Climate Change and Aboriginal and Torres Strait Islander Health

Discussion Paper

About the artwork:

Bindarray (Gumbaynggirr for 'Many Creeks') digital artwork
By Talah Laurie
Gumbaynggirr & Yaegl mob(s)

Bindarray (Gumbaynggirr for 'Many Creeks') is inspired by the age-old practice and flow of knowledge exchange, from our Elders to our young ones. This piece incorporates existing elements that are unique to the HEAL project logo, such as the tri-colour ribbon that connects different mobs by the flow of rivers; which eventually meet and the representation of many mobs, from many countries sitting and connecting.

Climate Change and Aboriginal and Torres Strait Islander Health

DISCUSSION PAPER

Prepared for the Lowitja Institute and the National Health Leadership Forum by

**Healthy Environments and Lives (HEAL) Network &
Centre for Research Excellence in Strengthening Systems
for Indigenous Health Care Equity (CRE-STRIDE)**

November 2021

This work is published and disseminated by Lowitja Publishing, an activity of the Lowitja Institute, Australia's national institute for Aboriginal and Torres Strait Islander health research, as part of its Discussion Paper series.

The Lowitja Institute's Discussion Paper series encourage dissemination of critical analysis. For example, literature reviews, key issues affecting Aboriginal and Torres Strait Islander health and wellbeing research, works in progress, and research methodologies.

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Acknowledgments

The Healthy Environments and Lives (HEAL) Network is a highly interdisciplinary, cross-sectoral network uniting stakeholders from research institutes, government agencies, industry, services and communities from across Australia, with a vision to improve health through a more sustainable environment. The Centre for Research Excellence in Strengthening Systems for Indigenous Health Care Equity (CRE-STRIDE) is an Aboriginal and Torres Strait Islander led, long-term collaboration of health researchers, service providers and policymakers with expertise in Aboriginal and Torres Strait Islander health systems research, public health and health and social policy.

Together, we acknowledge Aboriginal and Torres Strait Islander peoples as the first custodians of the land, seas and waterways of Australia and pay respect to their culture and knowledges that have sustainably cared for Country. In this spirit, we have a shared commitment to strengthening health system resilience, preparedness and responsiveness to climate change, and reducing health, social and economic inequities within and across communities and generations.

A note on photographs:

- Photos on pages 4, 21, 24, 25, and 26 courtesy Assoc. Prof. Aunty Linda Payi Ford
- Photos on pages 12, 31, 32 and 34 courtesy Amba-Rose Atkinson
- Photo on page 18 Stock Image
- We also thank the authors and the Telethon Kids Institute for their photo contributions.

Background

This discussion paper describes climate change in Australia and its impact on the health and wellbeing of Aboriginal and Torres Strait Islander people. It highlights Aboriginal and Torres Strait Islander-led initiatives in climate change adaptation and mitigation that strengthens wellbeing and benefits the global community.

The main findings are presented from a scoping review of academic and grey literature that was guided by the following key questions:

- What are the direct and indirect impacts of climate change on Aboriginal and Torres Strait Islander health and wellbeing?
- What strategies are Aboriginal and Torres Strait Islander and other First Nations communities using for mitigation and adaptation?

This discussion paper was commissioned by the Lowitja Institute based on the need to address the health and wellbeing impacts of climate change identified by the National Health Leadership Forum – a collective partnership of national Aboriginal and Torres Strait Islander health and wellbeing organisations. With the recent release of the sixth assessment report from the Intergovernmental Panel on Climate Change (IPCC 2021) and the upcoming United Nations Convention on Climate Change (COP26), this discussion paper provides a timely overview of the existing scholarship and provides the groundwork for the development of a set of recommendations for further advocacy and action.

Key findings

Impacts from climate change will vary considerably across Australia. Generally, there will be a rise in average temperatures and increased frequency and intensity of heatwaves particularly in northern and inland areas. Sea levels will continue to rise compromising low-lying island and coastal communities. Cyclones and rainfall events will increase in intensity raising flooding risk. Decreased rainfall in southern areas will increase the likelihood of drought.

There are many varied direct and indirect climate change impacts on the morbidity and mortality of Aboriginal and Torres Strait Islander people. Climate change is compounding historical injustices and disrupts cultural and spiritual connections to Country that are central to health and wellbeing. Health services are struggling to operate in extreme weather with increasing demands and a reduced workforce. All these forces combine to exacerbate already unacceptable levels of ill-health within Aboriginal and Torres Strait Islander populations.
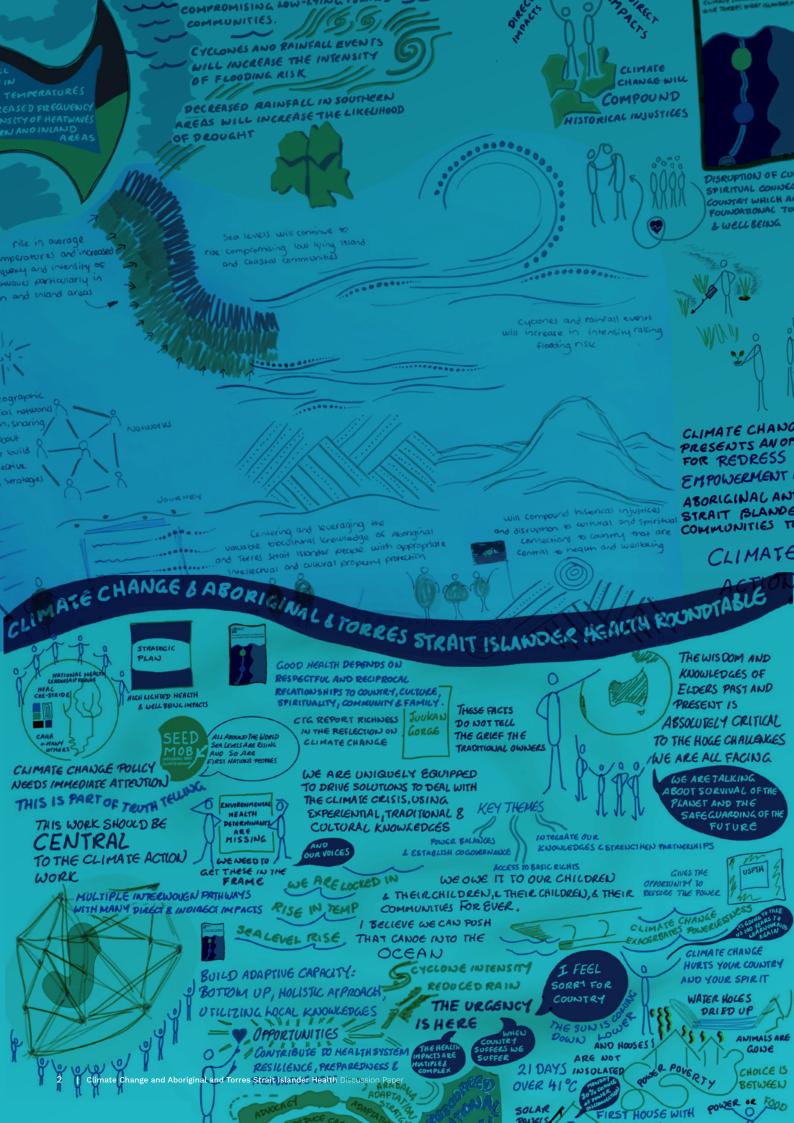
To date, Aboriginal and Torres Strait Islander people have not been sufficiently included in national conversations about climate change. There are gaps in research and data and most reporting on climate change does not include Aboriginal and Torres Strait Islander or local knowledge in the assessment findings.[1]

Many solutions are known but access to these solutions is not equally or equitably available across Australia. These issues are inextricably linked to structural and systemic racism.

Climate change presents an opportunity for redress and empowerment of Aboriginal and Torres Strait Islander communities to lead climate action planning based on their intimate traditional and historical knowledges of Country.

Best-practice principles to facilitate this include:

1. Building adaptive capacity of communities by restoring basic rights to adequate housing and access to Country and its resources;

2. Place-based adaptation and mitigation planning given the diversity of Aboriginal and Torres Strait Islander cultures, as well as the diversity of climate impact.

3. Establishing equitable power relationships and co-governance arrangements at multiple levels to provide Aboriginal and Torres Strait Islander communities more certainty and control in protecting Country;

4. Centering and leveraging the valuable biocultural knowledge of Aboriginal and Torres Strait Islander people with appropriate intellectual and cultural property protection;

5. Building respectful, trusting partnerships to share and weave together Aboriginal and Torres Strait Islander and Western knowledge systems to inform innovative adaptation and mitigation;

6. Providing sustainable resourcing and program flexibility to support innovation and long-term monitoring and evaluation; and

7. Establishing geographic and intersectoral networks for collaboration, sharing and learning about experiences to build sustainable effective climate action strategies.

1. For example, the recent Intergovernmental Panel on Climate Change (IPCC 2021) report has severe limitations, most notably it says on pg. 115 (Chapter 1):'Indigenous and local knowledge includes information about past and present climate states. However, assessing this knowledge, and integrating it with the scientific literature, remains a challenge to be met. This lack of assessment capability and integration leads to most Working Group I chapters still not including Indigenous and local knowledge in their assessment findings'.

COMPROMISING LOW-LYING ISLANDS COMMUNITIES.

CYCLONES AND RAINFALL EVENTS WILL INCREASE THE INTENSITY OF FLOODING RISK

DECREASED RAINFALL IN SOUTHERN AREAS WILL INCREASE THE LIKELIHOOD OF DROUGHT

DIRECT IMPACTS

DIRECT IMPACTS

CLIMATE CHANGE WILL COMPOUND HISTORICAL INJUSTICES

DISRUPTION OF CU SPIRITUAL CONNEC COUNTRY WHICH A FOUNDATIONAL TO & WELL BEING

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...rise in average ...temperatures and increased ...quency and intensity of ...waves particularly in ...n and inland areas

Sea levels will continue to rise compromising low lying island and coastal communities

Cyclones and rainfall events will increase in intensity raising flooding risk

...ographic ...ial networks ...n sharing ...bout ...o build ...eative ...strategies

Networks

Journey

Centering and leveraging the valuable biocultural knowledge of Aboriginal and Torres Strait Islander people with appropriate intellectual and cultural property protection

Will compound historical injustices and disruption to cultural and spiritual connections to country that are central to health and wellbeing

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CLIMATE ACTION

CLIMATE CHANGE & ABORIGINAL & TORRES STRAIT ISLANDER HEALTH ROUNDTABLE

STRATEGIC PLAN

NATIONAL HEALTH LEADERSHIP FORUM
HEAL CRE-STRIDE
CAHA + MANY OTHERS

HIGHLIGHTED HEALTH & WELLBEING IMPACTS

SEED MOB
ALL AROUND THE WORLD SEA LEVELS ARE RISING AND SO ARE FIRST NATIONS PEOPLES

CLIMATE CHANGE POLICY NEEDS IMMEDIATE ATTENTION

THIS IS PART OF TRUTH TELLING

THIS WORK SHOULD BE CENTRAL TO THE CLIMATE ACTION WORK

ENVIRONMENTAL HEALTH DETERMINANTS ARE MISSING

WE NEED TO GET THESE IN THE FRAME

MULTIPLE INTERWOVEN PATHWAYS WITH MANY DIRECT & INDIRECT IMPACTS

WE ARE LOCKED IN

RISE IN TEMP

SEA LEVEL RISE

BUILD ADAPTIVE CAPACITY: BOTTOM UP, HOLISTIC APPROACH, UTILIZING LOCAL KNOWLEDGES

OPPORTUNITIES

CONTRIBUTE TO HEALTH SYSTEM RESILIENCE, PREPAREDNESS &

GOOD HEALTH DEPENDS ON RESPECTFUL AND RECIPROCAL RELATIONSHIPS TO COUNTRY, CULTURE, SPIRITUALITY, COMMUNITY & FAMILY.

CTG REPORT RICHNESS IN THE REFLECTION ON CLIMATE CHANGE

JUUKAN GORGE

THESE FACTS DO NOT TELL THE GRIEF THE TRADITIONAL OWNERS

WE ARE UNIQUELY EQUIPPED TO DRIVE SOLUTIONS TO DEAL WITH THE CLIMATE CRISIS, USING EXPERIENTIAL, TRADITIONAL & CULTURAL KNOWLEDGES

AND OUR VOICES

KEY THEMES

POWER BALANCES & ESTABLISH COGOVERNANCE

INTEGRATE OUR KNOWLEDGES & STRENGTHEN PARTNERSHIPS

ACCESS TO BASIC RIGHTS

WE OWE IT TO OUR CHILDREN & THEIR CHILDREN, & THEIR CHILDREN, & THEIR COMMUNITIES FOR EVER.

I BELIEVE WE CAN PUSH THAT CANOE INTO THE OCEAN

CYCLONE INTENSITY

REDUCED RAIN

THE URGENCY IS HERE

THE HEALTH IMPACTS ARE MULTIPLE & COMPLEX

WHEN COUNTRY SUFFERS WE SUFFER

21 DAYS OVER 41°C

SOLAR PANELS

THE WISDOM AND KNOWLEDGES OF ELDERS PAST AND PRESENT IS ABSOLUTELY CRITICAL TO THE HUGE CHALLENGES WE ARE ALL FACING

WE ARE TALKING ABOUT SURVIVAL OF THE PLANET AND THE SAFEGUARDING OF THE FUTURE

GIVES THE OPPORTUNITY TO RESTORE THE POWER

USFTH

CLIMATE CHANGE EXACERBATES POWERLESSNESS

ITS GOING TO TAKE US 100 YEARS TO LEARN HOW AGAIN

CLIMATE CHANGE HURTS YOUR COUNTRY AND YOUR SPIRIT

WATER HOLES DRIED UP

ANIMALS ARE GONE

I FEEL SORRY FOR COUNTRY

THE SUN IS COMING DOWN LOWER AND HOUSES ARE NOT INSULATED

POWER POVERTY

CHOICE IS BETWEEN

POWER OR FOOD

FIRST HOUSE WITH

ADVOCACY

ADAPTATION

ARABANA ADAPTATION STRATEGY

Climate Change and Aboriginal and Torres Strait Islander Health Roundtable
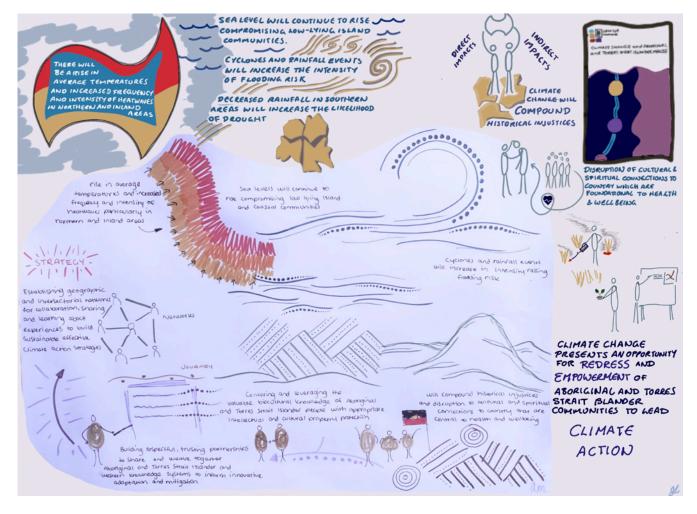
On 20 October 2021, Lowitja Institute, in partnership with the National Health Leadership Forum (NHLF) and the Climate and Health Alliance (CAHA), held a roundtable event to discuss climate justice and the health and wellbeing impacts of climate change for Aboriginal and Torres Strait Islander peoples.

Participants included researchers, community leaders, young people and other climate and health advocates. Roundtable participants discussed the key findings in this paper and the critical questions it identified (Appendix 1) under three key themes: restoring rights; collective advocacy, addressing power asymmetries and equitable governance; and weaving together knowledges and strengthening partnerships.

Participants heard from a range of community leaders and experts on the effects of climate change on the health and wellbeing of Aboriginal and Torres Strait Islander peoples and communities.

