



RACP
Specialists. Together

Climate Change and Australia's Healthcare Systems

A Review of Literature, Policy and Practice

Major Partner



Endorsing Partners



Australasian College
for Emergency Medicine



ANZCA
FPM



The Royal
Australian &
New Zealand
College of
Psychiatrists



COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND



RACGP

Royal Australian College of General Practitioners



Royal Australasian
College of Surgeons



AUSTRALASIAN COLLEGE OF
SPORT AND EXERCISE PHYSICIANS



RANZCOG™

Report prepared for The RACP by Monash Sustainable Development Institute; the Climate and Health Alliance; Monash School of Public Health and Preventive Medicine; and Melbourne School of Population and Global Health and Melbourne Climate Futures, University of Melbourne



MONASH
University

MONASH
SUSTAINABLE
DEVELOPMENT
INSTITUTE



THE UNIVERSITY OF
MELBOURNE



CLIMATE
AND
HEALTH
ALLIANCE

Report Authors

Peter Bragge: Director, Monash Sustainable Development Institute (MSDI) Evidence Review Service

Alyse Lennox: Senior Research Officer, MSDI Evidence Review Service

Loyal Pattuwage: Research Officer, MSDI Evidence Review Service

Tony Capon: Director, MSDI

Fiona Armstrong: Executive Director, Climate and Health Alliance (CAHA)

Milly Burgess: Projects and Operations Officer, CAHA

Corey Watts: Project Consultant, CAHA

Sue Cooke: Project Consultant, CAHA

Kathryn Bowen: Professor and Deputy Director, Melbourne Climate Futures; Professor – Environment, Climate and Global Health, Melbourne School of Population and Global Health, University of Melbourne

Danny Liew: Deputy Head of School (Education and Enterprise), Chair of Clinical Outcomes Research, and Co-Director of the Centre of Cardiovascular Research and Education (CCRE) at the School of Public Health and Preventive Medicine, Monash University

Citation

Bragge P, Armstrong F, Bowen K, Burgess M, Cooke S, Lennox A, Liew D, Pattuwage L, Watts C, Capon T. Climate Change and Australia's Health Systems: A Review of Literature, Policy and Practice. Monash Sustainable Development Evidence Review Service, BehaviourWorks Australia, Monash University. Melbourne, October 2021. Available at: <https://www.racp.edu.au/advocacy/policy-and-advocacy-priorities/climate-change-and-health>

Funding declaration

This project was funded by The Royal Australasian College of Physicians.

Acknowledgement

We thank the 10 medical colleges who participated in the Climate Change and Health Research Project Advisory Committee for contributing expertise and advice to this report.

Conflict of interest declaration

The authors declare no conflict of interest.

Copyright

© Royal Australasian College of Physicians 2021

All rights reserved. Except as provided in the Copyright Act 1968, this work may not be used, reproduced, adapted or communicated without the written consent of the copyright owner. Requests and inquiries should be directed to: Royal Australasian College of Physicians, 145 Macquarie Street, Sydney 2000

P: 1300 697 227 **E:** policy@racp.edu.au

Disclaimer

While Monash University has taken all due care to ensure that the information contained in this work is accurate at the time of publication, it provides no express or implied warranties or makes any representations in relation to this work or any content. The information contained in this work is provided 'as is' and without any guarantees as to its accuracy, currency, completeness or reliability. To the extent permitted by law, Monash University excludes all liability for any loss or damage occasioned by use of this work or information contained in this work. Monash University is not responsible for decisions or actions taken on the basis of the content of this work and you use the information in this work at your own discretion and risk.

Contents

Executive Summary	05
Recommendations	06
Project Summary	07
Introduction	07
Project findings	10
Literature Review: Summary and Findings	15
Summary	16
Method	17
Results	18
Key findings across the included reviews	21
Policy and Institutional Analysis: Summary and Findings	27
Summary	28
Context	29
An analysis of climate and health governance in Australia	31
Climate and health policy in Australia	32
Climate change mitigation and adaptation policies and programs relevant to health by jurisdiction	34
The carbon footprint of healthcare in Australia	37
Key findings: Insights from policy and institutional analysis and interviews	39
The way forward	43
Case Studies: Summary and Findings	44
Summary	45
Findings	47
Economic Analysis	69
Aim	70
Methods	70
Results	74
Appendices	87



Executive Summary

The need for urgent action to address the health impacts of climate change is well-established. Australia is facing greater climate change impacts than many other parts of the world.

Like all countries, Australia's health system confronts the dual challenge of dealing with human impacts of climate change and reducing its own substantial contributions to the country's carbon footprint. This report, commissioned by The Royal Australasian College of Physicians (RACP), is designed to provide Australia's peak healthcare organisations with evidence-based recommendations for Australian policymakers, health systems, health professionals and the communities they serve.

The report comprises four research projects undertaken by Monash Sustainable Development Institute (MSDI), the Climate and Health Alliance (CAHA), Monash University's School of Public Health and Preventive Medicine and the University of Melbourne's School of Population and Global Health:

A systematic literature review identified 17 reviews of health system response to climate change, finding high-quality evidence of interventions (including energy efficiency measures, waste reduction, reusable textiles, and changes to anaesthetic and surgical practices) that can reduce carbon footprint, save money and improve healthcare outcomes. However, system-level responses are lacking; policy and regulatory support is required; and more research is required, both into effective responses and how to implement these in policy and practice.

