



THE RISKS TO AUSTRALIA OF A 3°C WARMER WORLD

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EXECUTIVE SUMMARY

As the driest inhabited continent, Australia is highly vulnerable to the impacts of global warming. The summer bushfires of 2019–20 in a tinder-dry country, or the three severe coral bleaching events within five years that caused a loss of over 50% of hard coral cover in the shallow waters of the Great Barrier Reef, demonstrate some of the consequences of a warming planet for Australia's people, economy and environment.

Multiple lines of evidence show that the incidence of extreme weather events will increase as the planet warms. Such events are a natural feature of the climate system, but there is strong evidence that many of them, such as heatwaves, bushfires, storms and coastal flooding, have become more frequent and intense in recent times. These extremes and their risks are likely to escalate as global temperatures continue to rise and our capacity to respond becomes compromised as the frequency increases.

The only way to reduce the risk of these unpredictable and dangerous outcomes is for a substantial reduction in the emissions of greenhouse gases into the atmosphere. Our planet's living systems have evolved over thousands of years in a temperature range that includes relatively minor fluctuations around the long-term average. However, most cannot evolve quickly enough to accommodate the rapid increases in average temperatures we now observe and feel.

The total emission reductions currently pledged by the Australian and international governments through the United Nations Framework Convention on Climate Change Paris Agreement (UNFCCC), even if implemented on time, will translate as average global surface temperatures of 3°C or more above the pre-industrial period by 2100.¹

1 Climate Action Tracker. Temperatures. <https://climateactiontracker.org/global/temperatures/> (2020).

Given this situation, we must consider the vulnerability, risks and costs of Australia's policies and strategies for responding to climate change. In particular, we need to understand the comparative risks and costs of not improving our current commitment to reducing greenhouse gas emissions.

The planet is well on the path to devastating climate change. In 2019, Australia's warmest year on record, average surface temperatures were 1.1°C above the pre-industrial period. Australia has warmed on average by 1.4°C since national records began in 1910. Current global and Australian policies to reverse this trend are inadequate. We must plan to do better and prepare for the worst.

Predicting how Australia will change at or beyond 3°C of global warming is challenging. However, by using multiple lines of evidence, such as computer modelling of the climate system, observed changes, and historical paleoclimate studies, we can develop an understanding of future temperatures as well as where we may reach irreversible 'tipping points'—passing thresholds that trigger sudden and accelerating changes in larger climate systems—and how to mitigate those risks.

The report synthesises the observed impacts of climate change on Australia and the risk to our future of the current global trajectory of greenhouse gas emissions. It focuses on the consequences of 3°C of global warming in the absence of greater mitigation strategies for four areas of importance to Australia's future: our ecosystems, food production, cities and towns, and health and wellbeing. The impacts of those changes on the lives and wellbeing of Australians are discussed in detail.

THE PRECAUTIONARY PRINCIPLE

This report is a risk assessment based on peer-reviewed scientific literature. Our approach is to include those risks where there is evidence for a link to climate change, even if there is currently some debate about the probability of the impact occurring or the strength of the climate change response. We adopted the precautionary principle: if a potentially damaging effect cannot be ruled out, it needs to be taken seriously.

THE GLOBAL CONTEXT

There is no scientific doubt about the source, reality and consequences associated with the current level of unmitigated climate change. Human activities, such as the burning of fossil fuels and the destruction of forests, are rapidly changing Earth's climate. The rate of these changes in atmospheric greenhouse gases such as carbon dioxide (CO₂) and methane are unprecedented in millions of years, driving growing impacts on natural and human systems across the world.

If the international community fails to meet the emission reduction targets under the UNFCCC Paris Agreement, this will result in a global mean surface temperature increase of approximately 3°C or more by mid to late century. This level of warming is well above the targets considered manageable under that agreement.

This increase in global average surface temperature lies between the Intergovernmental Panel on Climate Change projections for the ‘medium-high’ and ‘high’ greenhouse gas emissions scenarios.² The 3°C temperature rise also corresponds with the average of the projected temperature rise by 2100 (2.7–3.1°C) if current climate policies around the world continue.³

Limiting climate change to 1.5°C is now virtually impossible. A rapid transition to net zero greenhouse gas emissions is required if the international community is to limit warming to “well below 2°C” in line with the Paris Agreement. As with the COVID-19 pandemic, acting early and urgently reduces the scale of the impacts and can save many lives and livelihoods. This also has significant potential benefits in terms of health and regional development and embracing the new economic opportunities associated with a move to net zero greenhouse gas emissions.

AUSTRALIA'S ECOSYSTEMS IN A CHANGING CLIMATE

Australia's natural resources are directly linked to our wellbeing, culture and economic prosperity. Yet our ecosystems have already been transformed due to a global increase of 1.1°C in average temperature since the late 19th century, with severe consequences for thousands of species.