We come together from the lands of many traditional custodians around Australia. Please join me in acknowledging their Elders past and present; their custodianship of our lands, seas, cultures, and, most especially today—given the topic we are here to discuss—their wisdom and knowledges. That wisdom and those knowledges—accumulated over millennia—are absolutely critical to the huge challenges we are facing not only as Aboriginal and Torres Strait Islander peoples, but as the Australian nation, indeed, the world, the planet. The task of tackling climate change feels, quite frankly, overwhelming. It is a huge challenge, especially for young people... We are talking about the survival of the planet and the safeguarding of the future. How are we going to do that for not only for all of us living on this continent, but for humanity? That's the stakes.

Pat Anderson AO, Chairperson of Lowitja Institute
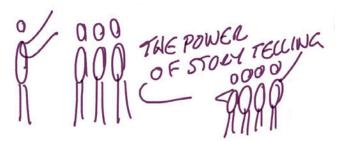
Roundtable discussion

Important themes to emerge throughout the roundtable discussions were:

Storytelling

The roundtable participants heard powerful and moving stories from communities on the frontline of climate change. A strong theme emerged on the need to elevate Aboriginal and Torres Strait Islander voices within climate change policy and action and to centre Aboriginal and Torres Strait Islander peoples as leaders in protecting Country.

There was also recognition of the power of storytelling and that everyone's story deserves to be heard. Climate change is often portrayed by statistics and numbers but the power, truth and motivation to take action lies in people's stories and lived experiences today. People's stories are a powerful advocacy tool for action. Cross-sectional collaboration such as this roundtable and reciprocal relationships based on trust are also critical.

Participants acknowledged the emotional toll and hurt conversations on the impact of climate change have for Aboriginal and Torres Strait Islander peoples.

BOX 1:
Climate change is impacting lives today

Roundtable participants heard that Central and Northern Australia are facing significant stress as they are most impacted with temperatures rising due to climate change.

In the Northern Territory, NT Housing has not utilised solar for power in public housing, instead the Government continues to rely on traditional electricity despite the NT having the opportunity to take advantage of solar power. The process to put solar panels on public housing was described as "a nightmare of red tape" with so much paperwork to fill out it is a disincentive to change to renewable energy.

Housing in Central Australia is often unsuitable for its climate with many not built to standards. Most housing lacks insulation and power has become unreliable and costly causing power poverty and stress on families and communities. The impact of power poverty has created constant worries of disconnection, inability to cool down from heat, food spoiling as fridges can't stay on, and medications can't be kept appropriately cool with refrigeration. Families are having to choose between food or power with both resulting in ill health, particularly for people who need to store their own insulin.

Government continues to be unwilling to listen to what community are saying and are seen as more willing to provide housing to non-local health staff or other service provider workers than they are to the people living in community.

The same issue occurs in the Torres Strait where most homes have no air conditioning and humidity is often more than 90-95% over summer putting people at risk of heat stress over extended periods where day and night-time conditions are very uncomfortable.

Country and place – Local answers, local knowledges, local solutions

Participants expressed that Aboriginal and Torres Strait Islander peoples know what is best for their Country and that greater value needs to be placed on local knowledge and experience.

There was broad consensus throughout the roundtable discussions that solutions need to be community led and there are many examples of successful local solutions already being implemented, for example through carbon reduction programs. Government policies and programs need to empower communities to implement local solutions and action on climate change.

"If our Country is suffering … we also suffer."

Amba-Rose Atkinson

Cultural authority and knowledges

Human health is often seen as separate from the natural ecosystem; however, this is not consistent with Aboriginal and Torres Strait Islander concepts of health and wellbeing.

There is an urgent need to centre and strengthen the role of Aboriginal and Torres Strait Islander knowledges in the fight against climate change.

"The scientists are seen as experts, but our mob have been doing this for thousands of years. Don't look at us as the victims—see us as the heroes. Centre us as the experts—protecting Country."

Amelia Telford, Seed Mob

Truth telling, power and racism

Power imbalances and systemic racism were identified as critical reasons why Aboriginal and Torres Strait Islander peoples are not being included in discussions and action on climate change. Consistent with historical practices, Aboriginal and Torres Strait Islander peoples are marginalised within climate policies, programs and legislation and more Aboriginal and Torres Strait Islander people must be represented at the decision-making table and within existing processes. Participants identified the need for other organisations to create space for Aboriginal and Torres Strait Islander voices and to identify powerful allies who are likely to act to overcome resistance from government.

There are also clear examples of inequitable access to resources and solutions to act on climate change, for example the near impossible process to install and connect solar panels on remote Aboriginal housing in the Northern Territory. Systemic and structural racism was seen as underpinning much of the apathy to addressing climate change for Aboriginal and Torres Strait Islander peoples.

Participants highlighted the need to leverage existing policy frameworks to implement greater action on climate change and centre the role of Aboriginal and Torres Strait Islander peoples. For example, the Uluru Statement from the Heart, United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), United Nations Permanent Forum on Indigenous Issues, the National Agreement on Closing the Gap, the National Aboriginal and Torres Strait Islander Health Plan, and the Victorian Treaty and Truth-telling Yoo-rrook Justice Commission. International frameworks, including the UNDRIP and the Paris Agreement[1] also need to be highlighted and utilised as legally binding frameworks and as powerful tools for change.

1. The Paris Agreement is a legally binding international treaty on climate change. Its goal is to limit global warming to well below 2, preferably to 1.5 degree Celsius, compared to pre-industrial levels. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016.

Opportunity for redress and empowerment

Climate change was discussed as an opportunity for redress and empowerment for Aboriginal and Torres Strait Islander Peoples. The roundtable heard from Dr Rhys Jones, a Māori scholar, on positioning climate change as an extension of, and within the context of, ongoing colonisation. Climate change impacts are the intensification of a sustained colonial process. As well as ecological tipping points there are relational tipping points which mean we need to invest in restoration of relationships – between humans and between humans and our more than human relatives. There is a need to balance urgent and incremental change and ensure action does not perpetuate existing inequities. Climate action, mitigation, and adaptation will not be enough on their own. Climate justice, including the cultural and social determinants of health, must be the goal.

"There is no climate justice without First Nations justice."

"We need climate justice, because it isn't just about the environment, it's about people in communities who have lost so much."

Amelia Telford, Seed Mob

Listen to our mob – young and old

The roundtable heard about the importance of maintaining focus on intergenerational collaboration – continuing to remember, learn from and elevate the wisdom of Elders and following the path being forged by young Aboriginal and Torres Strait Islander people. Young Aboriginal and Torres Strait Islander people want to be involved, they have ideas and want a voice. Groups such as Seed Mob are about highlighting and promoting Indigenous Voice, protecting Country and driving the Indigenisation of a new way of implementing climate action to achieve climate justice.

Education has a key role to play. The roundtable heard about the links between Country, identity and education for young Aboriginal and Torres Strait Islander people and how education can change opinions and action on climate change.

Participants heard the importance of staying positive, focusing on what's working, planning and being prepared. Communities are calling out for action and support to lead this work. Climate change is about land, waters and air or Country degrading and this is what causes ill health from a physical, emotional, cultural and spiritual perspective.

Outcomes and emerging recommendations

This discussion paper and the roundtable discussions highlight that action on climate change is now extremely urgent. The calls are clear:

- **Take action** – Climate action that respects human rights and achieves equitable health and environmental outcomes is urgently required. The climate crisis is already disproportionately affecting the health and wellbeing of First Peoples. We need to address existing inequities and ensure future action (or inaction) does not perpetuate these inequities.

- **Value and centre our knowledges and rights as First Peoples** – Aboriginal and Torres Strait Islander peoples have protected Country for millennia and have survived dramatic climatic shifts. We are intimately connected to Country and our knowledges and cultural practices hold solutions to the climate crisis.

- **Work with us** – Communities need dedicated resources and support to protect Country and implement adaptation and mitigation planning. We are ready to work in partnership and we need equitable access to housing, renewable energy solutions and our lands and waters to protect Country.

- **A movement for Climate Justice** – Climate change will affect us all – but some of us more so than others. We are all intimately connected to one another and our planet. Climate change is an opportunity to re-set our relationships for the better and seek a healthy and just future for all Peoples. We need to ensure climate action (or inaction) learns from the past and does not perpetuate existing inequities. This is climate justice.

Please see also Appendix 4 for an illustrated record of the Climate Change and Aboriginal and Torres Strait Islander Health Roundtable.

Introduction

It is a pivotal time for the planet and our way of life. Human-induced climate change has already led to significant biodiversity loss and remains a major threat to our society and the environment. Transformative change is urgently needed to slow greenhouse gas emissions (Dube, Chikodzi & Nhamo 2021; IPCC 2021). Globally, communities are already experiencing the tragic effects of a warming climate: the intense widespread 'Black Summer' bushfire season in Australia replicated more recently in the northern hemisphere; extreme heat in North America and Canada; and flash flooding in Europe, Japan and south-east Asia — all striking indicators of changing global climate systems (van Oldenborgh, Krikken, Lewis et al. 2021; Vardoulakis, Marks & Abramson 2020). While First Nations communities globally contribute least to emissions, climate change affects them earlier and more severely compared to other populations (Friel, Marmot, McMichael et al. 2008; Whyte 2017).

Extreme environmental events will increase under climate change predictions. There will be multiple adverse impacts on Aboriginal and Torres Strait Islander communities, exacerbating already disproportionate levels of ill health, stress, and hardship. Colonisation created disparities in health and wellbeing between Aboriginal and Torres Strait Islander and non-Indigenous Australians through dispossession of traditional land and waterways, suppression of culture and disempowerment. Climate change is compounding these historical injustices, increasing inequities and feelings of powerlessness as communities despair over the desecration of their land-, water- and seascapes (Howitt, Havnen & Veland 2012; Jones 2019; Whyte 2017).

There are unique and considerable direct and indirect effects from climate change impacting deep, spiritual ties to *Country* — the traditional lands and waters of Aboriginal and Torres Strait Islander peoples that are sacred and necessary for survival (McNamara & Westoby 2011; Moggridge & Thompson 2021). Country is a fundamental determinant of health, foundational to Aboriginal and Torres Strait Islander identity, knowledge systems and cultural practices (Dudgeon, Milroy & Walker 2014; Nursey-Bray & Palmer 2018). Over generations, Aboriginal and Torres Strait Islander people have been the caretakers of Country, enhancing biodiversity, maintaining habitat, and supporting ecosystem resilience. In return, Country has nourished Aboriginal and Torres Strait Islander people physically, mentally, spiritually, and culturally (Berry, Butler, Burgess et al. 2010; Burgess, Johnston, Berry et al. 2009; Kingsley, Townsend, Phillips et al. 2009; Rigby, Rosen, Berry et al. 2011).

In climate action planning and research, Aboriginal and Torres Strait Islander perspectives have been mostly overlooked and undervalued. This is despite the accumulation of traditional knowledge from sustainably adapting and looking after Country over millennia (Nursey-Bray, Palmer, Smith et al. 2019). Climate change provides an immediate opportunity for 'two-way seeing' — the weaving together of Aboriginal and Torres Strait Islander knowledges with Western science to inform mitigation and adaptation approaches (Alexander, Bynum, Johnson et al. 2011; Bartlett, Marshall & Marshall 2012; Cullen-Unsworth, Hill, Butler et al. 2012; Ford, King, Galappaththi et al. 2020; Green, Billy & Tapim 2010). This discussion paper examines existing scholarship on the impact of climate change on Aboriginal and Torres Strait Islander communities, the barriers to addressing this impact and highlights proactive work being undertaken by Aboriginal and Torres Strait Islander communities to care for Country and its health co-benefits.

Key concepts

This section explains common terminology used in climate change literature. We recognise that Aboriginal and Torres Strait Islander perspectives may differ from these explanations, underscoring the need to effectively engage with communities when discussing climate change, mitigation and adaptation (Nursey-Bray, Palmer, Smith et al. 2019).

Climate refers to regional patterns of weather, like the wet and dry seasons of northern Australia. Natural transformations in climate typically occur over very long timeframes (thousands of years). However, there has been a rapid change in the Earth's climate observed since industrialisation in the early 1900s, largely attributed to human-produced greenhouse gas emissions, particularly carbon dioxide (CO_2) from the use of fossil fuels (e.g., coal, natural gas, and oil). Termed anthropogenic **climate change**, it has also been driven by vegetation clearing and increasing urbanisation (Griffith University & CSIRO 2014; While & Whitehead 2013).

Pictured left: Associate Professor Aunty Linda Payi Ford – Caring for biodiversity on Country — Pandayal on Rak Mak Mak Marranunggu Country on E2, Delissaville, Wagait, Larrakia Aboriginal Land Trust, NT

The Earth's atmosphere naturally holds in heat from the Sun due to the presence of certain 'greenhouse' gases including CO_2, water vapour, and methane. Human activity is primarily increasing CO_2 emissions at a much greater rate than natural processes can remove it, effectively trapping more heat within the atmosphere. Termed the '**greenhouse effect**', this is increasing the warming of Earth's surface (Griffith University & CSIRO 2014). While it may seem small, the 1–2°C increase in **global warming** since the 1900s is driving regional and seasonal extreme temperatures, warming oceans and melting sea ice, intensifying cyclones and heavy rainfall events, shifting habitat ranges of plants and animals and increasing biodiversity loss (Lindsey & Dahlman 2021).

There is an urgent imperative to curb emissions to address the harmful impacts of climate change. **Mitigation** strategies aim to reduce the amount of emissions or remove CO_2 from the atmosphere in natural sinks like vegetation and soil. **Carbon farming and abatement** programs reduce the amount of CO_2 produced through land management practices. For example, strategic fire management can prevent large and intense bushfires from occurring and emitting more greenhouse gases. **Carbon sequestration** removes and stores carbon through revegetation of cleared areas including seagrass meadows and through improved agricultural practices that increase the level of carbon in the soil. Transition to renewable energy technology such as solar and wind power, increased public transport and electric vehicles are other forms of mitigation.

Climate change **adaptation** strategies help communities adjust and cope with impacts from global warming. While Aboriginal and Torres Strait Islander people have adapted to different climates over millennia, the comparatively rapid rate of change occurring now is presenting complex challenges. Adaptation planning will help communities prepare for the adverse consequences of these changes.

Adaptive capacity is the ability or **agency** of a community to undertake adaptation to moderate potential damage and take advantage of climate action opportunities that can also produce social and health co-benefits. Adaptive capacity is mediated by socio-economic factors, health status, geographic location (e.g., remoteness, low lying coastal areas) and power structures that exist within government and political institutions (Hall & Crosby 2020; Nursey-Bray, Palmer, Smith et al. 2019).

The **social and cultural determinants** of health are important enablers of adaptive capacity and agency. **Social determinants** are the conditions in which people are born, grow, live, work and age (Marmot 2005). For Aboriginal and Torres Strait Islander people, the continuing cycle of political, social and economic marginalisation has led to cumulative adversities (systemic racism and discrimination, transgenerational trauma, unequal power structures) which have constrained the ability of communities to adapt to climate stresses (Howitt, Havnen & Veland 2012; Usher, Jackson, Walker et al. 2021). **Cultural determinants** strengthen wellbeing through connection to Country, family, kinship and community; by practicing language, spiritual beliefs, traditional knowledges and healing; and self-determination (Salmon, Doery, Dance et al. 2019).

Aboriginal and Torres Strait Islander knowledges refer to both traditional and historical knowledge that communities possess across generations from long and more recent observations in changes to Country (Nursey-Bray, Palmer, Smith et al. 2019; Nursey-Bray, Palmer, Stuart et al. 2020). These **biocultural knowledges** have developed through learning, monitoring, recording, and communicating relationships observed within ecosystems between humans, plants and animals. Knowledges manifest in traditional language, cultural protocols and spiritual totemic relationships to plants and animals. They differ from Western climate science, bringing observations across geological timeframes (prior to measuring equipment) and with fine local-scale (Morgan-Bulled, McNeair, Delaney et al. 2021).