A policy and institutional analysis (PIA) found that despite a lack of policy drivers, there are strong signs of emerging leadership on climate action at health service, network and state / territory government levels.

Progress is strongest in jurisdictions where supporting legislative and regulatory environments provide an authorising environment. Individual-level leadership is also in evidence where strong leadership, support and encouragement are present. The COVID-19 pandemic has illuminated the feasibility of the rapid, system-level change required to tackle the climate health challenge. However, a clear need was identified across all health professions for capacity building regarding the climate change and health nexus and how to communicate and advocate based on this knowledge.

A series of case studies representing a broad array of geographical regions, climate risks / opportunities, sectors, and communities (including Aboriginal and Torres Strait Islander people), and sectors provided a human face to the other project findings. Severe impacts to the healthcare system from drought, bushfires, extreme heat, coastal inundation and other climate-related extreme events have already been felt across Australia. These powerful stories of climate-related impacts on healthcare infrastructure, operations, workforce, and service demand bring into sharp relief the human costs to the general community, including the impacts on the healthcare workforce.

An economic analysis calculated the losses associated with bushfires between 2021 and 2030 inclusive, based on estimates of bushfire risk relative to the severity of the 2019 Black Summer bushfires over the coming decade. The modelled analysis predicted the loss of 1480 lives; healthcare costs of \$69 million; and a \$10 billion reduction in gross domestic product. This modelling shows that \$1 billion invested to reduce the impact of bushfires on health by 10% would be recouped in a decade.

From these four projects emerge a series of key themes which underpin seven recommendations drawn from this program of research.

Recommendations

1 Implement and fund a coordinated national strategy on climate change and health

- ✦ Enable a systems approach to action and decision-making within and across all relevant policy portfolios.
- ✦ Foster strong collaboration between all levels of government, health institutions, medical colleges, professional associations, industry and civil society.
- ✦ Encourage community consultation and engagement on the strategy which draws on diverse knowledges including from rural and remote communities.

2 Commit to delivering net zero healthcare by 2040

- ✦ Develop a plan informed by research, evidence and action including from the National Health Service (NHS) in England, World Health Organization (WHO) and Health Care Without Harm.
- ✦ Ensure that the plan encompasses 5-yearly goals.

3 Invest in climate health vulnerability and capacity assessments with a focus on locally-led planning

- ✦ Support all healthcare systems to undertake vulnerability and capacity assessments (VCAs), including in rural and remote communities.
- ✦ Embed VCAs within healthcare system management, accreditation standards and performance measures.

4 Establish a dedicated climate health resilience research fund to support innovation and evidence-based action

- ✦ Direct research funding to (i) vulnerability and capacity assessments (VCAs) to manage risks to human health including from extreme weather events; (ii) evaluation of climate health interventions; and (iii) implementation research evaluating translation of evidence-based interventions into policy and practice.
- ✦ Connect research and innovation efforts through communities of practice that share knowledge and translate effective strategies at scale.

5 Develop climate health capacity in the healthcare workforce and the wider health system

- ✦ Equip health professionals with climate health information, training and resources.
- ✦ Integrate education about climate change and health into all health professional training degrees and Continuing Professional Development.

6 Embed Aboriginal and Torres Strait Islander knowledge and leadership in all climate health policy and action

- ✦ Recognise the unique wisdom of Aboriginal and Torres Strait Islander people and communities when developing health system and societal policy responses to climate change.
- ✦ Support a culturally safe and holistic community-led approach to building climate health resilience.

7 Invest in prevention and early intervention as a key element of climate health action

- ✦ Focus on preventive population-level measures to support health system resilience.
- ✦ Eliminate unnecessary healthcare to reduce financial and environmental costs and avoid waste.





Project Summary

The Intergovernmental Panel on Climate Change (IPCC) is very clear: climate change is widespread, rapid, and intensifying, with “unprecedented” effects seen around Australia and planetwide.¹

Introduction

Without a swift and deep reduction in fossil fuel and other greenhouse gas emissions to net-zero, the Paris Agreement’s 1.5–2°C guardrail will slip out of reach, straining society’s efforts to adapt. The report’s headline — ‘Code Red for Humanity’ — succinctly conveys the threat and the urgency for action.¹

Similarly, a recent update to a paper originally signed by over 11,000 scientists from 153 countries reported that 18 of 31 ‘planetary vital signs’ indicate very troubling trends, along with little progress by humanity to address climate change.² The scientists *“reaffirm the climate emergency declaration and again call for transformative change, which is needed now more than ever to protect life on Earth and remain within as many planetary boundaries as possible.”*²

Australia faces greater climate change impacts than many other parts of the world. Already, Australia and the world are, on average, more than 1°C hotter than last century.³ On our present course, the world

is expected to warm by 1.5°C in about 20 years.⁴ Modelling predicts that unless strong action is taken, Australia faces up to 6 degrees mean annual temperature increase since the preindustrial era by 2100.⁵ This is an unthinkable outcome given that even half of this — a 3-degree rise — would render Australia’s ecological systems unrecognisable due to alterations in the distribution or loss of thousands of species.⁶