Heat stress has impacted marine and coastal ecosystems, destroying habitats and reducing biodiversity. Land-based environments have been affected by drought, fire, extreme heatwaves, invasive species and disease, leading to large-scale mortality of trees, birds and tree-dwelling mammals. Many species are shifting where they live, but cannot keep up with the rate of change, especially given the geography of Australia. Rising sea levels are amplifying storm impacts, damaging coastal ecosystems such as coral reefs and mangrove forests, and causing increasing issues for human health and wellbeing in coastal areas.

The conservation of Australia's unique ecosystems has ramifications for Australian industries such as tourism and recreation. For example, the Australian tourism industry contributed \$54.7 billion to the economy in 2016–17, with the top five attractions for international visitors being nature-based: beaches, wildlife, the Great Barrier Reef, wilderness areas and national parks. All of these are at risk from climate change, along with ecosystems that support forestry, agriculture (particularly bee-pollinated crops) and fishing industries.

Critical thresholds in many natural systems are likely to be exceeded as global warming of 1.5°C above pre-industrial levels continues. These impacts will increase as global warming reaches 2°C and beyond, with iconic ecosystems such as the Great Barrier Reef and the World Heritage-listed Kakadu National Park being severely affected.

At 3°C of global warming, many of Australia's ecological systems would be unrecognisable. The decline of Australia's natural resources would accelerate through changing distributions or loss of thousands of species and disrupted ecological processes such as habitat maintenance.

2 Collins, M. *et al.* Long-term Climate Change: Projections, Commitments and Irreversibility. in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (eds. Stocker, T. F. *et al.*) 1029–1136 (Cambridge University Press, 2013).

3 Climate Action Tracker. Temperatures. <https://climateactiontracker.org/global/temperatures/> (2020).

AUSTRALIAN AGRICULTURE, FORESTRY, FISHERIES AND FOOD SECURITY

Australian agriculture and food security are already exposed to increased risk from drought, heatwaves, fires, floods and invasive species.

Impacts from declining rainfall and more frequent droughts for areas such as south-eastern and south-western Australia would intensify under 2°C or more of global warming. Declining river flows would reduce water availability for irrigated agriculture and increase water prices. Future water resource availability would be affected by the combined changes in rainfall and global surface temperature increases.

Heat stress is a significant issue for livestock systems due to impacts on animal welfare, reproduction and production. Projected temperature and humidity changes suggest an increased number of heat stress days per year. At the same time, more frequent storms and heavy rainfall would likely lead to worsening erosion of grazing land or loss of livestock from flooding.

Impacts for primary producers and rural communities include lost profitability for Australian farms, reduced water availability and elevated heat stress affecting land use for crops. For example, broadacre crops such as wheat and barley have seen reductions in profitability by up to 22% since 2000. Decreasing farm profitability is leaving many Australians in rural and regional communities at risk of declining health and economic wellbeing.

Forestry faces growing pressures from a warming and drying climate. Increased fire risks, changes in rainfall patterns and species-specific pest impacts are likely to threaten forests in the hotter, drier regions of Australia such as south-western Australia, although cooler regions such as Tasmania and Gippsland may see increased production. Existing plantations would change substantially with 3°C of warming.

Fisheries and aquaculture industries are impacted by ocean acidification and warming, which affects species distribution, reproduction and overall health of stock. Decreasing stock levels would cause a decline in profitability, and many aquaculture fisheries enterprises may cease to exist, change fundamentally, or move to other locations if these impacts become worse.

Changes to supply chains and ongoing vulnerabilities to extreme weather events may cause higher rates of unemployment, mental health issues, suicides and heat-related health conditions in some regions of Australia. Strategic planning to create new business opportunities in these regions has the potential to reduce some of these risks.

AUSTRALIAN CITIES AND TOWNS

Close to 90% of Australians live in cities and towns and will experience climate change impacts from the perspective of an urban environment. The risks of extreme events such as heatwaves, severe storms, major floods, bushfires and coastal inundation from sea level rise continue to increase and will be more intense and frequent as temperatures exceed 2°C of warming.

Global sea level continues to rise, posing severe risks to properties, infrastructure and ecosystems. An estimated 160,000 to 250,000 Australian properties are at risk of coastal flooding with a sea level rise of 1 m by the end of the century.

Strategies for managing the impacts of sea level rise involve reducing or ceasing building in high-risk areas, adjusting infrastructure planning and maintenance, protecting coastal land with structures such as sea walls and ecosystems such as sand dunes and mangroves, or abandoning assets at risk.

The energy security of many Australian cities and towns is at risk from climate change-driven impacts. Extreme heat conditions, bushfires and storms put strain on power stations and infrastructure while simultaneously increasing demand for energy supply as reliance on air conditioning increases. Much of Australia's electricity generation relies on ageing and increasingly unreliable coal-fired power stations. Oil and gas industries are also vulnerable to delays in operations or damaged infrastructure from extreme weather events. Exploring options for diversifying energy sources and improving existing energy infrastructure will be important to ensure a reliable energy supply into the future.

Changing perceptions of climate risk and exposure are also capturing the attention of the insurance and financial sector. Insurance firms face increased claims due to climate-related disasters, including floods, cyclones and mega-fires. Under some scenarios, one in every 19 property owners face the prospect of insurance premiums that would be effectively unaffordable by 2030. A 3°C world would render many more properties and businesses uninsurable.

Cities and towns, however, can also be part of the climate solution. High-density urban living translates to a lower per capita greenhouse gas emission 'footprint', and innovative solutions are easier to implement in urban environments. Urban planners can utilise designs that consider passive cooling techniques to reduce city temperatures, such as incorporating more plants and street trees during planning; however, these strategies may require changes to stormwater management and can take time to be effective.

HEALTH AND WELLBEING OF AUSTRALIANS

More frequent and intense weather events such as heatwaves, droughts, cyclones, bushfires and floods have direct and indirect impacts on human health, livelihoods and communities. The elderly, young, unwell, and those from lower socio-economic backgrounds are at increased risk.

Heatwaves on land and sea are increasing in length, frequency and intensity. These changes affect human health through physiological heat stress and by worsening existing medical conditions. Bushfire-related health impacts are increasing, causing direct loss of life and exacerbating pre-existing conditions such as heart and lung disease. Fire conditions in the spring and summer of 2019–20 were classified as 'Catastrophic' for the first time in many parts of Australia. These extreme conditions will increase at 2°C and further at 3°C, and would have direct and indirect health impacts such as economic hardship and ongoing mental health challenges.

The availability of water is also linked directly and indirectly to human health and wellbeing. As climate change increases to 2°C above the pre-industrial period, many communities in eastern and south-western Australian regions will need to consider alternative water supply options if declining rainfall trends continue. This would likely impact local economies and lead to displacement for many people living in rural communities. Climate-sensitive infectious diseases, such as Ross River virus and other vector-borne diseases, will shift in their geographical distribution and intensity

of transmission as weather patterns change. Diseases normally considered to be a concern in tropical climates may spread to more temperate areas across Australia, including major population centres.

Strategies such as improving early warning systems for extreme weather events, assessing the climate resilience of healthcare services, implementing nature-based solutions (such as increasing green spaces in urban areas) and reducing energy use in healthcare facilities would help Australia adapt to the impacts of climate change on the health of its citizens.

THE WAY FORWARD: STAYING WELL BELOW 2°C AND AVOIDING 3°C

POLICY ACTIONS FOR A POSITIVE FUTURE

Reaching net zero emissions by mid-century is an absolute minimum if we are to avoid the worst impacts of climate change. Australia is well positioned to meet this challenge, with a skilled workforce, industrial base and renewable energy resources facilitating easier emission reductions compared to many other countries. States and territories such as the Australian Capital Territory, South Australia and Tasmania are leading the way in the renewables race, and Victoria, New South Wales and Queensland are showing promise with recent announcements on renewable energy projects. Australia has enormous potential to be a clean industrial powerhouse.

However, Australia should develop a more substantial interim emissions reduction goal than its current Nationally Determined Contribution under the Paris Agreement—and we need to act quickly. Given the threats we face, Australia must revisit its emission reduction commitments and provide the leadership and collaboration required to place the world and Australia on a safer climate trajectory.

To achieve net zero, Australia will need to:

- remove greenhouse gas (GHG) emissions from electricity generation and distribution
- electrify the transport sector
- increase energy efficiency and reduce emissions from industrial activities and buildings
- reduce non-energy related GHG emissions from industrial processes and agriculture
- implement negative emissions options through biosequestration and technological means
- stop deforestation and land degradation, and accelerate revegetation of cleared and degraded land
- shift energy export industries to zero emissions as a matter of urgency.

Australia can become a clean energy exporter and potentially a global renewable energy superpower. We have a relative advantage with our abundant natural resources for solar and other renewable energy generation, as well as significant deposits of new economy minerals critical for developing batteries and other low-emission technologies.

TRANSITIONING TO NET ZERO

Acting early to transition to net zero emissions would reduce the scale of climate change impacts and have significant potential benefits for human health and regional development, as well as creating new industrial opportunities.

Sector-by-sector transition policies and support for regional economies will need to be designed to support vulnerable groups, including to ease the change for communities, workers and businesses that currently depend on high emissions of GHGs.

The most immediate requirement is a phase-out of coal-fired energy generation in favour of cheaper and cleaner renewable generation and storage technologies, a process that has already started and needs to accelerate. Similarly, any expansion of the gas industry is incompatible with achieving the Paris Agreement targets. Phasing out fossil fuels should be accompanied by electrification of transport, heating and industrial energy use. Significant opportunities also exist in making our homes and buildings more energy efficient.

The emission reduction commitments of the Paris Agreement cannot be met without also managing emissions from the agricultural and land sectors, including stopping deforestation and increasing investment in restoration and carbon sequestration in soils. Many of these actions will have significant co-benefits in addition to reducing GHG emissions, such as better air quality, biodiversity, employment and health outcomes.

Accelerated investment in clean energy, zero-GHG emission industrial installations, electric transport and more energy efficient housing and public buildings can enhance productivity and improve living standards. Public investment during and after the COVID-19 pandemic offers a chance for economic recovery that is consistent with long-term low-emissions outcomes.

REPORT RECOMMENDATIONS

Current international commitments to greenhouse gas (GHG) emission reduction, if unchanged, would result in average global surface temperatures that are 3°C or more above the pre-industrial period. The evidence presented in this report indicates that this would have serious consequences for Australia and the world.

To rectify this situation, we recommend the following 10 actions for Australia:

- 1 Join global leaders in increasing actions for tackling and solving climate change as a matter of urgency.** Australia lags far behind the best practice demonstrated by many countries. Given how much Australia stands to lose if GHG emissions are not reduced, **we also recommend** that Australia accelerates its transition to net zero GHG emissions over the next 10 to 20 years.
- 2 Develop strategies to meet the challenges of extreme events that are increasing in intensity, frequency and scale.** Extreme events at 1.1°C of global warming are placing Australian lives and livelihoods at increasing risk, with concern that 3°C of global warming would not be sustainable. **We also recommend** a broad-ranging investigation of Australia's readiness for meeting the growing number of climate-related disasters, such as droughts, fires, floods, storm surges, heat stress and ecological damage, that would occur with global temperature increases of 3°C or more.
- 3 Improve our understanding of climate impacts, including tipping points, as well as the compounding effects of multiple stressors at global warming of 2°C or more.** The current understanding of abrupt and compounding changes and their consequences for Australian human and natural systems is at an early stage. **We also recommend** further investigation into effective adaptive responses in preparation for rapid and complex changes.
- 4 Systematically explore how our food production and supply systems should prepare for the challenges of climate change.** Australian agriculture and food security are exposed to increasing risk from droughts, extreme high temperatures, coastal inundation, floods, invasive species and fires. **We also recommend** that Australia prepares for potential interruptions to its food import and export systems driven by global environmental, social and economic changes.
- 5 Expand our understanding of the impacts and risks of climate change for the health of Australians.** Climate change already seriously affects the health of Australians and improved strategies need to be developed to reduce these growing risks. **We also recommend** an in-depth study on the potential impacts of 3°C global warming on health and wellbeing, particularly how impacts can be reduced.

6 Introduce a suite of policies that would deliver deep and rapid cuts in emissions across the economy. In the current absence of an economy-wide carbon price, there will need to be comprehensive sector-by-sector approaches. **We also recommend** that policies are developed to support the economic and social transition to a low GHG emission outcome, especially in regions where fossil fuel-based industries are currently prominent. This includes the development of strategies to halt further deforestation and land degradation while facilitating carbon storage.

7 Scale up the development and implementation of next-generation low to zero greenhouse gas technologies. If Australia is to argue for increasing international action, greater commitment is required to implement zero to low emissions technologies and the rapid phase-out of fossil fuels by mid-century. **We also recommend** the development of a strategic plan that maps out the markets and investment opportunities for Australian industries in areas such as offshore renewable energy, green hydrogen fuels, minerals for low GHG emission technologies, mass-scale storage, embedded renewable energy, and more efficient and low GHG emission transport systems for aviation, shipping, road and rail transport.

8 Review Australia's capacity and flexibility to take up innovations and technology breakthroughs for transitioning to a low GHG emission future. **We also recommend** greater support for innovation and technology breakthroughs by way of a dedicated facility for supporting broad-based applied research on the removal of GHG emissions from the economy, which is consistent with meeting and exceeding current commitments to emission reduction under international agreements.

9 Develop a better understanding of climate solutions through dialogue with Aboriginal and Torres Strait Islander peoples, particularly strategies that have helped people manage Australian ecosystems for tens of thousands of years. **We also recommend** a meaningful dialogue between all Australians regarding the steps needed to avoid global warming of 3°C by 2100.

10 Continue to build adaptation strategies and greater commitment for meeting the challenges of change already in the climate system. While the major theme of this report is about the urgency of action needed to mitigate GHG emissions, **we also recommend** increasing efforts to build and implement adaptation strategies and actions to meet the challenges of climate that will continue to change until mid-century and beyond.