Climate change trends and projections

The legacy effect of previous greenhouse gas emissions has resulted in Australia experiencing warmer years now than any other observed during the 20th century, accompanied by more severe heatwaves and fire weather (BOM & CSIRO 2020). There has been observed rainfall reductions in southeast Australia that has led to a decline in stream flows and contributed to long-term drought periods such as the Millennium drought (BOM & CSIRO 2020). Sea levels have risen leading to increased risk of coastal inundation, storm surges and erosion.

Continued emission of greenhouse gases will cause further warming and long-lasting changes in the climate system (IPCC 2021). In Australia, there will be significant regional differences in temperature and rainfall (Figure 1 & Appendix 2). Figure 1 shows climate projections for temperature, extreme fire weather and sea level across different regions, cities, and regional centres where Aboriginal and Torres Strait Islander communities live. It provides both near future (2030), and far future forecasts (2090) under different greenhouse gas emissions scenarios: *low emissions* – significant reduction in greenhouse gas emissions, such as reaching net zero by 2050; *intermediate emissions* – such as Australia's current commitment to reduce greenhouse gas emissions by 26–28 per cent below 2005 levels; and *high emissions* — no policy to reduce greenhouse gas emissions (Gergis 2021).

Over the next ten years, climate change projections are very similar regardless of the emission scenario, meaning the Earth is already predicted to warm on average by 1.5°C despite mitigation action. Beyond 2030 however, climate change predictions begin to separate significantly based on different emission scenarios. The projection graphs in Figure 1 (i–iv) show this variation with the open circles representing low, intermediate, and high emissions scenarios.

There will be a rise in temperature across all regions with the frequency and intensity of heatwaves predicted to increase under intermediate and high emissions, particularly in the Monsoonal North (top end of Northern Territory), Rangelands (Central Australia) and Central Slopes (western New South Wales) where there are high proportions of Aboriginal and Torres Strait Islander people in the populations. Average annual warming in these regions will be around 2 or 4°C by 2090 under intermediate and high emission scenarios respectively (Figure 1: i). For Darwin in 2090, its predicted that the annual average number of days over 35°C will range between 52 (low emissions) and 265 days (high emissions) (Figure 1: ii). Extreme fire weather in the Rangelands will also increase substantially under a high emissions scenario to 28 days per year (Figure 1: iii). Along Australia's coastline, sea levels will rise between 0.36 (low emissions) to 0.66 metres (high emissions), compromising low-lying island and coastal communities, including Cairns, Darwin and Port Hedland (Figure 1: iv). In addition, Australia's oceans will grow warmer and increase in acidity severely impacting diversity of marine life. Cyclones and rainfall events will increase in intensity raising flooding risk. Decreased rainfall in southern parts of the country will increase the likelihood of drought and extreme fire weather (CSIRO & BOM 2015).
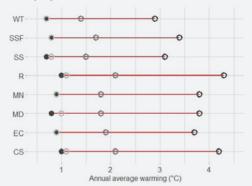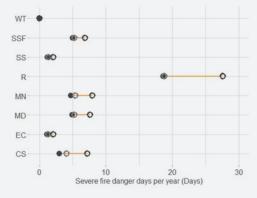
Figure 1: Climate projections

A. Aboriginal and Torres Strait Islander proportion of regional population (%) in Natural Resource Management (NRM) cluster
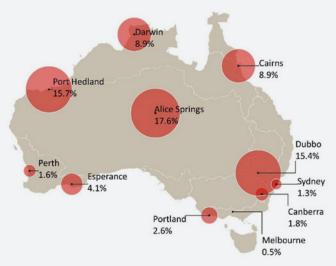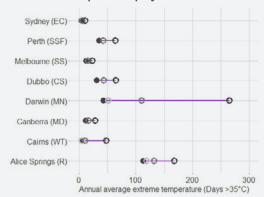

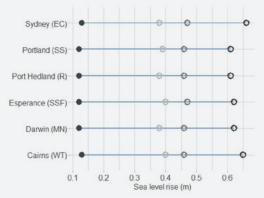**B. Aboriginal and Torres Strait Islander proportion of regional population (%) in selected towns/cities**

i. Heat projections

ii. Extreme temperature projections

iii. Fire danger days projections

iv. Sea level rise projections

KEY: **WT** = Wet tropics   **SSF** = South and Southwest Flatlands   **SS** = Southern Slopes   **R** = Rangeland
MN = Monsoonal North   **MD** = Murray Darling   **EC** = East Coast   **CS** = Central Slopes

● Near future (2030) All RCP (i, iv) or RCP4.5 (ii, iii)   ◯ Far future (2090) intermediate emissions - RCP4.5 (i, ii, iii, iv)
◔ Far future (2090) low emissions - RCP2.6 (i, ii, iv)   ◉ Far future (2090) high emissions - RCP8.5 (i, ii, iii, iv)

Figure 1 A) Indigenous population representation (%) in NRM cluster, 2016; and B) in selected towns/cities, 2016. Projections of i) heat#, ii) extreme temperature*, iii) fire danger days*, and iv) sea level rise# were plotted for the near (2030) and far (2090) future based on low (Representative Concentration Pathway - RCP2.6), intermediate (RCP4.5) and very high greenhouse gas (GHG) emissions (RCP8.5) where data were available.

#Change relative to 1986-2005 were plotted as median values of model simulations of 20-year moving average; *Change relative to 1981-2010 were plotted as median values of model simulations. Data Sources: Australian Bureau of Statistics 2016 census; Climate change in Australia: projections for Australia's NRM regions. Technical report. Canberra: CSIRO, Bureau of Meteorology; 2015.

Whilst Aboriginal and Torres Strait Islander people make up more of the population living in remote areas, the majority (approximately 80%) live in cities and regional towns (ABS 2017). These communities will face increased health risks from the built environments of urban centres that will intensify the effects of global warming. Known as the 'urban heat island effect', it is caused by both the trapping (absorbed and retained by materials such as buildings and roads) and releasing of heat (from industrial systems and engines), and the lack of natural cooling systems such as the presence of water sources and natural vegetation (IPCC 2021). This localised phenomenon shows that urbanisation is contributing to heat stress in cities due to more hot days and night-time extremes, not felt in surrounding regions. Projections also show increased risk for urban coastal communities due to increased sea levels and storm surges (IPCC 2021).

Climate change impacts on Aboriginal and Torres Strait Islander health and wellbeing

Prior to colonisation, Australia consisted of more than 250 Nations representing a broad diversity of cultures and knowledges. Central to all Aboriginal and Torres Strait Islander cultures is the holistic nature of health and wellbeing. Good health is dependent on respectful and reciprocal relationships to Country, culture, spirituality, community and family (Figure 2). It is a cultural responsibility to look after and respect oneself (connection to body, mind and emotions), each other (family, kinship, community) and the environment (connection to Country). Aboriginal and Torres Strait Islander people had unfettered access to food and water within their traditional lands and managed these resources sustainably, taking cues from the environment and working to protect it for future times and generations. These traditional knowledges, developed through processes of observation, learning and adapting over millennia, have been transmitted through generations as lore and cultural practice, forming a code for maintaining balance with one another, with Country and other living beings.
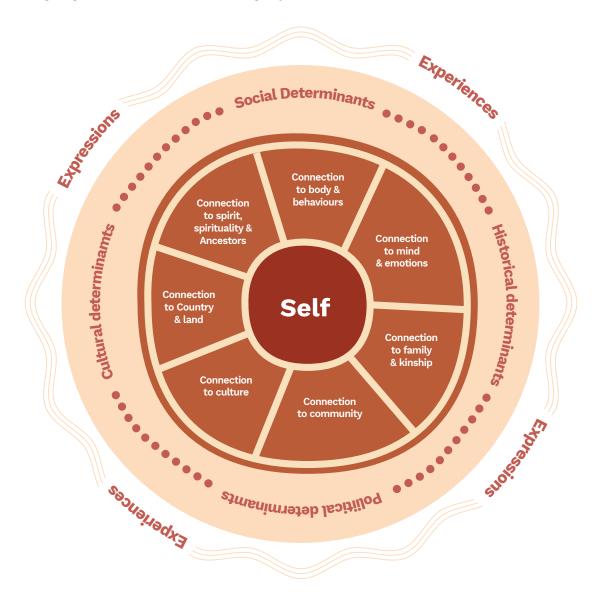
Mparntwe (Alice Springs), Arrente Country

Colonisation severely disrupted these connections, the impact of which is still felt acutely today. Land dispossession, social and cultural dislocation (including the destruction of languages) and systematic genocide (including the forced removal of children from their families) have led to inter-generational trauma with devastating consequences for the health and wellbeing of Aboriginal and Torres Strait Islander people. Continued systemic and interpersonal racism has reinforced socio-economic exclusion and mistrust in mainstream institutions (Biddle 2011) with negative consequences for social and emotional wellbeing (Paradies & Cunningham 2012). Consequently, there are significant chronic disparities across socio-economic and health indicators between Aboriginal and Torres Strait Islander and non-Indigenous Australians. Aboriginal and Torres Strait Islander people are more likely to have long-term health conditions such as diabetes, heart and kidney disease (AIHW 2020). Remote communities are more likely to report these conditions and have poorer access to and use of health services (AIHW 2015, 2019a).
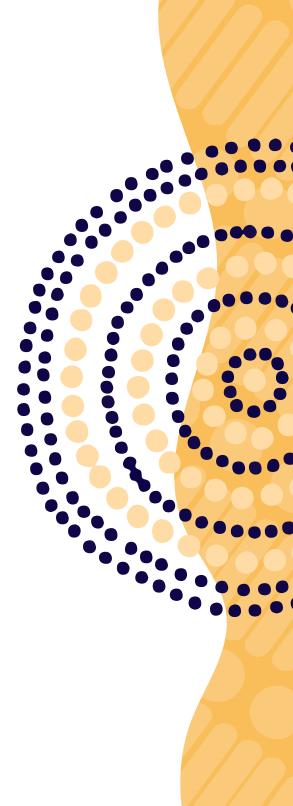
Existing health disparities and the close bond with traditional lands exacerbates the impact of climate change for Aboriginal and Torres Strait Islander people. Adverse physical health effects from climate change include heat-related disorders, vector-borne diseases, food and waterborne diseases, respiratory

Figure 2: Aboriginal and Torres Strait Islander domains of wellbeing (Transforming Indigenous Mental Health and Wellbeing Project 2021)

disorders and exacerbation of chronic diseases including heart and kidney disease (Levy & Patz 2015). Along with direct impacts — deaths, injuries and worsening health (including mental health) from excessive heat, bushfires, floods and sea-level rise — there are indirect 'cascading consequences' for community resulting from altered natural systems (air quality, water and food security and vector-borne and infectious diseases) and from altered social systems (employment and workforce productivity, housing comfort, and health service delivery) (Hall, Barnes, Canuto et al. 2021; Hall & Crosby 2020; Morgan-Bulled, McNeair, Delaney et al. 2021; Race, Mathew, Campbell et al. 2016a). There are also non-tangible impacts such as loss of connection and culture affecting social and emotional wellbeing that are more difficult to define and quantify. Climate change impacts are expanded on in Section 3 of this paper.

There are multiple, interwoven pathways linking climate change and health and wellbeing (Berry, Waite, Dear et al. 2018). The COVID-19 pandemic has shown the effectiveness of Aboriginal and Torres Strait Islander leadership in responding to complex public health issues (Lowitja Institute 2021), and communities have already been leading approaches to address climate risk. For example, Aboriginal and Torres Strait Islander knowledges are being applied in Caring for Country initiatives that have a multitude of social, cultural, economic and health co-benefits beyond positive environmental outcomes (Burgess, Johnston, Berry et al. 2009; Kingsley, Townsend, Phillips et al. 2009; Woodward, Hill, Harkness et al. 2020). These Aboriginal and Torres Strait Islander led partnerships enhance respect and recognition of traditional knowledges within the mainstream population and policy agendas. However, current health and environmental policy and legislative frameworks are presenting formidable barriers to broadening the implementation of equitable partnership approaches to climate change action.

Policy context

This section describes the complex legislative and policy environment at the intersection of Aboriginal and Torres Strait Islander health, self-determination and environmental management. Compared to other similarly colonised countries, Australia does not have a treaty or legal framework that enshrines certain rights for Aboriginal and Torres Strait Islander people despite decades of advocacy. The Uluru Statement from the Heart (2017) continues the call for truth, treaty and a voice. Inequitable power structures are a major form of uncertainty undermining Aboriginal and Torres Strait Islander communities' ability to build adaptive capacity and respond to climate challenges (Lyons, Hill, Deshong et al. 2019).

International frameworks addressing climate change and human rights

Recognising the threat of human interference with the climate system, the United Nations developed the Framework Convention on Climate Change (UNFCCC 1994). With almost universal membership, the Convention compels countries to stabilise atmospheric concentrations of greenhouse gases, particularly industrialised nations given they contributed most to past and current sources. Countries must regularly report against their commitments to reducing greenhouse gas emissions. Successive UNFCCC meetings at Kyoto (1997), Copenhagen (2009) and Paris (2015) have sought commitments to increase climate ambition and lower emissions. Australia's commitment to reduce emissions by 26–28 per cent of 2005 levels by 2030 is generally viewed as inadequate to limit global warming to the Paris Agreement target of 1.5°C (Climate Council of Australia 2019).

The *United Nations Declaration on the Rights of Indigenous Peoples* (2007), supported by the Australian Government, sets minimum standards and affirms basic rights that will safeguard the survival, dignity and wellbeing of Indigenous communities across the globe. In recognising these rights and the value of Indigenous peoples' knowledges for sustainable environmental management, the Declaration supports Aboriginal and Torres Strait Islander participation in planning and implementing climate change responses. Other international human

rights instruments adopted in 1966 that are relevant to Indigenous people and climate change include the *International Covenant on Civil and Political Rights* up and the *International Covenant on Economic, Social and Cultural Rights* that outlines rights to self-determination and adequate housing, health, food, and water.

Inadequate legal and policy measures in Australia to reduce greenhouse gas emissions has led to climate litigation. In a bid to pressure the Australian Government to do more to reduce greenhouse gas emissions, a group of eight Torres Strait Islanders are taking a claim to the United Nations against the Australian Government for breaching their fundamental rights to culture, family and life (Box 2, below).

BOX 2:

'Torres Strait 8' – linking human rights to climate change

The low-lying islands of Zenadth Kes (the Torres Strait) are going underwater. Sea levels in the region are rising by 6–8 mm per year. In 2019, a group of eight Torres Strait Islanders lodged a complaint against Australia to the United Nations Human Rights Committee for breaching their fundamental rights to culture and life by failing to address climate change. They are asking the Australian Government to: cease the use and export of thermal coal; decrease greenhouse gas emissions by at least 65 per cent below 2005 levels by 2030 and to net zero by 2050; and provide proper adaptation measures on the islands. It is the first time the United Nations has heard a case by climate-vulnerable people against their own government. The Australian Government has responded believing its actions on climate change are adequate in meeting human rights obligations of the Torres Strait Islander people. Since the complaint was lodged, the Government announced a $25 million package to construct seawall infrastructure.

"We live in fear where we will go to. We are concerned where we are relocated to in the future. We are not talking about 100 years, but 30 to 50 years. We have our ancestors here, they are tying us to our land. We don't want to leave our loved ones behind." — Yessie Mosby, one of the 'Torres Eight' quoted in Mosby & Keller (2020)

National policy and legislation: Aboriginal and Torres Strait Islander rights and climate change

Land and culture

Being "on-Country" and "Caring for Country" has demonstrated ecological benefit and positive health impacts through healthier diets, more exercise and enhanced family wellbeing and spiritual connection (Burgess, Johnston, Berry et al. 2009; David, Wilson, Yantarrnga et al. 2018; Kingsley, Townsend, Phillips et al. 2009; Wright, Yap, Jones et al. 2021). The *Native Title Act, 1993* and various state land rights and cultural heritage regimes regulate access to, and activities undertaken on Country and are meant to uphold and protect rights of Aboriginal and Torres Strait Islander peoples, based on their ancestral relationship and traditional customs. Native Title, however, does not provide for other beneficial social and economic development and commercial opportunities, limiting the potential for autonomy and use of Country as the community desires (AHRC 2009; Altman, Buchanan & Larsen 2010). As seen recently, this lack of autonomy and control has potentially devastating consequences for both climate change — the extinguishment of Native Title for the Adani coal mine; and for wellbeing — the wilful destruction of 46,000 years of cultural heritage at Juukan Gorge in the Kimberley. Power imbalances enabled through existing land rights legislation has hampered improvements to Aboriginal and Torres Strait Islander socio-economic positioning and health and wellbeing (Henderson, Byleveld, Standen et al. 2016; Watson 2007) (Box 3).

BOX 3:

Land Rights and Health

In 2006, an Amendment Bill to the *Aboriginal Land Rights (NT) Act, 1976* passed with little community consultation. It provided Traditional Owners option to grant 99-year leases over their land and townships to promote private investment. While entry into the lease system is voluntary, communities have been coerced into providing leases in exchange for government funding for basic rights such as housing and education and there are similar implications for provision of health services (Creamer & Hall 2019; Grealy 2021; Watson 2007).

The *NSW Aboriginal Land Rights Act, 1983* led to the establishment of Local Aboriginal Land Councils (LALCs) providing them control of Aboriginal reserve and mission land as an act of reconciliation and compensation for historic dispossession. However, the LALCs were not provided the resources nor technical knowledge and skills required of local councils to develop and maintain housing, roads, water and sewerage systems - key health and safety infrastructure. Twenty-five years of significant underfunding has led to widespread housing disrepair, community infrastructure failures and associated health risks (Henderson, Byleveld, Standen et al, 2016). Over the last decade, policy initiatives are attempting to catch-up the backlog (e.g., Aboriginal Communities Water and Sewerage Program, Roads to Home Program, Housing for Health). Health impacts from substandard housing, water, sewerage, power and telecommunications infrastructure will be compounded by global warming (NACCHO 2021; Race, Mathew, Campbell et al. 2016b).

In the national *Housing for Health* program, surveys of public housing in 190 Aboriginal communities over 1999–2012 revealed that only 10 per cent of homes were electrically safe, 35 per cent had a functioning shower and 6 per cent had a kitchen in which food could be stored, prepared, and cooked. Most faults were due to poor maintenance or poor initial construction/installation. The program was able to make substantial improvements over this time, however the main limitation was funding (Pholeros, Lea, Rainow et al. 2013). In NSW, improvements made under *Housing for Health* led to significantly reduced rates of hospitalisations for infectious diseases (Phibbs & Thompson 2011).
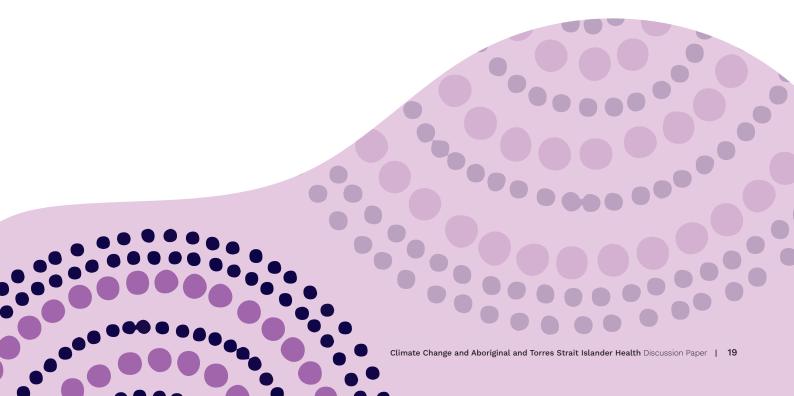
Water

An integral part of Country, healthy waterways nurture Aboriginal and Torres Strait Islander identity, spirituality, and culture (Moggridge & Thompson 2021). In Australia, legislation separates rights to water and land. National water policy has failed to recognise Aboriginal and Torres Strait Islander peoples' traditional rights and interests effectively declaring the surface and ground waterways of Australia *aqua nullius*, as the water belonging to no-one (Marshall 2017). The National Water Initiative (NWI) is aimed at addressing water mismanagement and ensuring a balanced distribution to meet both economic and environmental values. The NWI has enhanced the commodification of water through expanded trading schemes and while it explicitly recognises Aboriginal rights and interests, these are relegated to one of many minority 'other public benefits' amongst recreation, tourism and fisheries (Marshall 2017; Moggridge & Thompson 2021). In advocating for water rights within Australia's water management regime, Aboriginal Nations in the lower Murray-Darling Basin developed the term 'cultural flows' —

water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations. (MLDRIN 2007)

Despite subsequent government recognition of the importance of cultural flows and promised funding to secure cultural flows, nothing has eventuated, continuing the exclusion of Aboriginal communities from their inherent rights to access water on Country (Moggridge & Thompson 2021).

Australia's history of water commercialisation, overextraction, diversion, and pollution are threatening important cultural resource sites across Australia. In the Northern Territory, due to lack of consideration of cultural values in water licence assessments, the Central Land Council (CLC) undertook its own survey of the impact of a proposed agricultural licence to draw 40,000 megalitres of water per year over 30 years to grow export crops. Some 29 different sacred sites and songlines on Warrabri and Iliyarne Country are threatened, even by the smallest drop in the water table (Donaldson 2021).

Aboriginal people should have control over water, it is part of our country. We thought we had land rights but what good is land without water? "... Extracting water from the desert "makes no sense. We can't be certain it can be recharged and rain is not as reliable as it used to be. David Curtis Jungarrayi quoted in CLC media release (Central Land Council 2021, p.3)

Housing and community infrastructure

Access to affordable, safe, sustainable housing and quality living environments is a key determinant of health (NACCHO 2021). A safe home has adequate space for members of the household with functioning plumbing and electrical utilities to maintain good health and hygiene (Ware 2013). One in five (20%) Aboriginal and Torres Strait Islander people live in overcrowded homes compared to 6–7 per cent of non-Indigenous people (AIHW 2019b). In Central Australia, up to 22 residents have been recorded in a 3-bedroom house and a family of a renal dialysis patient camped in a backyard for over one year to access health facilities nearby (Landsbury, Redmond, Memmott et al. 2020). Almost half (49%) of Aboriginal and Torres Strait Islander households in remote areas are overcrowded compared to urban areas (8%) (AIHW 2019b).

One in three (33%) Aboriginal and Torres Strait Islander people are living in houses with major structural defects or plumbing or electrical issues (AIHW 2020). Construction of Aboriginal housing has been plagued by inappropriate design, use of cheap, substandard materials and inconsistent maintenance (NACCHO & AHCWA 2019; Pholeros, Lea, Rainow et al. 2013). Failures in household utilities and community infrastructure lead to environmental health risks related to water supply, food safety, sewerage systems and functioning health hardware such as taps and washing machines (NACCHO 2021). Water quality in remote communities often fails to meet national standards (Office of the Auditor General Western Australia 2015). Overcrowding and infrastructure defects increase the risk of injury, disease and psychological distress (NACCHO 2021). Poor housing conditions also reduce residents' ability to control indoor temperatures with high indoor temperatures associated with poor sleep, cardiovascular disease, respiratory illness and poor mental health (WHO 2018). There has been little research on the health effects of indoor temperature variations for people living in extreme climates in Australia.

Provision of Aboriginal and Torres Strait Islander housing occurs across multiple levels of government and administrative arrangements, via state-owned and managed and Indigenous Community Housing Organisations (NACCHO 2021). Current funding and policy approaches to Aboriginal and Torres Strait Islander public housing are inadequate to meet demand and improve existing stock (NACCHO 2021). Best practice recommendations in the National Indigenous Housing Guide are rarely adopted, there is a lack of effective tenancy and property management and construction and maintenance are outsourced with minimal regulatory oversight (Grealy 2021; Horne, Martel, Arcari et al. 2013; NACCHO 2021; Pholeros, Lea, Rainow et al. 2013).

Provision of emergency and transitional housing solutions in crisis situations also remains a policy problem in Australia (NACCHO 2021). The inclusion of a new housing target to reduce overcrowding in the National Agreement on Closing the Gap signals a start to an integrated cross-government approach to housing and health. More funding support is required to boost housing investment with mandatory consideration of sustainability needs in the context of climate change, for example construction of housing and use of materials that can withstand extreme weather, and eco-efficient design to minimise reliance on polluting energy sources (NACCHO 2021).

Health

Aboriginal and Torres Strait Islander health leadership has led the way in securing a seat at the policy development table for the refresh of the National Aboriginal and Torres Strait Islander Health Plan for 2021–2031, the new National Aboriginal and Torres Strait Islander Health Workforce Plan and through the Coalition of Peaks central to the new National Agreement on Closing the Gap (Commonwealth of Australia 2021). Up until now, environmental health determinants have largely been absent from national Aboriginal and Torres Strait Islander health policies. In the latest Close the Gap Agreement, there are targets obligating the government to reduce household overcrowding and increase the proportion of land and sea subject to Aboriginal and Torres Strait Islander rights and interests (Commonwealth of Australia 2021). While a positive step forward, there is no specific mention of the need for climate change planning despite the obvious and profound risks to public health. Encouragingly, the imminent refresh of the *National Aboriginal and Torres Strait Islander Health Plan* has social and cultural determinants of health as foundational aspects and a priority area of healthy environments, sustainability and preparedness.

In the absence of overarching climate change and health policy, the Lowitja Institute has called on governments to "effectively respond to the climate emergency and invest in mitigation, prevention and adaptation planning for Aboriginal and Torres Strait Islander communities" (Lowitja Institute 2021, p.7).
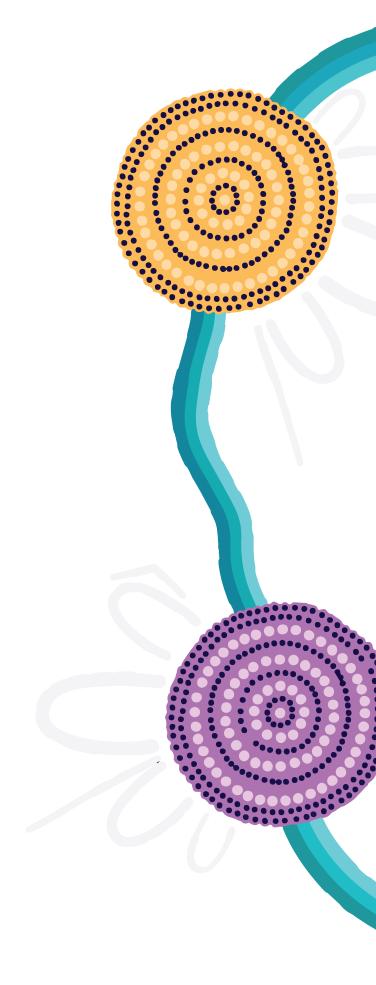
This includes committing resources to communities and community-controlled organisations to undertake holistic intersectoral planning and risk assessments to manage extreme weather. Appropriate planning will require Aboriginal and Torres Strait Islander leadership and embedding of cultural knowledges within a national response to the climate crisis (Lowitja Institute 2021).

An integrated rights-based approach to climate change and Aboriginal and Torres Strait Islander health

As described above, some individual policy initiatives are beginning to incorporate aspects of climate change and sustainable development, but an intersectoral and nationally consistent approach is required. The Climate and Health Alliance has designed a national framework for governments to integrate climate change action and health, directing policymakers to

recognise the importance of connection to land for Aboriginal and Torres Strait Islander people's health and well-being and ensure that access to traditional lands and respect for native title underpins decision-making with regard to land use and land use change. **Climate and Health Alliance** (2017, p.29)

From the analysis of policy and legislation, it is clear that to restore justice and protect the rights and interests of Aboriginal and Torres Strait Islander communities, a national framework needs to integrate their meaningful participation and leadership at all levels of planning and implementation.

Scoping review of climate change and Aboriginal and Torres Strait Islander health

This section provides outcomes from a rapid scoping review of the literature that addressed two questions:
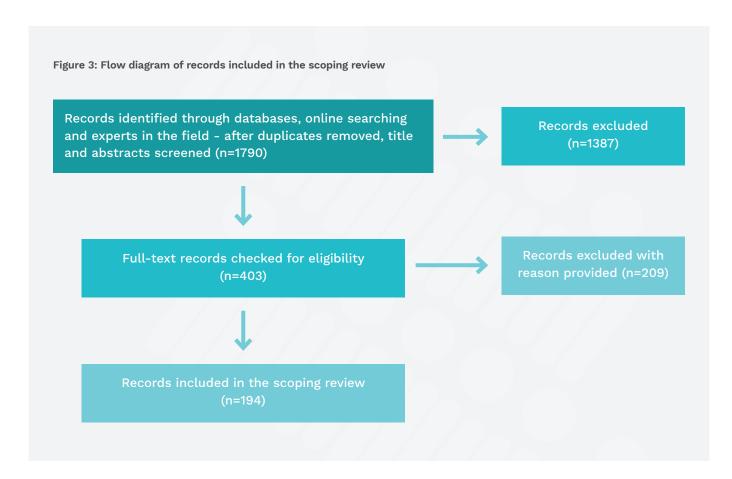
1. **How climate change impacts on the health (both directly and indirectly) of Aboriginal and Torres Strait Islander people, and**

2. **What are the mitigation and/or adaptation approaches to climate change that benefit the health of Aboriginal and Torres Strait Islander people and First Nation communities globally.**

The review looked at both the academic literature (peer-reviewed) as well as publicly available information (grey literature) in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis extension for scoping review (PRISMA-ScR). Our search methodology and results are outlined in Appendix 3. Figure 3 summarises the screening processes with 1,790 records initially identified and 194 items included in the final review.

Direct impacts on health

Extreme temperature

Heatwaves (extended periods of hot weather) impact workforce productivity and exacerbate existing chronic disease (Hall & Crosby 2020). Across all populations, increases in heat-related mortality and morbidity are projected to occur with climate change (Vardoulakis, Dear, Hajat et al. 2014). Acclimatisation to hotter temperatures can offer some protection, however, there are upper physiological limits to human thermoregulatory capacity and people living in tropical regions are already close to the upper limit of potential to acclimatise further (TSRA 2018). Extreme heat raises core body temperature and affects motor-cognitive function increasing the likelihood of occupational accidents and injuries for outdoor workers including in agricultural, mining and land management (Hall & Crosby 2020; Yenneti, Ding, Prasad et al. 2020). Hotter temperatures can also increase adverse pregnancy outcomes and increase

Figure 3: Flow diagram of records included in the scoping review


```
Records identified through databases, online searching
and experts in the field - after duplicates removed, title    →    Records excluded
and abstracts screened (n=1790)                                      (n=1387)
                        ↓
Full-text records checked for eligibility                      →    Records excluded with
(n=403)                                                              reason provided (n=209)
                        ↓
Records included in the scoping review
(n=194)
```

hospital admissions for mental health and chronic conditions (Ebi, Capon, Berry et al. 2021; Mathew, Mathur, Chang et al. 2017). In urban centres, the combined effects of heatwaves and poor air quality has increased emergency department admission rates for Aboriginal people in Perth (Patel, Jian, Xiao et al. 2019) and Aboriginal children in Brisbane due to respiratory conditions (Xu, Liu, Ma et al. 2014). Most deaths attributable to heatwaves arise from exacerbations of pre-existing conditions rather than direct impacts such as heatstroke (Borchers Arriagada, Bowman, Palmer et al. 2020; Green, Bambrick, Tait et al. 2015).

There are also indirect effects on health due to lower rates of physical activity in high heat and humid environments (TSRA 2018). Hotspells may also trigger instances of interpersonal violence where social intolerance levels increase from heat irritation (Sobhy, Jones, Peterman et al. 2019; TSRA 2018). This has severe implications for Aboriginal and Torres Strait Islander communities particularly inland and in northern areas where median temperature rises are expected to range between 2.9 and 4.3°C by 2090 (CSIRO & BOM 2015) (Figure 1: i).

Aboriginal and Torres Strait Islander communities in northern coastal regions are already experiencing sea-level rise and its devastating consequences for traditional homelands (Green, Alexander, McLnnes et al. 2010; Suppiah, Collier & Kent 2011; Zander, Petheram & Garnett 2013) including inundation of townships, burial sites, turtle breeding grounds and associated impacts on wellbeing (Arabena & Kingsley 2015; Nursey-Bray, Palmer, Smith et al. 2019). Indigenous rangers from Kakadu National Park and rangers from the Djelk Indigenous Protected Area, have also identified that many cultural sites have been impacted by sea-level rise (Carmichael, Wilson, Namarnyilk et al. 2018). Under climate change there will be more frequent extreme coastal surges leading to salt inundation of freshwater supplies, collapse of protective mangroves systems and coastal erosion (Climate Council of Australia 2014).

An ultimate consequence of sea-level rise may be the forced migration off Country as forewarned by Torres Strait Islander communities (TSRA 2016). Forced migration as an adaptation strategy is a 'last resort' option due to the irrevocable loss and damage to health and wellbeing that comes from permanent

Arnhem Land

displacement (Middleton, Cunsolo, Jones-Bitton et al. 2020). Communities in the Northern Territory have spoken of preferred temporary migration to places relatively close to existing locations within homeland locations (Carson, Bird, Bell et al. 2014). Where sea-level rise forces permanent relocation such as in the case of low-lying island communities, the affected communities need to have control over migration decisions. In other Pacific communities, barriers to relocation have included place attachment, loss of economic livelihood, identification of suitable land for relocation and community consensus (Dannenberg, Frumkin, Hess et al. 2019). A relocated community in Fiji reported the following benefits: movement away from environmental risks to health, adequate drinking water and sanitation, improved food security, livelihood opportunities, access to schools and health services, and appropriate housing design (McMichael & Powell 2021). More research is needed on the health impacts of managed retreats, including surveillance of health and wellbeing indicators before and after communities migrate due to climate hazards (Dannenberg, Frumkin, Hess et al. 2019). Where migration is unavoidable, planning needs to commence early to minimise harm and disruption (Carson, Bird, Bell et al. 2014; TSRA 2016).

Extreme fire weather, bushfires, smoke and air pollution

Increased days of extreme fire weather are predicted across all regions due to climate change. Models show a link between the 2019–2020 'Black Summer' season and climate change induced temperature extremes in south-eastern Australia (van Oldenborgh, Krikken, Lewis et al. 2021). There were 33 direct deaths and 417 excess deaths attributed to the bushfire smoke (Nairn, Beaty & Varghese 2021). Similar to heatwaves, most deaths from bushfire smoke result from exacerbation of pre-existing health conditions, such as respiratory and heart problems (Borchers Arriagada, Bowman, Palmer et al. 2020) and may contribute to mental health issues related to displacement from homes and communities (Hall & Crosby 2020). A significant proportion of Aboriginal people were impacted by the Black Summer fires in NSW and Victoria, comprising 5.4 per cent of the population in the fire-affected areas (Williamson, Markham & Weir 2020). In addition to infrastructure damage and loss of stock and crops, bushfires present risks to water security from ash siltation and contamination, loss of biodiversity and damage to or destruction of significant cultural sites (Borchers Arriagada, Bowman, Palmer et al. 2020; Hall & Crosby 2020).

Patch burning on edge of flood plain Country, Karapitar on Rak Mak Mak Marranunggu Country on E2, Delissaville, Wagait, Larrakia Aboriginal Land Trust, NT

Climate change and warmer weather conditions may result in higher concentrations of ground-level ozone (the main pollutant in 'smog'), which has an impact on respiratory health and has been associated with increased daily mortality (Physick, Cope & Lee 2014). Other problematic airborne particulates driven by warmer conditions include fungal spores and plant pollen that can cause respiratory, eye and skin conditions (Hall & Crosby 2020; Melody, Bennett, Clifford et al. 2016).

Aboriginal fire management knowledges have been successfully incorporated into hazard reduction strategies in southern Australia, mostly through grassroots led small-scale collaborations (Smith, Neale & Weir 2021). Formal incorporation into wildfire mitigation policy has yet to occur due to the bureaucratic dismissal of Aboriginal practices as suffering from a 'lack of evidence' (Smith, Neale & Weir 2021). To overcome these barriers, alternative strategies are being pursued to create more durable and authoritative examples such as the production of a seasonal calendar that integrates Aboriginal traditional fire regimes with Western science (McKemey, Rangers, Ens et al. 2021; Smith, Neale & Weir 2021). After a decade of advocacy, traditional fire

practices have received scientific acceptance in the Northern Territory, being used as carbon abatement strategies to minimise intensities and occurrences of bushfires that account for approximately half of the Territory's greenhouse gas emissions (Altman, Buchanan & Larsen 2010).

Drought (and desertification)

With lower frequency of seasonal rainfall events predicted for southern areas of the Rangelands and in Southern Australia, more drought periods are expected to occur. Out of all climate change impacts, drought is the costliest, affecting food production and establishing conditions ripe for bushfires and dust storms. Along with economic shocks (agricultural and employment impacts), drought lowers the quality of air (from increased dust), food and water (Hall & Crosby 2020; Rigby, Rosen, Berry et al. 2011). Prolonged drought is known to negatively affect mental health for rural populations including Aboriginal communities (Hart, Berry & Tonna 2011). In addition to employment and money worries, the sense of loss triggered by seeing the land 'sick' and affecting communities' ability to undertake cultural responsibilities, were key wellbeing concerns of Aboriginal communities

Lands of the Kariyarra, Ngarla, and Njamal people as the Traditional Custodians of Port Hedland
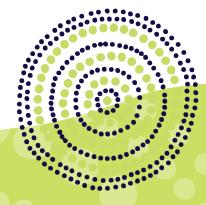
in drought-affected regions (Rigby, Rosen, Berry et al. 2011). Remote Aboriginal communities in arid areas, will be increasingly exposed to particulate air pollution from geogenic dust due to their geology, dry climate, exposure to wind erosion and, in some cases, proximity to mining activities. Geogenic dust is associated with eye irritation, as well as exacerbation of underlying cardiovascular and respiratory disease (Melody, Bennett, Clifford et al. 2016). Increased dust storms in Central Australian deserts may extend to either the east or west coast having implications for cardio-respiratory diseases across a broad geographic area (Campbell, Stafford Smith, Davies et al. 2008).

Cyclones, extreme rainfall, floods

In addition to causing infrastructure damage, death and injury, cyclones and floods can also risk food security due to supply chain disruption or crop destruction (Hall & Crosby 2020). Water supplies may also become contaminated from sewerage and other runoff (Hall & Crosby 2020). Modelling has suggested that while cyclones may become less frequent, warmer sea surface temperatures will increase the intensity and penetration of tropical cyclones in Australia further inland and southward thereby subjecting a much larger geographic area to higher wind speeds and intense rainfall (Bruyère, Done, Jaye et al. 2019). A recent example is Tropical Cyclone Debbie that crossed the northern coast of Queensland in 2017 and caused a trail of destruction hundreds of kilometres through Queensland and into NSW, primarily due to damaging winds, periods of torrential rainfall and widespread major flooding. In the Northern Rivers region, the ensuing flood disproportionately impacted rural Aboriginal communities and other low socio-economic households living within flood zones (Matthews, Longman, Berry et al. 2019). These households also indicated higher psychological morbidity after the flood including probable post-

traumatic stress disorder and lower levels of social capital, a prerequisite for adaptive capacity (Matthews, Longman, Bennett-Levy et al. 2020). In contrast, Aboriginal communities in Darwin were perceived to have greater resilience compared to the non-Indigenous population after Cyclone Tracy in 1974 as they were not so dependent on material possessions and could rely on land for food and the social capital available through extended family networks (Haynes, Bird & Carson 2014).

Aboriginal and Torres Strait Islander communities have been mostly excluded from disaster risk planning. Emergency management is viewed as something done 'for' rather than 'with' Aboriginal and Torres Strait Islander communities (Howitt, Havnen & Veland 2012; James, Burton, Campion et al. 2021). A survey in remote communities in Western Australia showed that 40 per cent of communities prone to cyclones did not have evacuation plans (Howitt, Havnen & Veland 2012). After extensive flooding following a tropical cyclone, ill-preparedness and lack of community engagement resulted in the evacuation and traumatic displacement of the Kiwirrkurra community in the East Pilbara for more than 18 months. The Kiwirrkurra's return was self-facilitated, supported through the sale of community artworks (Howitt, Havnen & Veland 2012). Emergency management services need to engage earlier with communities to build understanding of Aboriginal and Torres Strait Islander worldviews and negotiate what are appropriate disaster responses and recovery procedures. This includes understanding the historical legacies and intergenerational trauma associated with forced removals and dispossession (Howitt, Havnen & Veland 2012; James, Burton, Campion et al. 2021).

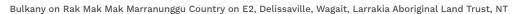# Indirect impacts on health from altered natural systems

Food security

Climate change threatens productivity of local horticultural crops and availability of traditional food sources for Aboriginal and Torres Strait Islander communities due to extinctions, biodiversity loss and impacts on animal and plant distributions (AHRC 2009; Altman, Buchanan & Larsen 2010; TSRA 2018; Zavaleta-Cortijo, Ford, Arotoma-Rojas et al. 2020). For example, increased heat and coastal erosion are threatening the breeding patterns of turtles (Nursey-Bray, Palmer, Smith et al. 2019). The environmental cues that were the basis of traditional seasonal calendars are changing in ways that mean Aboriginal communities cannot 'read' the landscape requiring an adjustment to this knowledge (Nursey-Bray, Palmer, Smith et al. 2019). Reduced food supply can affect health both directly (nutrition and diet) and indirectly (affordability). Loss of locally sourced foods will mean changes to subsistence practices and communities becoming more reliant on store foods that can be

of poor quality, as well as unreliable and expensive in rural and remote areas due to transportation and storage costs. Extreme weather events from climate change will also risk these supply chains, driving up the price of healthy food and further compromising food affordability and accessibility in communities (Hall & Crosby 2020; Keating 2013).

Water security

Predicted declines in rainfall over central and southern Australia will add further stress to surface and underground water resources. In addition to drought conditions, saltwater intrusions and intense storms and floods have the potential to contaminate existing freshwater supplies for Aboriginal and Torres Strait Islander communities (Hall & Crosby 2020; TSRA 2018). Communities are already experiencing shortages of safe drinking water and are worried about the drying up of ancient waterholes and the safety of ground-water dependent sacred sites, further risking health and wellbeing (Donaldson 2021; Hall, Grodecki, Jackson et al. 2021). For example, many remote communities rely solely on bore water for drinking supplies which will be under threat from climate

Bulkany on Rak Mak Mak Marranunggu Country on E2, Delissaville, Wagait, Larrakia Aboriginal Land Trust, NT

change due to slow recharge rates of underground aquifers (Melody, Bennett, Clifford et al. 2016). Some Torres Strait Island communities are already forced to rely on expensive desalination to help fulfil potable water needs (TSRA 2018). Poor water supply for communities also risks increasing the incidence of diseases including diarrhoeal disease, hepatitis B and skin infections due to poor sanitation (Jaravani, Massey, Judd et al. 2016).

Infectious disease

Climate change is likely to increase incidence of climate-sensitive infectious disease through several transmission pathways: insect vectors, air, food, water, and soil. Increased distribution of mosquito borne diseases (Dengue, Ross River and Barmah Forest Virus) may occur due to geographical expansion of favourable breeding conditions, with warmer temperatures and increased humidity and rainfall/flooding creating stagnant water reservoirs (Hall, Barnes, Canuto et al. 2021; Hall & Crosby 2020). For example, while there are mostly sporadic outbreaks of Dengue in northern Queensland, the *Aedes* mosquitoes that carry Dengue are expected to increase in distribution south and west across the country with implications for Aboriginal and Torres Strait Islander communities due to lower health care access and poor housing infrastructure that increases risk of mosquitoes exposure (Akter, Hu, Gatton et al. 2021).

Hotter temperatures are increasing risk of food-borne disease such as *Salmonella* and *Campylobacter* (Hall & Crosby 2020). Water and soil-borne diseases such as melioidosis, nontuberculous mycobacteria and leptospirosis may increase from higher rainfall and storm events (AHRC 2009; Hall, Barnes, Canuto et al. 2021). Sewerage and other contamination of water supplies from storm run-off may affect incidence of gastroenteritis and Hepatitis A (Hall & Crosby 2020). Tuberculosis (TB) is an airborne infectious disease of particular concern in the Torres Strait with its proximity to Papua New Guinea where multi-drug resistant TB is prevalent. Conditions that enhance the spread of TB (higher humidity, rainfall and temperature) are predicted for the Torres Strait (Hall, Barnes, Canuto et al. 2021).

Lands of the Kariyarra, Ngarla, and Njamal people as the Traditional Custodians of Port Hedland

Karapitar on Rak Mak Mak Marranunggu Country on E2, Delissaville, Wagait, Larrakia Aboriginal Land Trust, NT

Indirect impacts from altered social systems

Housing and community infrastructure

Housing and health are inextricably linked. As described earlier, the quality and quantity of Aboriginal and Torres Strait Islander housing is substandard and there is overcrowding issues across remote, rural, and urban areas. Health impacts will be exacerbated by the inability to shelter safely from extreme weather such as heatwaves (high temperatures in both day and night) and intensified cyclones (Green, King & Morrison 2009; Hall & Crosby 2020). As evidenced in the COVID-19 pandemic (Landsbury, Redmond, Memmott et al. 2020), overcrowded conditions increase the risk of transmission of infectious conditions (including skin, eye, and respiratory infections) (Hall & Crosby 2020; Melody, Bennett, Clifford et al. 2016; Xu, Liu, Ma et al. 2014). Climate change will increase demand for energy and with rising costs of electricity supply, low-income Aboriginal and Torres Strait Islander households are less likely to have the resources to cope (Memmott, Reser, Head et al. 2013). For example, in Central Australia, there is hesitancy in the use of air conditioners due to running costs, so residents stay outdoors in shaded areas and sleep outside during the night (Horne, Martel, Arcari et al. 2013). Unsuitable housing design and energy poverty together affects people's capacity to adapt to hot weather (Race, Mathew, Campbell et al. 2016a).

Early involvement and consultation during mitigation and adaptation planning is essential as some action on adaptation measures may have undesirable consequences or Aboriginal and Torres Strait Islander communities may miss out altogether. For example, there is deep worry amongst Warumungu leaders that their communities, who are already experiencing extreme heat conditions, will not benefit from a large solar farm planned on their traditional lands that will export power to Darwin and Singapore (Chlanda 2020). Under current land rights legislation, there is no certainty of inclusive Aboriginal and Torres Strait Islander community development alongside large-scale renewable energy projects unless measures are taken to ensure it (Hunt, Riley, O'Neill et al. 2021).

Intangible loss and social and emotional wellbeing

Intangible losses from climate change are difficult to quantify. Extreme weather will compromise community ability to carry out cultural responsibilities in caring for Country that will further compound ecosystem degradation, reduce biodiversity and impact overall social and emotional wellbeing. There is a complex interplay between physical, social, economic, and cultural factors that shape mental health and wellbeing (Berry, Waite, Dear et al. 2018). Social and emotional wellbeing issues can also manifest in a variety of ways including strong emotional responses (suicide, post-traumatic stress, depression, and anxiety) to emerging conditions including climate change anxiety and eco-grief (Middleton, Cunsolo, Jones-Bitton et al. 2020). A recent international review of climate change, mental health and First Nations peoples reported psychological and emotional disruption from altered place attachment (similar to the notion of 'solastalgia' (Albrecht, Sartore, Connor et al. 2007) – "the homesickness you have when you are still at home"), changes in food security systems, forced relocation and disrupted cultural continuity (Middleton, Cunsolo, Jones-Bitton et al. 2020). It also reported extenuated feelings of anger, abandonment and helplessness having to deal with problems caused by other people; emotions that are linked to historical and ongoing disempowerment (McNamara & Westoby 2011; Middleton, Cunsolo, Jones-Bitton et al. 2020). There are subtle differences in emotional responses across genders and age groups largely dependent on experience and responsibilities; for example, intensified feelings of solastalgia for Elders due to

Gunbalanya, Mengerr Country

their longer experience connected to Country and for men distress over risks to seasonal farming/hunting affecting their employment and land-based identity (Middleton, Cunsolo, Jones-Bitton et al. 2020), similar to mental health impacts experienced by drought-affected farmers in Australia (Hanigan, Butler, Kokic et al. 2012; Hart, Berry & Tonna 2011).

Impact on health service provision

Climate change can impact both the integrity of health system infrastructure and the effectiveness of service operations through environmental interruptions, increased demand and reduced workforce capacity. Health care services in remote areas are at particular risk due to climate extremes and levels of isolation. For example, in the Kimberley region of Western Australia during a flood season in 2017/2018, delivery of essential goods and medical supplies to communities with high chronic disease burden was extremely challenging and costly (NACCHO & AHCWA 2019). A risk assessment of climate impacts on the Torres Strait health system identified interdependencies across sectors including energy (increased blackouts jeopardising communication and food and vaccine supply), water (lack of safe supply), employment (loss of client

financial resources to access care) and transport (movement of goods and health staff between communities) (NACCHO & AHCWA 2019; TSRA 2018).

The healthcare workforce is inequitably distributed within Australia with chronic staff shortages in rural and remote regions (Pendrey, Quilty, Gruen et al. 2021). Remote areas generally rely on a transient health workforce (short-term locum, fly or drive in and out models). Lack of quality, 'fit for purpose' housing and infrastructure impedes the recruitment and retention of staff (NACCHO & AHCWA 2019). Climate change will magnify these workforce pressures. In a recent survey of Northern Territory medical and health professionals about predicted climate impact on working conditions, 34 per cent indicated they would consider leaving due to extreme heat, intensified floods and cyclones, rising sea levels, bushfires and water shortages (Pendrey, Quilty, Gruen et al. 2021). Nearly 75 per cent thought that climate change was making or would make parts of the Northern Territory uninhabitable, and 85 per cent were witnessing the severe impacts of climate change on the Aboriginal communities they served (Pendrey, Quilty, Gruen et al. 2021). Climate-related workforce migration will further reduce service access for Aboriginal communities compounding existing health inequities.

Co-existence and water, Kungali (Ibis) and Kalalak (corella) at Gunn in Palmerston on Larrakia Country

Climate change adaptation and mitigation

As the world's oldest living culture, Aboriginal and Torres Strait Islander peoples have constantly adapted to both natural and 'un-natural' disturbances. Climate change is seen as the next significant challenge with Aboriginal and Torres Strait Islander people already participating in adaptation and mitigation and strongly advocating for action nationally (e.g., Seed Mob — Seed Indigenous Youth Climate Network) and internationally (e.g., participation on the International Indigenous Peoples Forum on Climate Change[1]). This

section highlights existing initiatives and describes the groundwork required to build on this Aboriginal and Torres Strait Islander leadership that will ultimately benefit the whole of society.

Critically, any type of climate change planning needs to be inclusive of Aboriginal and Torres Strait Islander people and organisations (Hill, Walsh, Davies et al. 2020; NACCHO & AHCWA 2019). Inclusive planning, particularly with population groups most at risk, builds social connectedness and reduces the potential for maladaptation, where strategies are not suited to community context (NACCHO & AHCWA 2019; Race, Mathew, Campbell et al. 2016a).

1. International Indigenous Peoples Forum on Climate Change: http://www.iipfcc.org/

Laying the groundwork

Documented conversations with Aboriginal and Torres Strait Islander communities about responding to climate challenges consistently focus on basic rights (livelihoods, shelter, food and water) that have been diminished by colonial and post-colonial injustices (Martuwarra RiverOfLife, Taylor & Poelina 2021; Nursey-Bray & Palmer 2018) (Box 4). Appropriate planning requires a holistic approach, sufficient resourcing and intersectoral collaboration to address priority needs of the community (Race, Mathew, Campbell et al. 2016a). There are several immediate needs that can strengthen community adaptive capacity:

- **Upgrade existing housing and community infrastructure** (including water and sanitation) to relevant standards and to withstand local climate conditions (NACCHO 2021). Change building and tenancy regulations where necessary to improve future housing development, design, and modification processes (Horne, Martel, Arcari et al. 2013).

- **Provide relevant information, skills and know-how.** Aboriginal and Torres Strait Islander communities recognise the need to weave together their own knowledge systems with Western science, however communities may have limited access to technical expertise particularly in remote areas (Nursey-Bray, Palmer, Smith et al. 2019). For example, technical skills in renewable energy technology can assist with energy poverty and communities to maintain more reliable energy systems (Memmott, Reser, Head et al. 2013).

- **Provide sustainable resourcing and flexibility in government program funding**. The stop/start nature of initiatives that have supported local adaptation projects do not allow for ongoing and sustainable approaches to be developed and trialled. Most projects have occurred through academic/community partnerships utilising short-term research funding (Nursey-Bray, Palmer, Smith et al. 2019). There has also been examples of community-led initiatives that have missed out on resource support because they have not 'fitted' into government defined climate adaptation frameworks and priorities (Nursey-Bray, Palmer, Smith et al. 2019).

- **Ensure equitable governance and power-sharing arrangements** for community autonomy to drive adaptation processes based on local knowledge, cultural values, needs and priorities (Nursey-Bray, Palmer, Smith et al. 2019).

- **Promote intersectoral collaboration** for holistic approaches to adaptation planning that address multiple environmental, social, cultural, health and economic goals (Nursey-Bray 2019; TSRA 2014).

BOX 4:

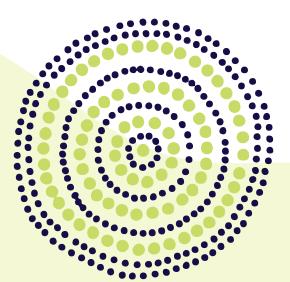### First Law, Living Waters – decolonising water governance
(Martuwarra RiverOfLife, Taylor & Poelina 2021)

Co-governance of water resources is required to ensure sustainable and equitable distribution, especially with climate change increasing water security risk. The discretionary nature of Aboriginal rights outlined in the National Water Initiative mean that water is preferentially delivered to users who meet Western economic development objectives. The Walalakoo Aboriginal Corporation are taking proactive steps to decolonise water governance, implementing their own 'First Law, Living Waters' framework on Native Title lands in West Kimberley. They are drawing on commonalities across both governance frameworks (sustainability, environment, benefits, and responsibility) to provide a foundation for open dialogue to shift colonialist thinking from securing rights to take water to a harmonised, reciprocal approach emphasising responsibility to look after water systems in line with Aboriginal worldviews.

Adaptation planning

Aboriginal and Torres Strait Islander people have championed the benefits of two-way science (Martuwarra RiverOfLife, Taylor & Poelina 2021; Woodward, Hill, Harkness et al. 2020). Environmental science initiatives funded primarily through government research programs (e.g., CSIRO, National Climate Change Adaptation Research Facility [NCCARF] and the National Environmental Science Program [NESP]) have advanced the field of best-practice knowledge co-production for Aboriginal and Torres Strait Islander-led caring for Country initiatives and climate adaptation (Hill, Walsh, Davies et al. 2020; Morgan-Bulled, McNeair, Delaney et al. 2021; Nursey-Bray & Palmer 2018; Woodward, Hill, Harkness et al. 2020) (Box 5).

Aboriginal and Torres Strait Islander communities across Australia led the development of the *Our Knowledge, Our Way in caring for Country* best practice guidelines in using Aboriginal and Torres Strait Islander knowledge to look after Country (Woodward, Hill, Harkness et al. 2020). Key aspects are: 1) strengthening Aboriginal and Torres Strait Islander knowledges by having rights to Country, revitalising knowledges and strong cultural governance over knowledges; 2) building strong partnerships through trust, respect, mutual learning and open-mindedness; 3) sharing and weaving knowledge; and 4) building networks to share knowledge. Networks are important to share and learn about different experiences of climate change, successful models of sustainable enterprise development and unique ways of communication and teaching knowledge (Woodward, Hill, Harkness et al. 2020).

BOX 5:
Arabana Adaptation Strategy
(Nursey-Bray & Palmer 2018)

The Arabana people, traditional owners of Kati Thanda (Lake Eyre South Australia), led a bottom-up participatory process of adaptation planning highlighting specific areas of local climate concern. The involvement of community throughout the process built social capital, leadership and empowerment, important protective factors for social and emotional wellbeing. Climate adaptation planning "...emerged as a mechanism by which to redress the legacy of dislocation caused by colonisation, heal ongoing wounds, and build capacity by facilitating a return to Country" (p.11). The project highlighted the integral importance of Country for Arabana people living off-Country in other locations due to historical removal or opportunities for employment.

Adaptation ideas proposed by community focused on economic opportunities for Arabana people to return to Country such as establishment of cultural centres to revive and house knowledge for future generations, cultural tourism and ranger programs. In developing their plan, the Arabana developed a set of criteria for effective adaptation (Nursey-Bray et al, 2018): holistic approaches that build on the connection between economies, livelihoods and the environment; recognise all forms of Indigenous knowledge; focus on building adaptive capacity; assist in addressing wider governance challenges (not just climate, but other issues like mining); and respect local cultural governance.

For the Arabana people, effective and sustainable climate change adaptation needs to address multiple cultural, social, and economic goals. They have used their plan as a foundation and springboard to other initiatives showing adaptation processes as nonlinear and needing to involve multiple actors from different sectors.

Land and Sea Management Programs/Ranger Programs

Government-supported Indigenous Land and Sea Management and Ranger programs offer an opportunity for community to work on Country. Investment has been concentrated in remote communities in northern Australia where there are large tracts of Aboriginal-managed land and high social, economic and health needs (Pert, Hill, Robinson et al. 2020). Also referred to as 'caring for Country', land and sea management is much more than environmental conservation — it is core to individual and community wellbeing, supporting Aboriginal and Torres Strait Islander identity and belief systems. Contemporary practices of Aboriginal and Torres Strait Islander land and sea management have led to post-colonial cultural revitalisation and maintenance (speaking language, practicing culture, passing on knowledge) with flow-on benefits to health and wellbeing (Garnett, Sithole, Whitehead et al. 2009; Larson, Stoeckl, Jarvis et al. 2020; Schultz, Abbott, Yamaguchi et al. 2018; Smyth 2011; Wright, Yap, Jones et al. 2021).

The few studies measuring the link between caring for Country activities and health and wellbeing show a positive relationship, with improved indicators for diabetes, hypertension, renal disease and psychological distress (Burgess, Johnston, Berry et al. 2009) and very high life satisfaction and family wellbeing (Kingsley, Townsend, Phillips et al. 2009; Wright, Yap, Jones et al. 2021). Being on Country and practicing culture such as speaking language, enhances this positive relationship (Wright, Yap, Jones et al. 2021). Modelling has indicated potential net annual savings of $268,000 in chronic disease/primary health care costs for remote communities participating in land management (Campbell, Burgess, Garnett et al. 2011). Analysis of Aboriginal and Torres Strait Islander business data showed that 65% of Indigenous Land and Sea Management Programs create commercial revenue and jobs that can trigger self-sustaining growth, stimulating demands for goods that Aboriginal and Torres Strait Islander communities generate (Jarvis, Stoeckl, Addison et al. 2018) (Box 6). There is also a positive knock-on effect to other local Aboriginal and Torres Strait Islander businesses not involved in land and sea management (Jarvis, Stoeckl, Addison et al. 2018).

Dunghutti Country

Carbon Farming – Abatement and Sequestration

The establishment of carbon market schemes and 'carbon credits' provided Aboriginal and Torres Strait Islander communities with economic benefits from their land and sea management (McMurray, Foley, O'Sullivan et al. 2019) (Box 6). Carbon farming involves both increasing storage of (or sequestering) carbon in vegetation, soil, and coastal systems (mangroves, seagrasses) and reducing the release of carbon, for example, through customary fire management. These activities generate carbon credits for sale to private corporations or the Australian Government, providing income for the traditional owner communities located within the abatement areas (Altman, Ansell & Yibarbuk 2020; McMurray, Foley, O'Sullivan et al. 2019).

The Aboriginal Carbon Fund (AbCF) is a not-for-profit company established to support community participation in the carbon economy. Through Aboriginal-led innovation, it aims to design sustainable social and economic development to 'build inter-generational wealth' (McMurray, Foley, O'Sullivan et al. 2019). AbCF connects communities who supply carbon credits with corporations looking to reduce their carbon footprint.

Quinkan Country

BOX 6:

Arnhem Land Fire Abatement (Northern Territory) Limited

(Altman, Ansell & Yibarbuk 2020)

A long-term collaboration of community-based ranger groups formed an Aboriginal-owned, not-for-profit company to use fire management for carbon abatement across some 80,000 square kilometres of savanna Country in Arnhem Land. The rangers 'patch' burn the landscape during early and mid-dry season while conditions are cool to prevent uncontrolled wildfires (and a significant amount of greenhouse gas emissions) later in the season. The company generates carbon credits for sale under contract to private corporations or the Australian Government, providing income for the traditional owner communities located within the abatement areas.

The case study demonstrates the successful weaving together of knowledge systems, combining remote-sensing technology to measure emissions reductions alongside Aboriginal fire management methodologies. After a decade of advocacy, the Arnhem Land Fire Abatement program received scientific acceptance and legal recognition of the carbon reduction achieved from Aboriginal fire management. This knowledge is being sought by national and international authorities, particularly after the 2019/2020 'Black Summer' of bushfires and similar devastation in other parts of the world.

The Arnhem land communities are benefitting culturally (through reinstatement of customary burning practices and protection of cultural sites), environmentally (through ecological benefits derived from Aboriginal fire management), economically (through income received through the carbon market) and socially (through social capital and the knowledge and skills built through participatory governance processes).

Ironically, climate change is threatening this community driven enterprise due to increased temperatures and lower rainfall in Northern Australia, reducing availability of conditions for early prescribed burning. This has flow-on effects to the communities' ability to generate enough carbon credits to meet its contractual obligations and derive income to continue the fire abatement program.

Modifying existing land practices for carbon outcomes supports water quality and promotes biodiversity. Beyond environmental benefit, carbon farming projects offer economic (employment), social and cultural benefits (McMurray, Foley, O'Sullivan et al. 2019). Working with communities, the AbCF are developing an environmental, social and cultural core-benefits standard to set carbon credit pricing in the ethical investment market for companies to meet (and promote) their United Nations Sustainable Development Goals, Reconciliation Action Plans and/or Corporate Social Responsibility Goals (McMurray, Foley, O'Sullivan et al. 2019).

There are, however, challenges with the design of carbon offset programs including fewer opportunities for such programs than might be anticipated, achieving carbon offset and co-benefits, and measuring effectiveness of such programs (Robinson, Renwick, May et al. 2016).

Despite the many examples of successful Aboriginal and Torres Strait Islander led climate change adaptation and mitigation stories, impacts on health are rarely explicitly stated or included as monitoring and evaluation indicators and there has so far been a lack of research on outcomes from community-based strategies to inform health policy and practice (Ford, Sherman, Berrang-Ford et al. 2018; Kipp, Cunsolo, Gillis et al. 2019).

Climate and health monitoring and evaluation data

While there is much investment and support for Aboriginal and Torres Strait Islander environmental management programs, health and wellbeing co-benefits have not figured prominently in impact evaluations (Barber & Jackson 2017). The 'Healthy Country, Healthy People' program of work in the Northern Territory has been a notable exception although measures were biomedical and based on psychological distress scales developed in other populations (Burgess, Johnston, Berry et al. 2009). Over time, researchers have worked with communities to develop wellbeing indicators that are based on values and priorities of Aboriginal and Torres Strait Islander people, such as connection to culture and family — for example, the Interplay Wellbeing Framework (Cairney, Abbott, Quinn et al. 2017), the Indigenous wellbeing concept (Larson, Stoeckl, Jarvis et al. 2020) and the Mayi Kuwayu national survey project (Wright, Yap, Jones et al. 2021). The AbCF too, instils the need for monitoring and evaluation processes to be driven by community perspectives on what they view as important (Donatuto, Campbell & Trousdale 2020; McMurray, Foley, O'Sullivan et al. 2019). These types of indicators developed by Aboriginal and Torres Strait Islander people and directed at measuring the intersection of environment and health, should be adopted consistently within climate and health projects for ongoing monitoring and evaluation and for building the evidence base to inform policy and practice. In the long-term, a nationally consistent set of indicators could be used to track the link between Aboriginal and Torres Strait Islander health and climate change across key wellbeing domains as recommended by the United Nations as part of the Paris Agreement reporting requirements (Middleton, Cunsolo, Jones-Bitton et al. 2020).

Scoping review synthesis
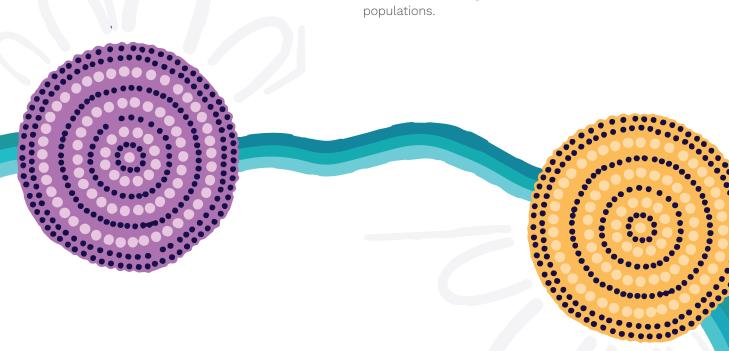
Limitations of the scoping review

This rapid scoping review search was conducted to identify studies linking climate change and health in Aboriginal and Torres Strait Islander populations. We conducted two separate searches focusing on 1) climate change impact on Aboriginal and Torres Strait Islander communities, and 2) climate change adaptation and/or mitigation in Aboriginal and Torres Strait Islander communities and First Nations internationally (Appendix 3). Due to this focus, we may have missed other research in the climate action field that could be potentially applicable to Aboriginal and Torres Strait Islander contexts.

Given the rapid nature of the review, we did not assess the quality of the evidence and methods used to generate the evidence. This review represents a broad sweep of both academic and grey literature to draw out common findings, key gaps for future research and policy and health service recommendations to support Aboriginal and Torres Strait Islander-led climate change action.

Key findings

The impact of climate change will vary considerably across Australia. Generally, there will be a rise in average temperature across all regions with the frequency and intensity of heatwaves increasing particularly in northern and inland areas. Sea levels will rise compromising low-lying island and coastal communities. Cyclones and rainfall events will increase in intensity raising flooding risk. Decreased rainfall in southern parts of the country will increase the likelihood of drought and extreme fire weather (CSIRO & BOM 2015).

There are many, varied direct and indirect climate change impacts on the morbidity and mortality of Aboriginal and Torres Strait Islander people. The 'cascading consequences' (Morgan-Bulled, McNeair, Delaney et al. 2021) of climate change will touch every aspect of Aboriginal and Torres Strait Islander livelihoods. It will compound historical injustices, extending colonial processes that disrupted cultural and spiritual connections to Country that are central to health and wellbeing. It will further threaten social and cultural determinants of health including access to Country, traditional foods and other food sources, safe water, appropriate housing, infrastructure, and health services. Health services will struggle operating in extreme weather with increasing demands and a reduced workforce. All these forces will combine to exacerbate already unacceptable levels of ill-health within Aboriginal and Torres Strait Islander populations.

Pictured left: Gumbaynggirr Country

Aboriginal and Torres Strait Islander perspectives have not featured prominently in the Australian national discourse on climate change. Climate challenges present an opportunity for redress and empowerment of Aboriginal and Torres Strait Islander communities to lead climate action planning based on their intimate traditional and historical knowledges of Country.
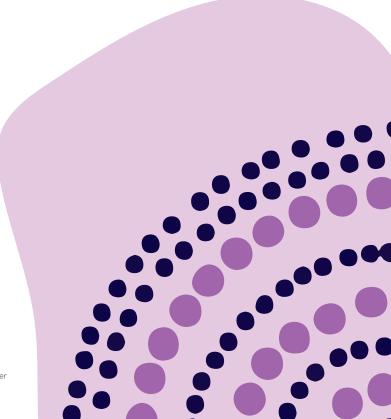
We highlighted stand-out projects in this paper that showcase Aboriginal and Torres Strait Islander leadership and the blending of knowledges in climate change advocacy, adaptation, and mitigation. Replicating their success in other locations will require the following principles and practices:

1. Building adaptive capacity of communities by restoring basic rights to adequate housing and access to Country and its resources;
2. Place-based adaptation and mitigation planning given the diversity of Aboriginal and Torres Strait Islander cultures as well as the diversity of climate impact;
3. Establishing equitable power relationships and co-governance arrangements at multiple levels to provide Aboriginal and Torres Strait Islander communities more certainty and control in protecting Country;
4. Centering and leveraging the valuable biocultural knowledge of Aboriginal and Torres Strait Islander people with appropriate intellectual and cultural property protection;
5. Building respectful, trusting partnerships to share and weave together Aboriginal and Torres Strait Islander and Western knowledge systems to inform innovative adaptation and mitigation;
6. Providing sustainable resourcing and program flexibility to support innovation and long-term monitoring and evaluation; and
7. Establishing geographic and intersectoral networks for collaboration, sharing and learning about experiences to build sustainable effective climate action strategies.

Key gaps in the literature

We identified 194 papers that met the inclusion criteria for this scoping review. In terms of geographical context, most focused on very remote/remote areas (59% compared to 15% rural and 7% urban of papers that specified a particular location), reflecting the *loci* of current and predicted extreme weather, land and sea management and other climate action initiatives. We found limited research on urban communities, as well as age and gender perspectives about climate change and adaptation. This necessitates further research to cover the full gamut of Aboriginal and Torres Strait Islander experience.

From what we could ascertain, only a minor proportion of studies had Aboriginal and Torres Strait Islander authorship (11%) or stated some level of community consultation (26%). Rates of Aboriginal and Torres Strait Islander scholarship have encouragingly increased over time, along with decolonising methodologies that actively seek and centre Aboriginal and Torres Strait Islander community experiences, knowledge and perspectives in climate change adaptation and mitigation. However, further improvement needs to occur along with improved bibliographic systems to identify Aboriginal and Torres Strait Islander scholarship more easily (Mohamed, Matthews, Bainbridge et al. 2021).
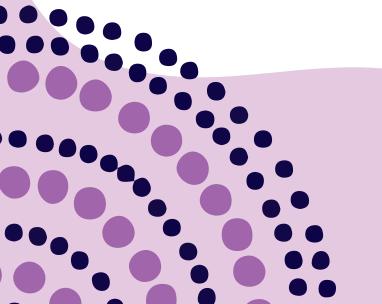
Most of the literature included aspects of climate change adaptation (69%), however, the majority described processes or principles around development of adaptation plans with Aboriginal and Torres Strait Islander communities, rather than implementation and evaluation. This may reflect the short-term nature of funding as discussed. Nearly one quarter reported mitigation strategies and these were primarily focused on land and sea management or ranger programs and carbon abatement through cultural fire practices. This highlights a need for sustainable funding in climate change and health research and development with a focus on evaluation of outcomes and analysis of other types of adaptation/mitigation strategies to cover all climate concerns and community contexts.

There are limited studies that jointly measure environmental and health co-benefits. More needs to be done to design and integrate environmental science and health research projects with communities along with appropriate data collection that represent important concepts of health and wellbeing for Aboriginal and Torres Strait Islander communities. Similarly, less than 5 per cent of papers described climate change impacts on Aboriginal and Torres Strait Islander health service operations and infrastructure.

Implications for policy and Aboriginal and Torres Strait Islander health services

Aboriginal and Torres Strait Islander community-controlled health services deliver comprehensive primary health care to communities with culture central to their holistic service delivery model. In addition to advocating for climate justice for communities, this review highlighted health sector actions that will require policy and funding support:

- Incorporating ecological approaches in primary health care models such as caring for Country activities that would extend documented benefits to all community members beyond ranger programs (Arabena & Kingsley 2015; Schultz, Abbott, Yamaguchi et al. 2018; Wright, Yap, Jones et al. 2021). Potentially reinvigorate the Aboriginal and Torres Strait Islander environmental health worker profession to undertake connection to Country initiatives as part of primary health care programs (NACCHO & AHCWA 2019).
- Participating in assessments of climate change impacts on communities and their consequences for health and wellbeing.
- Seeking funds to minimise the carbon footprint of the health system by transitioning to renewable energy, improving thermal properties of clinics and staff housing and instituting behaviours to conserve energy and reduce medical waste (TSRA 2018).
- Working with communities (and where required external experts) to develop local adaptation and mitigation plans. Work across sectors (transport, energy, communication, housing) for coordinated sustainable outcomes (TSRA 2018).

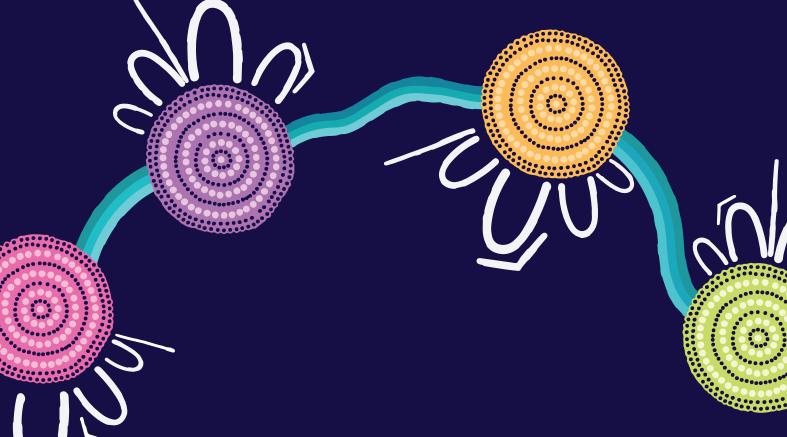Widjabal/Wiyabal Country (Lismore)

Conclusions

The key points made in this paper, largely reiterate calls made a decade ago by the then Aboriginal and Torres Strait Islander Social Justice Commissioner Tom Calma (AHRC 2009) for Aboriginal and Torres Strait Islander-led holistic approaches to climate action policy and practice. Given the lack of consistent effective national policy-making in the intervening period, perhaps this is not surprising.

Unfortunately, as the IPCC has highlighted, this means action on climate change is now extremely urgent. Action is required that respects human rights, values Aboriginal and Torres Strait Islander knowledges and fosters partnerships for fair and sustainable health and environmental outcomes.

A forward agenda for climate action and Aboriginal and Torres Strait Islander health needs to initially lay the groundwork within communities to build adaptive capacity. This begins with restoring basic rights such as adequate housing and access to land and sea Country and its resources. An agenda should focus on ways to strengthen Aboriginal and Torres Strait Islander knowledges and their inter-generational transmission and promote the value and legitimacy of biocultural knowledges within climate adaptation and mitigation planning. Strong partnerships across

environmental science and health sectors are required to bring together and build on existing scholarship in Aboriginal and Torres Strait Islander land and sea management and health and wellbeing co-benefits. Robust data frameworks need to be developed to document evidence that is meaningful for Aboriginal and Torres Strait Islander communities and can guide policy and practice. The focus of this work needs to be broadened across geographical contexts and across climate concerns to enable a sustainable future for communities on Country. The complex nature of climate change also requires strong partnerships across sectors so the multitude of risks (housing and health infrastructure, food security, water security, energy security, employment and economic impacts) can be addressed holistically.

This agenda will be difficult in the absence of national leadership in climate change and health. It will require collective advocacy to shift policies towards positive climate action. It will also require power asymmetries to be addressed in existing policy and legislative frameworks and establishing co-governance arrangements in land, sea, and water management.

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Acronyms and abbreviations

AbCF .... Aboriginal Carbon Fund

ABS .... Australian Bureau of Statistics

AHCWA .... Australian Health Council of Western Australia

AHRC............... Australian Human Rights Commission

AIHW................ Australian Institute of Health and Welfare

BOM .... Bureau of Meteorology

CAHA................ Climate and Health Alliance

CO2 .... carbon dioxide

CLC .... Central Land Council

COP26.............. United Nations Convention on Climate Change

CRE-STRIDE ... Centre for Research Excellence in Strengthening Systems for Indigenous Health Care Equity

CSIRO.............. Commonwealth Scientific and Industrial Research Organisation

HEAL .... Healthy Environments and Lives Network

IPCC .... Intergovernmental Panel on Climate Change

LALCs .... Local Aboriginal Land Councils

MLDRIN............ Murray Lower Darling Rivers Indigenous Nations

NACCHO........... National Aboriginal Community Controlled Health Organisation

NHLF .... National Health Leadership Forum

NWI .... National Water Initiative

NCCARF .... National Climate Change Adaptation Research Facility

NESP .... National Environmental Science Program

TB..................... Tuberculosis

TSRA .... Torres Strait Regional Authority

UNFCCC .... United Nations developed the Framework Convention on Climate Change
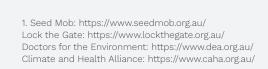
WHO................. World Health Organization

Questions to inform policy roundtable

Roundtable questions

This discussion paper informed a roundtable hosted by the Lowitja Institute on behalf of the National Health Leadership Forum and in partnership with the Climate and Health Alliance, prompting discussion and consideration of policy and program opportunities to accelerate climate action with the dual benefit of protecting and improving Aboriginal and Torres Strait Islander health and wellbeing. To stimulate discussion, a set of questions were posed under key themes. The first theme, restoring rights and equitable governance arrangements, will be key to sustainable and effective progress in mitigating and adapting to climate change. These questions are not necessarily new, nor do they cover specifically or completely the range of climate change issues likely to impact Aboriginal and Torres Strait Islander health. Instead, they build on previous recommendations for progressing reform and knowledge of best practice principles to stimulate discussion on advancing Aboriginal and Torres Strait Islander leadership and equitable governance for climate justice and a healthy, sustainable future.

Collective advocacy, addressing power asymmetries and establishing co-governance arrangements

1. How do we draw together existing grassroots advocacy groups (e.g., Seed Mob — Seed Indigenous Youth Climate Network, Lock the Gate, Doctors for the Environment[1]) and/or private-sector philanthropic groups to collectively campaign for national action on reducing greenhouse gas emissions and climate change?

2. In the absence of national political leadership, how can we unite across sectors and advance responsible action and planning for climate adaptation and mitigation on multiple scales (national, state, and local)? For example, can we build on the work of the Climate and Health Alliance to develop a national framework for climate change and health, that specifically integrates Aboriginal and Torres Strait Islander participation, knowledge, and leadership at national, state and local levels of planning and implementation?

3. What can co-governance arrangements look like in climate and health policy that would provide Aboriginal and Torres Strait Islander people equitable control over leading change to improve sustainability and wellbeing?

4. What are the barriers to establishing these co-governance arrangements? How can these be overcome?

1. Seed Mob: https://www.seedmob.org.au/
Lock the Gate: https://www.lockthegate.org.au/
Doctors for the Environment: https://www.dea.org.au/
Climate and Health Alliance: https://www.caha.org.au/

Laying the groundwork – restoring access to basic rights

5. How can government target investment in the long-standing issue of Aboriginal and Torres Strait Islander housing and community infrastructure? What processes need to change to ensure that any remedial action includes appropriate community participation and incorporates cultural, environmental and sustainable design?

6. How can we build co-governance arrangements into existing legislative and policy frameworks to increase security and certainty of Aboriginal and Torres Strait Islander rights to land, water and culture? How could these arrangements operate across multiple scales, i.e., national, state, community-level? Are there existing structures we could build on to facilitate co-governance arrangements?

7. How do we ascertain and deliver the information and knowledge needs of community on climate change and its health impacts? How can we systematically gather community priorities on their climate and health concerns to inform research, policy, and action?

Weaving together knowledges and strengthening partnerships across environmental, health and other sectors

8. How do we strengthen Aboriginal and Torres Strait Islander biocultural knowledges and their communication and documentation in a respectful way that protects intellectual and cultural property rights?

9. How can we systematically incorporate Aboriginal and Torres Strait Islander knowledges into climate adaptation and mitigation planning?

10. Which sectors/organisations need to be involved in a national coordinated response to the climate crisis? How do we foster intersectoral collaboration on climate action? Are there best practice examples where intersectoral collaboration has been effective in addressing complex issues?

11. What are the advantages/disadvantages of incorporating ecological approaches, such as connection to Country initiatives, into Aboriginal and Torres Strait Islander health service delivery? Are there best practice examples of this occurring currently? How can they be applied in urban contexts?

12. How can we grow the capacity and build a network of Aboriginal and Torres Strait Islander researchers across climate, environmental and health sciences?

13. What is the best way to identify, integrate and utilise existing sets of data and indicators to provide quantitative evidence for describing and predicting Aboriginal and Torres Strait Islander health and wellbeing outcomes from environmental threats and climate action? Do these datasets contain indicators relevant to Aboriginal and Torres Strait Islander health and wellbeing? If not, how do we develop new relevant measures?

14. How can principles of Aboriginal and Torres Strait Islander data sovereignty be embedded in climate mitigation and adaptation planning? Should there be a national set of indicators to monitor progress on climate action and Aboriginal and Torres Strait Islander health? Could these be incorporated into existing reporting mechanisms such as the 'Closing the Gap' initiative?

Appendix 2:
Climate change projections for Australia

Figure A1: Natural Resource Management (NRM) clusters

Table A2: Geographic modelling of human-induced climate change based on low, intermediate and very high greenhouse gas emission scenarios for near (2030) and far future (2090)

	NORTHERN AUSTRALIA				RANGELANDS	
	Monsoon North		Wet Tropics			
	2030	2090	2030	2090	2030	2090
Annual avg. warming (°C)#						
	All scenarios 0.9 (0.5-1.3)		All scenarios 0.7 (0.3-1.1)		All scenarios 1.0 (0.6-1.4)	
Low	--	0.9 (0.5-1.6)	--	0.7 (0.4-1.4)	--	1.1 (0.6-1.8)
Intermediate	--	1.8 (1.3-2.7)	--	1.4 (1.0-2.1)	--	2.1 (1.5-2.9)
High	--	3.8 (2.8-5.1)	--	2.9 (2.3-3.9)	--	4.3 (2.9-5.4)
Annual avg. extreme temp (days>35°C)*						
	Darwin		Cairns		Alice Springs	
Low	--	52 (24-118)	--	5.5 (4.4-14	--	119 (104-132)
Intermediate	43 (25-74)	111 (54-211)	5.5 (4.4-7.9)	11 (7.4-22)	113 (104-122)	133 (115-152)
High	--	265 (180-322)	--	48 (24-105)	--	168 (145-193)
Severe fire danger days/year*						
Intermediate	4.7	5.4	0	0	18.6	18.8
High	5.1	8.0	0	0	17.1	27.6
Sea level rise (m)#						
	Darwin		Cairns		Port Hedland	
	All scenarios : 0.12 (0.07-0.17)		All scenarios : 0.13 (0.09-0.18)		All scenarios : 0.12 (0.07-0.17)	
Low	--	0.38 (0.22-0.55)	--	0.40 (0.24-0.56)		0.38 (0.22-0.55)
Intermediate	--	0.46 (0.29-0.65)	--	0.46 (0.31-0.65)		0.46 (0.28-0.64)
High	--	0.62 (0.41-0.85)	--	0.65 (0.44-0.87)		0.61 (0.40-0.84)

#Change relative to 1986-2005 (median values and 10th - 90th percentile ranges of model simulations of 20-year average climate); *Change relative to 1981-2010.

Table A2 continued: Geographic modelling of human-induced climate change based on low, intermediate and very high greenhouse gas emission scenarios for near (2030) and far future (2090).

	EASTERN AUSTRALIA				SOUTHERN AUSTRALIA					
	East Coast		Central Slopes		Southern Slopes		Murray Darling		Southern & SW Flatlands	
	2030	2090	2030	2090	2030	2090	2030	2090	2030	2090
Annual avg. warming (°C)#										
	All scenarios 0.9 (0.5-4.7)		All scenarios 1.0 (0.6-1.5)		All scenarios 0.7 (0.4-1.1)		All scenarios 0.8 (0.6-1.3)		All scenarios 0.8 (0.5-1.1)	
Low	--	0.9 (0.5-1.5)	--	1.1 (0.6-1.8)	--	0.8 (0.4-1.3)	--	1.0 (0.6-1.5)	--	0.8 (0.5-1.3)
Intermediate	--	1.9 (1.3-2.5)	--	2.1 (1.4-2.7)	--	1.5 (1.1-2.0)	--	1.8 (1.3-2.4)	--	1.7 (1.2-2.0)
High	--	3.7 (2.7-4.7)	--	4.2 (3.0-5.4)	--	3.1 (2.5-4.0)	--	3.8 (2.7-4.5)	--	3.4 (2.6-4.0)
Ann. avg. extreme temp (days>35°C)*										
	Sydney		Dubbo		Melbourne		Canberra		Perth	
Low	--	--	--	--	--	--	--	--	--	--
Intermediate	4.3 (4.0-5.0)	6 (4.9-8.2)	31(26-37)	44 (36-54)	13 (12-15)	16 (15-20)	12 (9.4-14)	17 (13-23)	36 (33-39)	43 (37-52)
High	--	11 (8.2-15)		65 (49-85)	--	24 (19-32)		29 (22-39)		63 (50-72)
Severe fire danger days/year*										
Low	1.1	1.3	3.0	4.1	1.2	1.4	4.9	5.3	5.0	5.3
Intermediate	1.3	2.1	3.7	7.2	1.2	2.1	4.6	7.6	4.7	6.9
High										
Sea level rise (m)#										
	Sydney		--		Stony Point		--		Fremantle	
	All scenarios : 0.13 (0.09-0.19)		--		All scenarios : 0.11 (0.07-0.17)		--		All scenarios : 0.12 (0.07-0.17)	
Low	--	0.38 (0.22-0.54)			--	0.37 (0.22-0.53)			--	0.39 (0.22-0.56)
Intermediate	--	0.47 (0.30-0.65)			--	0.44 (0.27-0.62)			--	0.46 (0.28-0.65)
High	--	0.66 (0.45-0.88)			--	0.59 (0.38-0.81)			--	0.61 (0.39-0.84)

#Change relative to 1986-2005 (median values and 10th – 90th percentile ranges of model simulations of 20-year average climate); *Change relative to 1981–2010.
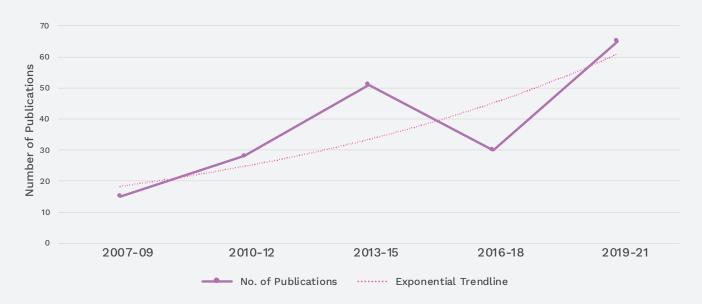
Appendix 3:
Scoping review methodology and results

Online databases Medline, CINAHL, Emcare, Scopus, Informit were searched, as well as Google for the grey literature. This first scoping stage used a combination of terms to search the subjects: climate change, Indigenous peoples, health, wellbeing, environment, land and sea management, adaptation, mitigation, intervention, resilience, extreme weather, drought, flood, heat, bushfire and housing. Experts in the field were also directly asked to provide any additional relevant publications or reports known to them. A total of 1790 records were found. Using criteria to assess the relevance of the sourced literature, the team reduced the related records to 403 to be reviewed. From there, 194 publications were included in this scoping review.

The trend in the number of publications since 2007 shows an overall gradual positive increase in the attention this area is receiving (Figure A2.1) with a strong focus on remote geographical settings (Figure A2.2). Publications were analysed by topic area (Figure A2.3). Findings show that publications discussing adaptation and mitigation strategies and/or interventions, were focused on land & sea management, water and drought, food as well as bushfires and air quality. While the literature looking at impacts, primarily looked at how diseases and the health outcomes of First Nation communities is being affected by changes in climate.

Year of Publication

Figure A3.1: Number of publications per year looking at Aboriginal and Torres Strait Islander health and climate change (up until August 2021) (n=194)

Geographical Settings

Figure A3.2: Number of publications by geographical setting looking at Aboriginal and Torres Strait Islander health and climate change (up until August 2021) (n=194)

Topic Areas

Figure A3.3: Key topic areas included in publications looking at Aboriginal and Torres Strait Islander health and climate change (up until August 2021) (n=194)
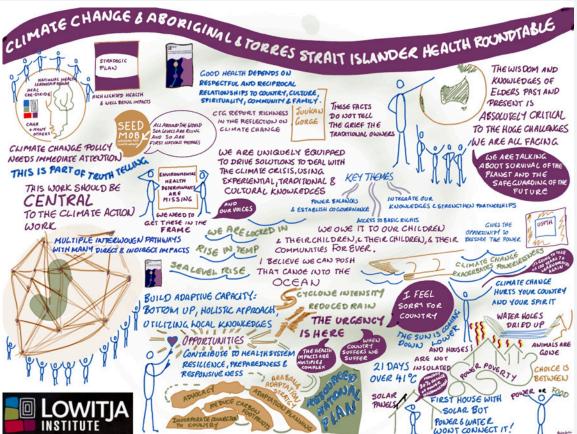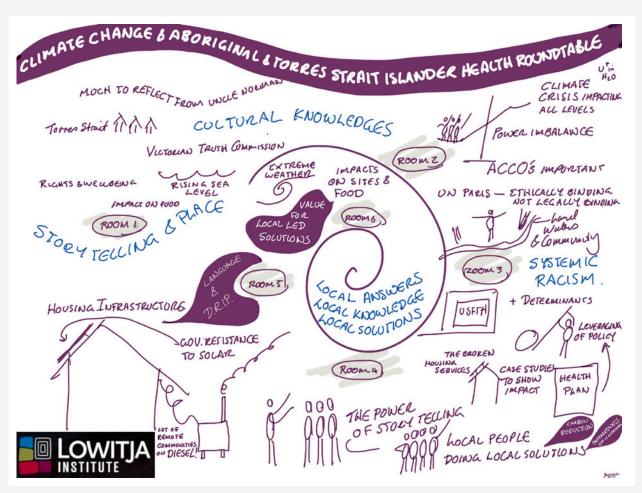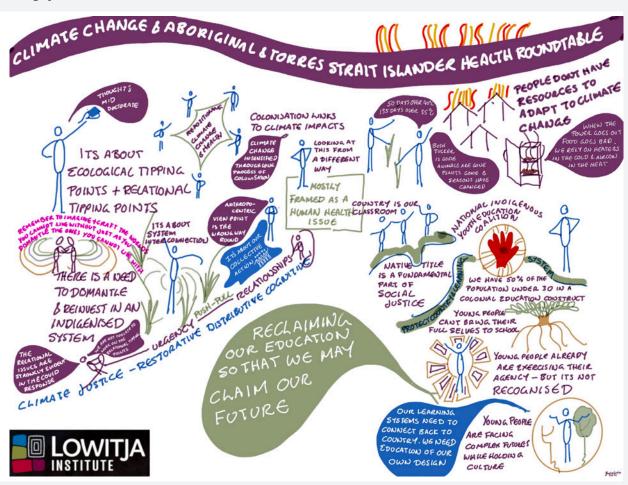
Appendix 4:
Illustrated roundtable report
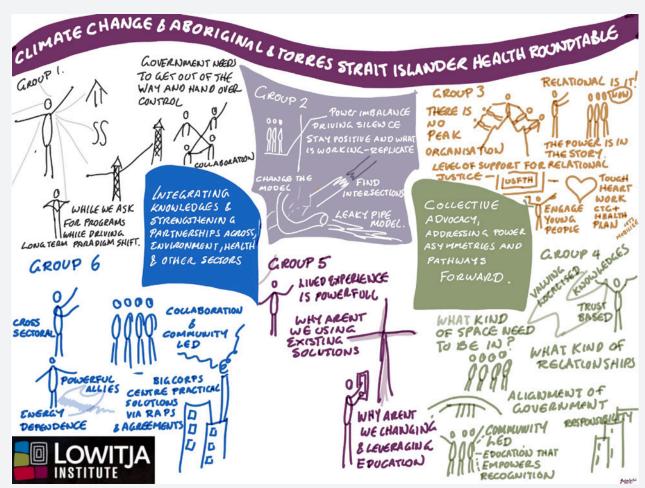

Discussion
Paper Summary
by Julia Curtis
and Allirra Moore

Drawing by
Julia Curtis

Drawing by Julia Curtis

Drawing by Julia Curtis

Drawing by Julia Curtis
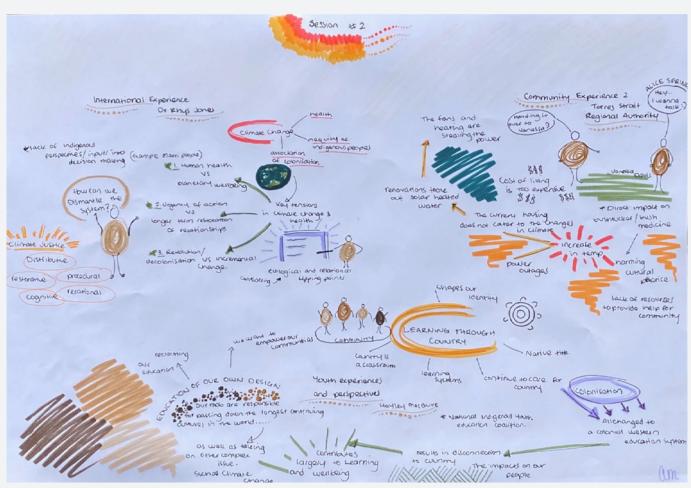

Drawing by Julia Curtis

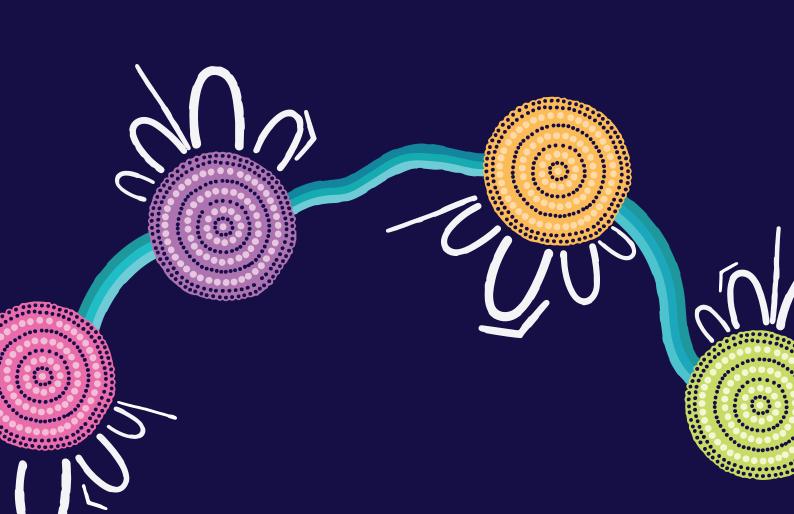**Drawing by Allirra Moore**

Drawing by Allirra Moore

Drawing by Allirra Moore

Drawing by Allirra Moore

Australia's National Institute for Aboriginal and
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