At 2°C of global warming, heat extremes would more often breach critical thresholds for food production and human health. Each additional fraction of a degree raises climate-related health risks, including the risk of complex, compound, and cascading impacts.^{7–9} To avoid the worst health impacts of climate change, global emissions must halve by 2030; reaching net zero by 2050.¹⁰ With clearer evidence of climate change countries are signalling stronger climate ambition. The US recently pledged to cut emissions by 50–52% below 2005 levels by 2030, putting it on track to net zero by 2050. Japan, Canada, the UK, the EU,



and South Korea have also strengthened their targets and other commitments, and the G7 has agreed to stop funding new fossil fuel projects.¹¹ Most countries — representing over two-thirds of global GDP and 72% of global emissions — now have some form of net zero emissions target.¹² If they match rhetoric with action, the world is projected to warm 2.0–2.4 °C by 2100. Stronger action is still needed, but the goal agreed to in Paris is within reach.¹³

Australians' support for strong climate leadership is growing and widening.¹⁴ Most expect the federal government to at least match the ambition of the UK, US, and others. Although Australia recently committed to a net zero by 2050 target, Australia is widely seen as a climate laggard;¹⁵ with inaction contributing to the erosion of our diplomatic credentials.¹⁶ Pacific island states¹⁷ and the United States¹⁸ have recently taken Australia to task, and Australia ranks last for carbon and energy policy in the 2021 Sustainable Development Report.¹⁹ Yet, Australia is 'uniquely placed to benefit economically from global decarbonisation', according to the OECD, with abundant renewable resources. We are, however, especially vulnerable to economic shocks and weather events in a world that is both warming and decarbonising.^{20,21} Not only have we missed opportunities for the lack of "a coherent and coordinated national strategy" and quicker action,

but we are now obliged to take a steeper emissions path to get to net zero by 2050.²² Carbon is about to be priced into trade, unnerving Australia's carbon-intensive export industries. The EU will phase in a carbon border adjustment mechanism (CBAM) in 2023–26, and the US and China appear to be giving carbon tariffs serious thought.²³

Paradoxically, health systems are part of both the problem and the solution.^{24–26} Australia's health system contributes approximately 7% of the nation's CO₂ emissions²⁷ — an emissions output equivalent to the whole of South Australia.²⁸ Australia's healthcare emissions compare with a global figure of 4.4%²⁹ with figures of 6% and 10% in the UK and US respectively.²⁷ Health systems are also the main line of defence for populations facing health threats resulting from the impacts of climate change including increased temperatures and climate-related extreme weather events — meaning that health systems are uniquely placed as part of both the problem of climate change but also responsible for managing its health consequences. In recognition of this, the World Health Organization's Special Report for COP26 provides an overview of the health impacts of climate change; outlines the health co-benefits of taking climate action; and makes 10 high-level recommendations for action.³⁰

Internationally therefore, the spotlight is on the climate health nexus, with health included in the program of the global climate negotiations in Glasgow, and a COP26 Health Initiative launched by the World Health Organization, the UK COP26 Presidency and international NGO Health Care Without Harm. This initiative calls on health ministries around the world to make commitments to act on climate change through two pathways: building adaptation and resilience; and setting a course for low carbon and sustainable healthcare. England's NHS became the first national health agency to commit to net zero by 2050.^{30,31} France now requires hospitals to report and reduce their emissions, and Argentina is the first to declare its intention to decarbonize health in its Nationally Determined Contributions (NDCs). Australia's NDC, meanwhile, makes no mention of health.³³ Australia has however joined the Adaptation Action Coalition.^{22,34}

Under the leadership of President Biden, the US has set in motion a government-wide program of adaptation and mitigation, establishing high-level interagency groups, mainstreaming climate risk management across the financial system, and deploying the purchasing and diplomatic powers of the US government to drive climate action at home and abroad.³⁵ Twenty federal departments and agencies — including Health and Human Services (HHS) — now have Climate Action Plans,³⁶ and agency heads are instructed to begin to remove fossil fuel subsidies.^{37,38} The HHS Secretary has set up a new Office of Climate Change and Health Equity, established a Healthcare System Readiness Advisory Council and an Interagency Working Group to reduce risks to vulnerable Americans. A 2016 National Climate Vulnerability Assessment³⁹ is being updated using the Center for Disease Control's (CDC) long standing Building Resilience Against Climate Effects (BRACE) Framework. These initiatives provide both inspiration and practical guidance for Australia.



“

COP26 Health Initiative calls on health ministries around the world to make commitments to act on climate change through two pathways: building adaptation and resilience; and setting a course for low carbon and sustainable healthcare.

Four strands of research in this project

A **policy and institutional analysis** to help The RACP understand the lie of the land of climate and health policymaking in Australia, with a view to reforms that reduce climate risks to the health system and help to realise the opportunities.

A **rapid systematic review** of how health systems around the world are responding to the threat of climate change.

An **economic analysis** estimating the health burden of bushfires in Australia from 2021 to 2030 and the cost-effectiveness of interventions to reduce this burden

A series of **case studies** representing a broad array of geographical regions, climate risks / opportunities, groups (including Indigenous), and sectors.

Project findings

The four strands of research conducted in this project identified seven interlinked and overarching themes, presented and discussed below.

Leadership

Leadership – at the individual, civil society, healthcare sector, and political levels – is essential for acceleration of action to ensure a climate resilient and environmentally sustainable healthcare system

Strong emission reduction targets set by the Commonwealth are a fundamental precursor to enable swift progress to climate resilient and environmentally sustainable healthcare systems, as identified in the literature review and PIA. This leadership can then

provide the enabling conditions for action at healthcare service levels, both at the individual institution level and in aggregated healthcare networks. The evidence from the PIA notes that despite the lack of policy drivers, there are strong signs of emerging leadership at a local level, at individual health services and their respective networks. Examples of such leadership include developing programs for staff engagement and preparing climate response plans. Evidence of change also exists at an individual staff level – for example in instances where healthcare professionals have developed a sense of agency and responsibility in relation to their own role in responding to the health impacts of climate change. This can, in turn, support wider institutional change and build momentum for action.

The power of the enabling environment created through legislation is highlighted in Victoria's *Climate Change Act 2017*, which obliges the development of sectoral mitigation and adaptation plans.⁴⁰ Numerous other policies, strategies and efforts of individuals, hospitals, government bodies and clinicians are identified. However, collective action is missing due to the fragmented nature of the health system and lack of national leadership. This means that responses to climate change are piecemeal and at times inadequate. For example, the Case Study on the South Coast NSW bushfires reports that lack of engagement of Aboriginal and Torres Strait Islander people in disaster response planning led to *"poor, culturally unsafe services being provided by some mainstream services and charities during the bushfires."*

The importance of the policy and regulation environment was echoed in the literature review, noting that policy and regulatory barriers to health system responses to climate change need to be addressed. Centralised regulation and guidance, community pressure and healthcare calls for action are important facilitators of policy and regulatory support^{41–44} — many such calls for action were noted in the literature review. However, substantial barriers exist including lack of or inadequate regulations;^{27,45} the need to shift manufacturing, transport and procurement practices;⁴⁶ lack of policy coherence;⁴⁷ and lack of political leadership.⁴⁸

The health sector can lead calls for greater action on climate change at all levels of government, as noted by the Paris Agreement (2015).¹³ As indicated in the case studies and a national survey undertaken by the Climate and Health Alliance⁴⁹ health practitioners are calling for information and support to help empower communities to develop and implement the necessary adaptation and mitigation strategies to respond to climate change.

Responses require collaboration and systems-based approaches

A nationally coordinated approach is needed to ensure appropriate responses to climate change across all jurisdictions. As identified in the review, higher impact will be reached with coordinated systems-based action, and the case studies illustrate the risks of a fragmented approach. Numerous agencies, regulators and advisory bodies exist at Commonwealth and state levels. Some have an explicit remit to address climate change, while others have considerable untapped potential if their functions are connected to climate change adaptation goals. However even if complex, multilayered health systems and colleges act in a coordinated fashion and lead mitigation and adaptation initiatives, they will ultimately be limited unless these initiatives are enabled by sectors outside of healthcare, for example energy and transport. Colleges and other healthcare actors will need to work with others, not just other health disciplines but across interdisciplinary and systems boundaries. It is likely that these other sectors are in turn dependent on health as a high carbon emitter to amplify and facilitate their efforts. Although such analysis is beyond the scope of this report, cross-sectoral efforts are the ultimate means of getting richer, stronger, outcomes that are better for everyone and more applicable to the real world and people on the ground.

Sharing experiences and lessons learnt is a crucial vehicle to encourage and implement 'Communities of Practice', which as the literature review shows, can accelerate widespread uptake and lead to innovative ideas and synergistic efforts. Similarly, the case studies indicate that when interested clinicians or service providers find exemplars that illustrate what is possible, they can be inspired to implement similar or even greater efforts. This is supported by behavioural and implementation science literature which is also described in the literature review.

“ Collective action is missing due to the fragmented nature of the health system and lack of national leadership.

The literature review identified few published studies at a system- or country- level. Given the scale of the climate change challenge, system- and country-level responses offer the most potential for significant impact.^{50,51} The example of the NHS reforms in the UK, described in the PIA, powerfully illustrates the potential of system-level responses to amplify the interventions that were identified in the literature review.

Evidence-based action is a fundamental principle for the healthcare sector.

Healthcare professions and their peak bodies are driven first and foremost by their motivation to provide best evidence-based care to their patients. Australia's medical colleges have the reputation, resources and power to lead and influence. The NHS has over the last decade provided a blueprint for how health systems can spend less money, reduce their carbon footprint and improve patient care. The catalyst for this was strong national leadership on emissions reduction, and this should be a key focus of advocacy for the colleges.

Responses to the impact of climate change on the health sector are best informed by the conduct of vulnerability and capacity assessments (VCAs), which will guide evidence-based actions. The WHO provides guidelines for the conduct of such assessments, which have been carried out globally.³⁰ The UK NHS also offer numerous resources pertaining to both assessment and system-wide action. The literature review and PIA both identify a need for a more comprehensive assessment of health system vulnerability to climate change including economic evaluation of risks and costs of inaction as well as savings from climate mitigation and adaptation measures. Currently there is insufficient funding for research to conduct such assessments. In addition, the case studies highlight a lack of coordinated investment in assessing climate health risks to specific populations and to health services, and insufficient evaluation of programs being delivered.

The case studies also provide clear evidence on how climate change is impacting Australians and the health system they rely on. Drought, bushfires, extreme heat, coastal inundation and other climate-related events can result in a dangerous combination of increased healthcare demand and reduced healthcare capacity. These impacts are not just physical – the case studies reveal mental health challenges, including for providers of healthcare. The literature review identified that mental health services are effective in dealing with mental health problems following acute climate-related events; however for sub-acute and longer term mental health impacts efforts directed at advocacy for mitigation policies and programs are also needed.

There is evidence of fertile ground on which to build meaningful action on climate change. An illustrative example spanning all research projects within this report is harnessing solar energy. The PIA describes Queensland's \$30 million initiative to install solar panels at 50 sites; the Case Study of Victoria's response to climate change describes the Regional Solar Health Program, which will reduce carbon emissions in public health facilities by 13,000 tonnes annually. The review by Barraclough (2020) cites five individual research studies examining the impact of solar power on reducing power consumption.⁴¹ Renewable energy will feature in Hunter New England Health Service's effort to become carbon neutral by 2030, ironically despite its location in Australia's most carbon intensive region, the Hunter Valley in NSW.

A discussion of the cost of action should also consider the cost of inaction. The economic analysis within this project calculated the losses associated with bushfires between 2021 and 2030 inclusive, based on estimates of bushfire risk relative to the severity of the 2019 Black Summer bushfires over the coming decade. The modelled analysis predicted loss of 1480 lives, equating to 4024 years of life; healthcare costs of \$69 million; and a \$10 billion impact on gross domestic product. This model shows that \$1 billion invested to reduce the impact of bushfires on health by 10% would be recouped in a decade.

Clear accountability frameworks will facilitate a rapid learning healthcare system.

Clear, practical and appropriate Monitoring, Evaluation and Learning (MEL) frameworks are required in order for the healthcare system to continually adapt and improve its sustainability efforts. Currently, there is insufficient attention on capturing lessons focused on what works and what doesn't, and ways to share knowledge. The case studies illustrate the variety of approaches that are showing promise across the nation. Resources to support the monitoring, evaluation and learning of these interventions can accelerate the adoption of these in other locations, notwithstanding the importance of context specific interventions. Innovative ideas can be trialled that support collaboration and help embed sustainable approaches.

Responding to climate change also requires strategic imagination to transform a system that is traditionally reactive to one that is proactive and focused on the delivery of high-value, net zero emissions and sustainable healthcare. The literature review finds that more research into effectiveness (rather than observational studies and commentaries) is needed, particularly relating to environmental impact assessments including life cycle analysis and economic evaluations of Returns on Investment (RoI). These types of applied research activities have clear value for articulating the business case for investing in climate resilient and environmentally sustainable healthcare systems.

Capacity development

Capacity development of the healthcare sector, the health workforce and the wider health system can enhance understanding and action on health and climate change.

There is a need for health professionals to be equipped with information, tools and resources to support them to anticipate, prepare for and respond to the health impacts of climate change. Specifically, the literature review found a need for more implementation studies, which, if available, can then be used to support training on appropriate interventions. The literature review did identify that training of healthcare workers to improve environmental performance of hospitals which reduces chemical use, waste disposal and surgical costs was a beneficial intervention.

A significant gap in relation to awareness of emerging policies, tools and resources was identified in the case studies, and the PIA reinforces the need for education and information for health professionals on the relationship between climate change and human health, and the role of health professionals in responding to the impacts.

The PIA also reveals the deep concern of engaged health professionals regarding the failure of policy to keep pace with the evidence regarding climate change and adverse health impacts (physical, mental, emotional, financial) on the population and on the health system in Australia. Whilst this concern is a clear issue, there is also an opportunity to collaborate with this segment of engaged health professionals to develop their capacity to continue their efforts to support system changes.



As noted in the case studies, equally important is the role of health professionals to help empower communities to make the necessary adaptive and mitigative changes to respond to climate change. Health practitioners want information and support to be able to do this.

There is much to be learned from the leaders in this area — particularly the UK's Greener NHS which provides consistent, evidence-based and health system-wide guidance. While these strategies and resources provide a useful starting resource, they may need to be adapted for the Australian context. The rapid growth in Australian and Aotearoa New Zealand (AoNZ) membership of Global Green and Healthy Hospitals indicates keen interest and appetite for authentic, credible peer support, information and guidance.

Diverse knowledge

Harnessing diverse knowledges across different contexts will yield appropriate and context-specific responses.

There is no 'one-size fits all' response to the impacts of climate change on the healthcare sector. Developing appropriate responses requires the inclusion of diverse voices and knowledges. As highlighted in the case studies, Aboriginal and Torres Strait Islander voices need to be clearly heard and should be central in the development of plans to guide climate preparedness, as well as disaster and emergency response affecting their communities. They should have access to community-driven, culturally safe, and properly resourced responses to disasters and equally to resilience building and preparedness for future impacts. Indigenous- and community-led or co-led approaches that embrace all sectors are vital and promising approaches. Similarly, in rural and regional settings, consultation with local stakeholders including those within the health system should be part of climate change responses as well as disaster preparedness and planning.

The literature review reveals little evidence of recognition of the importance of Indigenous perspectives or cultural safety in the literature, despite the case studies highlighting the importance of cultural safety and valuing Indigenous knowledge systems. They confirm many health professionals

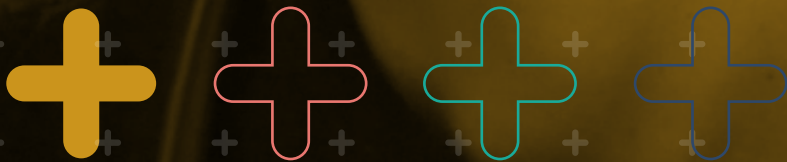
are aware of failing to overcome persisting barriers to equitable health outcomes, conscious of heavier burdens carried by Indigenous health workers, and are unsure of how to learn from First Nations people. In addition, the PIA identifies the emergence of an overdue but wider recognition about Aboriginal and Torres Strait Islander people and groups as custodians of valuable knowledge developed over millennia that can inform and guide policy and practice in relation to climate change and health risks and opportunities.

Prevention as a key tenet

Key principles of optimal healthcare — prevention, early intervention and reduction of low-value / non-evidence-based care — are highly congruent with the climate change agenda. Upstream action on climate change — particularly mitigation in Australia's context — will prevent burdens on the healthcare system and support its resilience. The literature review clearly identifies the range of low-emission healthcare alternatives that can reduce costs and improve health system resilience. The focus on prevention is reinforced in the case studies, which highlight that many health professionals, particularly non-metropolitan practitioners, feel exhausted by cascading and compounding stressors including droughts, fires, floods, and COVID-19. They recognise that proactive, capacity building, preventive, often population-level approaches are essential to build community resilience and address current and future healthcare needs. Further, the PIA demonstrates a recognition that desirable, rapid system change is possible in the face of serious threat and the COVID-19 recovery presents an opportunity that should not be wasted, to build back better for climate resilient and environmentally sustainable healthcare. This is reflected by international calls to draw upon lessons learned from COVID-19 to improve the resilience of health and social care systems.⁵² The economic analysis summarised above further underlines the value of prevention in financial terms.

Note: The Australian Glossary on Health and Climate Change published by The University of Sydney may aid interpretation of this research report.¹⁸¹





Literature Review

SUMMARY AND FINDINGS



Summary

The literature review identified 17 reviews of health system response to climate change, of which 8 were higher quality based on evaluation of review quality using a recognised appraisal tool.

A total of 34 health system responses were identified spanning interventions in operating rooms (n = 16), dialysis and respiratory medicine settings, at hospital-level and in community settings. Evidence from higher quality reviews reports a broad range of beneficial interventions including:

- ✦ Training of healthcare workers to improve environmental performance of hospitals which reduces chemical use, waste disposal and surgical costs;
- ✦ Energy efficiency measures which result in water and energy savings calculated in one study to be USD \$800 000–\$3 million annually;
- ✦ Recycling in operating rooms, dialysis and across hospitals which generate financial savings and circular economy benefits;
- ✦ Telemedicine which reduces carbon footprint, hospital referrals and more costly face-to-face consultations;
- ✦ Substituting desflurine in anaesthesia for lower-polluting agents, which reduces the greenhouse gas contribution of anaesthetic gases in operating theatres from 51–63% to 4%;
- ✦ Reusing textiles, as high-quality studies have demonstrated that disposable clothing has a 200–300% higher carbon footprint; 250–300% greater water need and 750% greater impact on solid waste production; and
- ✦ Reprocessing single-use devices which carries annual savings in the US of \$471 million and 7,000 tons of medical waste.



“

Given the scale of the climate change challenge, system — and country-level responses offer the most potential for significant impact.

Although the above examples demonstrate the potential of at-scale actions, few published studies at a system – or country – level were identified. Given the scale of the climate change challenge, system – and country-level responses offer the most potential for significant impact.^{50,51} The example of the UK NHS, outlined in the PIA, powerfully illustrates the potential of system-level responses to amplify the strategies outlined above. This documents not only the value of system-level change but the transformative steps required to achieve this.⁵³ Related to this, more research into effectiveness (as opposed to observational studies and commentaries) is needed – especially environmental impact assessments including life cycle analysis and economic evaluation of return on investment.^{27,44,54}

Policy and regulatory barriers to health system responses to climate change need to be addressed. Centralised regulation and guidance, community pressure and healthcare calls for action are important facilitators of policy and regulatory support.^{41–44} However, substantial barriers exist including lack of or inadequate regulations;^{27,45} the need to shift manufacturing, transport and procurement practices;⁴⁶ lack of policy coherence;⁴⁷ and lack of political leadership.⁴⁸ In addition to these barriers, individual and organisational-level implementation of effective strategies requires careful consideration of behaviour change and related theories. There is evidence from both reviews and primary studies that can guide communication and implementation strategies, including critical insights into the role of social influences on behaviour that have direct implications for implementation efforts. Future research should therefore strike a balance between discovery research to establish ‘what works’ in responding to climate change, and implementation research to evaluate effectiveness of strategies promoting meaningful individual- and organisational-level change.

Methods

The review question co-developed in consultation with The RACP was: “How are healthcare systems responding to the threat of climate change?”

A rapid literature review (‘review of reviews’) approach was used to address the review question as this is a recognised approach to gathering key information from research literature in limited timeframes where a full systematic review is not feasible.⁵⁵ Studies have shown that rapid literature reviews have similar conclusions to systematic reviews of the same topic.⁵⁶ The review protocol was registered on the global PROSPERO research review database (Registration number: CRD42021260450).

A comprehensive literature search was conducted in Medline via Ovid, Global Health via Ovid, Scopus, Cochrane Library, Health Systems Evidence, Social Systems Evidence and Google Scholar on June 11, 2021. The search was restricted to English language and literature published from 2016 onwards. Citation and full text screening were independently undertaken by two reviewers (PB and AL) using predetermined inclusion and exclusion criteria to reduce selection bias. Inclusion criteria were designed to identify reviews in any country and Australian primary studies.

Data extraction was performed by one reviewer (AL) and checked by a second reviewer (PB). Data extracted from relevant reviews included author/s name, date published, number of included studies, date of most recent search, aim, area of focus within the healthcare system (i.e. setting-specific, discipline-specific or general), response to climate change (i.e. intervention-specific or general) and key findings / conclusions. One reviewer performed quality appraisal (LP).

The quality of included systematic review was appraised using A Measurement Tool to Assessment Systematic Reviews 2 (AMSTAR 2)⁵⁷ and the quality of included narrative reviews was appraised using the Scale for the Assessment of Narrative Review Articles (SANRA).⁵⁸ Consistent with previous published approaches, studies of higher quality were defined as those meeting half or more of applicable quality assessment criteria.⁵⁹ Given that Australian and AoNZ primary studies were not the main focus of this review, the quality of these studies was not assessed. Interventions supported by at least one higher quality review and three primary studies were highlighted. Search strategies, inclusion and exclusion criteria are contained in Appendix 1.

Results

A total of 4409 citations were identified; 165 articles were reviewed in full-text and 17 reviews relevant to the review question were identified. These comprised four systematic reviews^{43,60–62} (which follow an explicit search, selection and synthesis method) and 13 narrative reviews^{27,41,44–47,54,63–68} (which follow less explicit/robust methods). Eight reviews were of relatively high methodological quality, comprising one systematic review⁴³ and seven narrative reviews^{44–46,54,63,64,67} and nine were of lower quality. Four primary Australian / AoNZ studies were identified.^{42,48,69,70} Details of search and screening, and quality appraisal scores for all reviews are contained in Appendix 2. Table 1 presents characteristics of interventions identified in the review that were supported by at least one higher quality review and at least three primary studies. An overview of all interventions across all reviews is contained in Appendix 3. Details of all included reviews are contained in Appendix 4.



Table 1. Health systems responses to climate change supported by at least one higher quality review and three primary studies

Setting	Intervention Review Sources (n studies cited)	Outcomes reported
Hospital	Training of healthcare workers to improve environmental performance of hospitals. Dupraz et. al. 2021 (2); Beloeil 2021 (1); Guetter 2018 (1); Bravo 2020 (1)	Reduced chemical use and improvements in waste disposal in hospitals; reduced cost of disposable equipment in surgery
	Donating unused medical supplies to countries in need. Guetter 2018 (3); Bravo 2020 (1); Brown 2020 (1)	Pilot programs have demonstrated effectiveness
	Energy efficiency measures (upgrading and adjusting HVAC; changing to LED lights; shortening operation duration; running multiple ORs; power down when idle; more efficient steriliser usage) Yates 2021 (4); Bravo 2020 (3); Dhillon 2015 (1); Brown 2020 (2); Palinkas 2020 (4); McGain 2020 (1)	Lower costs; improved surgical outcomes; less glare (LED lights); energy savings; water savings; energy-efficiency plans have been shown to save 800k–USD \$3 million annually
	Green building design (site near transport; use local materials; trees on site; natural lighting and ventilation; water harvesting; green roofs). Dhillon 2015 (6); McGain 2020 (2)	No difference in overall cost compared to non-green building; improved health of occupants; water conservation
	Recycling in Operating room, hospital and dialysis. Beloeil 2021 (2); Bravo 2020 (1); Barraclough 2020 (1); Brown 2020 (1); McGain 2020 (3)	Lower carbon footprint; financial savings; circular economy benefits

SUMMARY

Setting	Intervention Review Sources (n studies cited)	Outcomes reported
Community	Telemedicine Purohit 2021 (14); Yates 2021 (2); Allwright 2020 (5); Holmner 2012 (5); McGain 2020 (1)	Telemedicine reduces the carbon footprint of healthcare compared to face-to-face consultations where travel-related savings are sufficient to offset the carbon footprint of the telemedicine service; can reduce hospital referrals and face-to-face consultations and create economic savings in dermatology
	Mental health services Palinkas 2020 (23)	Evidence is strongest for interventions following acute climate-related events (e.g. floods, fires); less strong for long-term events (e.g. drought) and weakest for long-term, permanent changes (e.g. higher temperature, sea level rise)
Anaesthesia	Anaesthetic gas scavenging Guetter 2018 (1); Yates 2021 (2); Holmner 2012 (2); McGain 2020 (8)	Shown to be efficient; decreased climate impact; limits rebreathing of volatile gases
	Use isoflurane or sevoflurane instead of desflurane where able Yates 2021 (3); Beloeil 2021 (3)	Lower environmental contribution to warming
	Lower the gas flow rate in anaesthesia Yates 2021 (2); Beloeil 2021 (1); McGain 2020 (6)	Can significantly decrease the yearly amount of volatile agent used, yielding both an environmental and cost benefit; safe
	Wide-awake hand surgery (local anaesthetic) Bravo 2020 (5); Brown 2020 (3)	Reduced cost and reduced waste; no need for preoperative testing
Surgery	Environmentally Preferable Purchasing Yates 2021 (1); McGain 2020 (2)	Can achieve significant GHG reductions without compromising cost, clinical efficacy nor efficiency; reduces expenditure
	Reducing size of pre-packed surgical instrument bundles Yates 2021 (1); Brown 2020 (2)	Can cut energy use, reduce waste and save money
	Reusable textiles Yates 2021 (1); Beloeil 2021 (6); Bravo 2020 (1); Brown 2020 (2); McGain 2020 (1)	Can reduce waste and save money; much lower environmental impact
	Reprocessing single-use devices Yates 2021 (1); Beloeil 2021 (1); Bravo 2020 (2); McGain 2020 (4)	In 2018 reprocessing in the US saved \$471 million and 7000 tons of medical waste; lower carbon footprint; no evidence of patient harm

Key Findings Across the Included Reviews



Research has demonstrated the effectiveness of a range of health system responses to climate change which have been reported in high quality review-level studies

- ✦ At a hospital level, energy efficiency measures; recycling; hospital-wide efforts to reduce waste; and green building design have been demonstrated to save money, improve outcomes and optimise health of building occupants;^{43–46,54,63,64}
- ✦ At a community level, telemedicine reduces carbon footprint.^{44,54} Provision of mental health services is effective in dealing with mental health problems following acute climate-related events, however addressing sub-acute and longer term impacts of climate change requires efforts beyond clinical care including advocacy for mitigation policies and programs;⁶⁷
- ✦ In surgical settings there is evidence that changes to anaesthetic agents and processes decreases carbon footprint, saves money and reduces waste.^{44,46,63,64} Furthermore, environmentally preferable purchasing, reprocessing of surgical devices and adopting reusable textiles bring similar benefits.^{44,46,63}



System-level responses have the most potential for impact, but very few published examples exist

The majority of published studies pertaining to health system responses to climate change report on initiatives at the level of individual hospitals. Given the scale of the climate change challenge, system- and country-level responses offer the most potential for significant impact. For example, Yates et al. reported that reprocessing of single-use devices such as cardiac catheters, laparoscopic staplers and external fixation devices, under regulation of the Food and Drug Administration, offers a safe alternative to new purchases of such items.⁴⁴ In 2019 over 7,500 participating hospitals contributed to saving USD \$544 million; diverting almost 7 million kilograms of waste from landfill; and saving a further USD \$21 million in waste disposal charges.^{50,51}



Policy and regulatory support is needed to drive system-level action

The example of single-use device reprocessing illustrates the importance of policy and regulatory mechanisms. Facilitators of such strategies highlighted across the included reviews were:

- ✦ The US-based National Telehealth Policy Center which centralises information about state-specific telehealth laws, regulation and guidance;⁴⁴
- ✦ The likelihood that regulatory and community pressures will compel reductions in carbon usage;^{42,62} and
- ✦ A number of healthcare entities and associations calling for action on climate change.⁴³

Many reviews also outlined policy and regulatory barriers and challenges:

- ✦ The need for more countries to develop regulations for reprocessing – the cleaning and packaging of single-use equipment (such as blood pressure cuffs and cardiological catheters) for reuse;²⁷
- ✦ Limitations to regulations (health and safety regulations, building codes) preventing hospitals adopting sustainable practices;⁴⁵
- ✦ The need to shift the health sector's procurement policies – at present the procurement chain of drugs and devices (methods of manufacture, packaging, transport, energy requirements of drug delivery) accounts for the major part of carbon emissions from healthcare facilities;⁴⁶
- ✦ Discordance between policies that do not balance individual with planetary risk;⁴⁷
- ✦ The need for ophthalmologists to advocate for public health policy and the variable level of confidence and skill amongst doctors in doing so;⁶⁹
- ✦ The need for eHealth policies to incentivise mitigation and adaptation in the healthcare sector;⁶⁵
- ✦ Policymaker recognition of the value of sustainability in laboratory medicine;⁶⁶
- ✦ Consideration of the political and social aspects of disaster risk reduction as relevant to the provision of mental health services as well as broad climate change policy in health and other sectors;⁶⁷ and
- ✦ The need for leadership, policy and regulation to support climate change adaptation in Queensland's health and wellbeing sector.⁴⁸



More research into the effectiveness of health system interventions to address climate change is needed

- ✦ Reviews found that opinion pieces, perspectives and commentaries calling for action to address climate change were more frequently found than primary studies evaluating impact of strategies:
- ✦ The high-quality and recent systematic review conducted by Dupraz and Burnand contained 137 articles, of which only 22 presented research; these comprised 3 reviews, 12 surveys, 5 qualitative studies and only two studies evaluated effectiveness of strategies to address climate change;⁴³
- ