (e.g. heatwaves, floods and bushfires)**

Adaptation responses to extreme weather events aim to reduce the exposure and/or sensitivities of Aboriginal populations to heatwaves, flooding and bushfire events. Aboriginal peoples experience higher rates of preventable hospitalisations for chronic (e.g. diabetes, cardiac and mental health conditions) and acute conditions (e.g. heat stroke) compared to non-Aboriginal people, and climate change will exacerbate climate-sensitive health conditions and the demand for primary health services.

Resilience NSW is the lead disaster management agency for NSW, responsible for overseeing emergency management policy, co-ordinating disaster recovery and building community resilience (159). The NSW State Emergency Management Plan (EMPLAN) provides strategic overview of emergency, supported by a number of Sub Plans (160). These plans set out the emergency management aspects of prevention, preparation, response, and initial recovery arrangements of the respective hazards. These plans identify vulnerable subpopulations such as older adults, the young, those with chronic illnesses and mental health conditions, and those residing in isolated areas or fire/flood prone areas as requiring special attention.

**Recommendation 4:** Emergency management planning in NSW prioritise Aboriginal stakeholder consultation and representation in decision-making processes in all aspects of emergency management of climate related hazards including prevention, preparation, response and recovery arrangements, to address the needs of Aboriginal health in a culturally appropriate manner.

Addressing this recommendation will require consideration the holistic view of Aboriginal health including Aboriginal traditional knowledge. Caring for Country is a source of positive strength that promotes good health and wellbeing for Aboriginal people

This recommendation includes issues such as:

- Culturally appropriate evacuation and communication procedures including establishment and management of evacuation centres
- Messaging around climate related health risks (e.g. heatwaves, floods, bushfires) be developed in consultation with Aboriginal stakeholders and communicated in culturally appropriate ways.
- NSW Health, together with Aboriginal primary health care providers and specialty networks address potential gaps in healthcare access (e.g. treatment for cardiovascular disease, respiratory disease, diabetes management, renal disease in remote areas) due to climate hazard disruptions.

### **Housing**

Inadequate housing is a key contributor to the health gap between Aboriginal and Torres Strait Islander and non-Indigenous population and is an indicator of social disadvantage (48).

Aboriginal housing in NSW frequently lacks adequate passive and active thermal regulation, which puts older adults, the young people and those with underlying conditions more at risk from extreme temperature events. Cultural factors and extended family networks influence the way Aboriginal peoples occupy their households and may play a role in the increased rates of overcrowding seen in housing in Aboriginal communities in some areas (71), but socio-economic disadvantage and a lack of adequate housing in many locations contributes to higher rates of overcrowding. A 2014

study in NSW found significantly more Aboriginal peoples (14%) lived in overcrowded households compared to non-Aboriginal peoples (7%) (18). Overcrowding puts additional pressure on 'health hardware' reducing the capacity of residents to carry out healthy living practices and increases the risk of food-borne disease due to pathogen proliferation, exacerbation of close contact infectious disease transmission, chronic conditions and stress (48, 72). Overcrowding can be further exacerbated by environmental temperatures particularly in houses with limited cooling capacity resulting in many people having to live in the one air-conditioned room during extreme heat events. Adaptation responses to the incremental health risk of heat (the focus of this section) as well as the more extreme risk due to intense heatwaves generally focus on reducing the exposure to heat and/or improved management of heat sensitive conditions (e.g. chronic cardiovascular, respiratory, renal disease, psychosocial distress) of Aboriginal populations. In NSW cumulative housing disadvantages, including overcrowding, plumbing and electrical issues, inability to keep cool, and presence of vermin are associated with health impacts in Aboriginal people. Furthermore, a lack of adequate maintenance in Aboriginal community housing has been shown to be the overwhelming primary cause for failure of housing to support healthy living (153). The impact of inadequate housing on Aboriginal health is likely to be exacerbated by climate change.

**Recommendation 5:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders facilitate an assessment of current guidelines and policy around Aboriginal housing to better support health, including regionally specific guidelines for Aboriginal housing, and consideration of ongoing maintenance and affordability for tenants.

This recommendation includes working with housing providers and communities to address issues such as:

- cooling in Aboriginal housing, including consideration of the maintenance and affordability of associated energy costs.
- ensuring the capacity to prepare cook and store food in houses
- improving medication storage facilities and consider the feasibility of developing independent power sources for refrigeration

## **Water**

Extreme rainfall, floods, droughts and heat affect water quality and water flows in lakes and river systems. These events can lead to contamination of water sources accessed by Aboriginal peoples for drinking, or cultural and recreation uses. Adaptation responses should prioritise delivery of safe and palatable drinking water to Aboriginal communities via continued investment in water supply and sewerage infrastructure, especially in remote and regional locations where limited resources will be further stretched by climate change. NSW Health works closely with local water utilities on the provision of safe drinking water in NSW. Climate hazards including bushfires, floods and droughts are all associated with water related health hazards including water contamination and algal blooms, as well as ecological and social impacts such as fish kills and reduce access to water for recreational use.

The *NSW State Infrastructure Strategy 2018* recognises that future population growth and climate trends including rising temperatures and changing rainfall patterns will reduce the availability of

water for regional towns and industries (agriculture and mining) to the west of the Great Dividing Range and metropolitan centres to the east (161). It acknowledges that there are still regional towns and communities un-sewered and non-reticulated that will require substantial infrastructural upgrade to ensure secure water services that meet health and environmental standards (161). Funding has been allocated for programs to support a broad range of water and sewerage infrastructure projects (162) (163). The water and sewerage infrastructure needs of discrete Aboriginal communities are also supported under the NSW Governments Aboriginal Communities Water and Sewerage Program (ACSWP) in partnership with the NSW Aboriginal Land Council (NSWALC).

Aboriginal peoples have profound traditional knowledge on locating, collecting and storing water which has allowed them to survive on the continent for thousands of years (164). Given that the health and well-being of Aboriginal peoples are inextricably connected to environmental stewardship, recognising Aboriginal peoples' rights to water and enabling the practice of traditional water management and Connection to Country in an intensively regulated water sector in NSW today is vital. Recognising the importance of protecting the spiritual, social and customary values of Aboriginal communities with respect to water was stipulated for the first time in the *NSW Water Management Act 2000* (125). The act enables Native Title holders to exercise basic water rights, and establishes opportunities for Aboriginal peoples, together with catchment management authorities (CMAs), develop Water Resource Plans (WRPs) and apply for Special Purpose Aboriginal Licenses (SPALs), which DPIE regulates in accordance to the rules of the Water Sharing Plan for consumptive users (i.e. agriculture, mining, drinking, recreational, Aboriginal cultural access) and the environment for maintaining environment flows<sup>5</sup> (165). There are also guidelines on how to support the cultural and spiritual values of waterways, as well as a national framework for cultural flow established by the Australian Government. However, the fundamental issue of water injustice still persists for Aboriginal water entitlements.

**Recommendation 6:** NSW Health, NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities collaborate to identify priorities for data collection and research on water quality and water access for Aboriginal health and wellbeing including social and cultural practices.

**Recommendation 7:** NSW Health and NSW DPIE review risks from un-sewered regional towns and communities and from non-reticulated water supplies under a changing climate. Programs to upgrade these systems to ensure compliance with Australian drinking water guidelines and that sewerage services meet environmental standards should be prioritised, with a particular focus on Aboriginal health and wellbeing.

This recommendation includes issues such as:

- Water is central to the cultural, social and spiritual identify of Aboriginal peoples which in turn links to the holistic and whole-of-life view of Aboriginal health. 'Cultural flows' have been defined as water entitlements owned and managed by Aboriginal peoples to improve their spiritual, cultural, environmental, social and economic conditions. While

<sup>5</sup>Environmental flow describes the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystem and the human livelihood and wellbeing that depend on these ecosystems.

cultural flows have not yet been granted for the Murray–Darling Basin river system a national framework for cultural flows was released in 2018 (4). A comprehensive assessment of the direct and indirect health benefits of cultural flows for river systems should be developed to support Aboriginal health and climate adaptation responses

- Provide culturally appropriate public health messaging for Aboriginal peoples around water contamination hazards including climate related hazards. For example, a body of water may hold cultural significance to Aboriginal peoples and in response to specific contamination events (i.e. deterioration of water quality driven by rainfall, floods, droughts or bushfires) public health advisories on restricting or discouraging use of a water body may be issued.

### **Vector borne disease**

Adaptation responses to manage vector-borne diseases are focussed on reducing human exposure. Changes in vector ecologies due to climate change are difficult to predict and are influenced by human climate adaptation activities such as the installation of rainwater tanks, which can inadvertently extend the geographical range of mosquito breeding sites. Other human activities conducive to the spread of vector borne infections include travel and habitation patterns.

Primary prevention usually focusses on vector and pathogens surveillance and reducing vector breeding sites in proximity to local populations, in particular after heavy rainfall and flood events when there is unexpected pooling of water bodies.

NSW Health conducts the NSW Arbovirus Surveillance & Vector Monitoring Program(166) across NSW between November and April and provides early warning of flaviviruses (Murray Valley Encephalitis and Kunjin viruses) and alphaviruses (Ross River virus) in 30 locations around NSW.

**Recommendation 8:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities review vector borne disease risks for Aboriginal populations under a changing climate and recommend adaptation priorities.

This recommendation includes issues such as:

- Land management programs to minimise uncontrolled vector breeding habitats in Aboriginal communities
- Household related vector borne disease reservoirs and risk management, e.g. rainwater tanks, housing without screened doors/windows
- reviews of current regional-scale vector borne disease modelling to assess if the current surveillance programs address Aboriginal health risks, particularly in regions where changes in climate may facilitate the spread of vector borne disease in NSW.

### **Air**

Bushfires are an inherent feature of the ecology of Australian landscapes and climate change is likely to exacerbate the trend of longer fire seasons with more extreme fire weather leading to

fires that are historically unusually frequent, severe and, in some cases, economically destructive (128, 129). Air quality will also be impacted by the increasing frequency and severity of bushfires as well as fire risk management strategies such as hazard reduction fires. Windblown dust (geogenic) and the output of allergenic pollens are also expected to have an increasing impact on air quality under climate change (118).

Bushfires have both direct and indirect impacts on the health and wellbeing of individuals and communities in the short and long term. Direct health impacts can be life threatening and include burns, asphyxiation and injuries, as well as exacerbating chronic conditions, such as respiratory disease, cardiovascular disease and diabetes, and can also have short and long-term effects on mental health and wellbeing. Indirect impacts of bushfires include increased particulate air pollution from fire smoke which can penetrate deep into the lungs and cause respiratory and cardiovascular morbidity and mortality. Aboriginal peoples have higher rates of cardiovascular and respiratory mortality and morbidity and air pollution due to fire smoke, dust and aeroallergen exposure may amplify existing health disparities experienced by Aboriginal peoples.

**Recommendation 9:** NSW Health and NSW DPIE in collaboration with relevant agencies and stakeholders and Aboriginal communities facilitate local assessments of current and future exposure and health risks from fire smoke, dust and aeroallergens in Aboriginal populations to develop adaptation responses including health messaging

This recommendation includes issues such as:

- Reviewing the health benefits / impacts of incorporating traditional Aboriginal burning practices into bushfire management practices to improve fire management including related direct and indirect health benefits /impacts (e.g. cultural and economic benefits)
- Improved messaging around air pollution and health risks (e.g. fire smoke, dust and allergens) in consultation with Aboriginal stakeholders for culturally appropriate communication to Aboriginal peoples
- Land management programs to minimise the impacts of windblown dust in Aboriginal communities
- Household related indoor air exposure reduction options such as door and window seals to minimise ingress of outdoor air indoors during high fire smoke and/ or dust exposure events
- Socially and culturally appropriate clean air evacuation centres.

### **Food Security**

The underlying cause of food insecurity in Aboriginal communities includes socioeconomic factors such as income and employment, housing, overcrowding, transport, food costs, food and nutrition literacy, knowledge and skills (167). Transport and food costs are particularly important factors for remote Aboriginal populations. Climate change impacts such as increased periods of drought and extreme weather events, are likely to impact traditional food source availability. These food sources have a cultural significance as well as providing alternatives for families in financial stress. The full impact of climate change on some of these food sources (such as waterbirds (168),

kangaroo populations, availability of emu eggs, fish stocks etc) and the impact on Aboriginal communities has not been fully understood.

Adaptation responses to food insecurity include improving affordability, nutritional choices, housing hardware to enable hygienic food preparation, cooking and food storage, as well as enabling access to Traditional food-gathering and hunting to promote healthy traditional diets.

**Recommendation 10:** NSW Health and NSW DPIE, in collaboration with relevant agencies and Aboriginal stakeholders, facilitate a review of food insecurity in Aboriginal populations for the development of adaptation responses, including the impacts of climate change and how Aboriginal communities experience food insecurity.

This recommendation includes issues such as:

- Working with local supermarkets and food suppliers to find mechanisms that support equitable food prices, especially for remote Aboriginal communities and for communities vulnerable to drought conditions where reliance on expensive store-bought fruits and vegetables is unavailable
- The provision of safe and palatable drinking water for Aboriginal communities, particularly during extreme weather events such as droughts and floods
- Working with Aboriginal communities to improve food preparation, cooking and storage methods and food storage facilities, and consider the feasibility of developing independent power sources for refrigeration.
- Developing culturally appropriate public health advice to Aboriginal peoples on nutritional standards for food and encourage health eating and drinking (e.g. preferences for soft drinks). Children and young people can be targeted to reinforce early healthy eating habits early habits.
- Consulting with Aboriginal stakeholders on the cultural dimensions of food gathering, producing own food, preparing and eating food in order to perpetuate knowledge, promote healthy traditional diets, as well as improving the social and emotional wellbeing of Aboriginal peoples engaging in cultural practices whilst preparing for increased risks of pathogen proliferation in future warmer weather
- Consideration of commercial return from harvests of bush resources which contributes to the economic and social development for both urban and remote Aboriginal communities

## Conclusions

This report describes the Aboriginal health risks due to climate, and the likely increases in these risks due to climate change in NSW. The recognition that culture is an underlying determinant of good health is in line with the 'Closing the Gap' strategy which advocates for an Aboriginal and Torres Strait Islander-driven approach to health policy and program reform (2, 3). This strength-based approach is key to improving resilience to the impact of climate on Aboriginal health. Action is needed now to develop effective Aboriginal led adaptation responses to build resilience of Aboriginal populations to the current and future impacts of climate on health.

# Appendix A: Methods

## A. Literature review

### Data sources

This literature review has been informed by both academic literature and grey literature, as we aimed to gather a broad and diverse range of information not restricted to peer reviewed journals. A series of keyword searches were conducted, informed by discussion sessions within the project team. The project team includes two officers from the Aboriginal Health Branch of NSW Health who work closely with Aboriginal communities in NSW and up to four researchers from the University of Sydney. The selected keywords were based on several themes discussed, including climate change, climate-related hazards, health outcomes, physical, socioeconomic and cultural determinants, adaptation and related legislations and policies.

For peer reviewed journals, we conducted keyword searches (within title and abstract) assigned to subject headings on the Medline database. Keywords include climate change, health, impacts, extreme events, temperature, heatwaves, precipitation, rainfall, flood, bushfire, drought, water-borne, vector-borne, food-borne, air quality, housing, food security, mental, socioeconomic, culture, vulnerability, adaptation, vulnerability maps, Indicators, indigenous knowledge(s), Aboriginal, New South Wales, Australia.

For grey literature, including reports and articles, we conducted searches on government and institutional websites, including the Intergovernmental Panel on Climate Change, CSIRO, Bureau Of Meteorology, Australian Institute of Health and Welfare, NSW Health, NSW Department of Planning, Industry and Environment, AdaptNSW, Resilience NSW, Infrastructure NSW and Australian Government Initiative. Google searches were also conducted with the aforementioned keywords, with additional keywords including Native title, water rights and land rights.

Selected datasets were obtained from the Bureau of Statistics and the Australian Institute of Health and Welfare to illustrate the health gap and health status of Aboriginal peoples.

The majority of information was limited to the past 10 years (2010 – 2020) to ensure relevancy.

### Analysis of literature

The literature review summarised important subjects and themes relevant to the topic of health risks of climate change for Aboriginal populations, including discrete communities in NSW. These include the state of current and future climate in NSW, the demography of Aboriginal peoples, the existing health status of Aboriginal peoples and the determinants of health encompassing physical, socioeconomic and cultural dimensions, and the key climate and health relationships.

In order to describe the key climate and health relationships, we selected four themes based on key climatic conditions and environment effects which have a range of downstream health consequences (direct or indirect) on Aboriginal populations in NSW. We selected these key themes based on the ability to describe climate-health relationships encompassing the health determinants



and outcomes identified from the literature and consultations. The selected climate-related hazards are 1) temperature increase and extreme heat, 2) extreme rainfall and floods, 3) droughts and 4) Fire weather and air pollution. We also used a well-developed conceptual framework, which describes vulnerability to climate change as a function of **exposure** to climate-related risk; **sensitivity** or responsiveness to climate-related risk; and **capacity to adapt** to change (11, 12). The *vulnerability* framework intends to facilitate the elucidation of various environmental, socioeconomic and cultural factors (or indicators) that may contribute to health risks faced by Aboriginal and Torres Strait Islander peoples presently, as well as factors that may alleviate these risks regardless of future climate threats due to anthropogenic climate change.

Finally, to complement each of the climate-related hazard themes, we provided exposure maps (derived from the mapping methodology described in Section 5.3) to illustrate the vulnerability of Aboriginal populations, including discrete communities, to the selected climate exposure indicators.

## B. Stakeholder consultation

Our stakeholder consultation process was restricted due to COVID-19 disruptions which resulted in a reduced range of consultations which had to be conducted primarily via phone and online meetings and workshops. The aims of the consultation were to obtain a broader range of input on:

- the environmental, economic, social and cultural impacts of climate on health and wellbeing of Aboriginal peoples;
- climate and health adaptation responses, including those based on Indigenous knowledge
- priorities for future work on climate and Aboriginal health

The consultations occurred in two parts and focussed on targeted agencies / groups with a formal role in Aboriginal Health. The first part of the consultation was a series of targeted key informant interviews conducted during May and June 2020. The second part of the consultation process was a two-hour online workshop conducted on 28 October 2020 to obtain further stakeholder input and discuss the main findings of the draft project report.

Officers from the following agencies participated in the consultation process:

- NSW Health - Environmental Health Branch
- NSW Health - Centre for Aboriginal Health
- NSW Aboriginal Affairs
- Aboriginal Health and Medical Research Council (AH&MRC) of NSW
- NSW Rural Doctors Network
- Indigenous Allied Health Australia

The findings from the informant interviews and the online workshop are summarised in key themes. The main climate and Aboriginal health hazards highlighted by stakeholders include extreme heat, bushfires, drought, air pollution and food insecurity.

## C. Mapping

### Data sources

Data related to environmental exposures were primarily sourced from the New South Wales Department of Planning, Industry and Environment, specifically through the Australian Water Availability Project (for current period temperature and rainfall data) and the NSW and ACT Climate Modelling (NARClIM) Project for all projection data. Population data were sourced via the Australian Bureau of Statistics (ABS).

We identified discrete Aboriginal communities across NSW identified by various NSW government programs and compiled by the NSW Health Environmental Health Branch. The list has been validated by on-site/ field visits and mapping using the G-NAF (Geocoded National Address File), a trusted index of Australian address information. G-NAF contains the state, suburb, street, number and coordinate reference (or “geocode”) for street addresses in Australia. G-NAF does not contain any personal information or details relating to an individual or business [ref:

<https://geoscape.com.au/wp-content/uploads/2020/09/Unpacking-GNAF-.pdf>]

Migration data was sourced via the ABS Census for population and housing (2016), where the number of people identifying as Aboriginal, by age group, statistical area 3 (SA3), and SA3 in the previous census (2011) was enumerated. SA3 to rurality concordance was then used to code SA3s to rurality (available here: <https://data.gov.au/dataset/ds-dga-d056f2ed-faa7-4140-b950-6cccfb72e3fd/details?q=> ; SA3s are categorised according to largest proportion within RA). Data were then summarised and proportions by age group, Aboriginality and rurality in 2011 were calculated.

### Analysis

For all exposure estimates, summarised gridded datasets for environmental exposures were either calculated manually or obtained (in the case of NARClIM projections) to determine annual gridded estimates for NSW. Population weighted means at the Statistical Area 1 (SA1) level were then calculated using the 2016 ABS Australian population grid. SA1-level estimates were categorised according to the levels of the population-weighted indicator, with usual resident populations of Aboriginal vs. non-Aboriginal people summed by category to obtain proportions at the state level. When gridded data was provided with low resolutions, ordinary kriging methods were used to interpolate the data and obtain a higher resolution for visualisation via maps. All population weighted estimates, however, were calculated using data at the resolution provided.

### Software

All data processing and visualisation was performed using R version 4.0.2.

### Limitations

The usual resident populations, used for assessing state level exposure, are known to be biased when estimating Aboriginal and Torres Strait Islander populations in Australia. However, as these estimates were aggregated to the state level and only proportions were estimated, there is likely to be minimal bias in these estimates. While estimated resident populations (ERPs) have been corrected for the known undercounting of Aboriginal people, these are only available at the

Statistical Area 2 (SA2) level, a unit many times larger than SA1 divisions. To assess the suitability of using URPs versus ERPs, estimates were obtained using both methods, with negligible differences found across methods. As such, the smaller geographical unit (i.e. SA1 level using URPs) was used.

Additionally, all populations used were drawn from 2016 population levels, both the URPs at the SA1 level, and overall populations from the Australian population grid. While this is unlikely to impact the estimates of environmental exposures from the current period, all projection estimates were also based on 2016 population estimates. This means that projection estimates assume that the proportions of Aboriginal vs non-Aboriginal people at the SA1 level will remain static. While changes in these populations are to be expected, the overall proportions are unlikely to change substantially. Indeed, analysis of the 2006, 2011, and 2016 censuses revealed only small changes in the proportions of Aboriginal vs. non-Aboriginal at the SA1 level, with very little internal migration observed across rural and regional areas. As such, these estimates should be indicative of the population proportions in the near future.

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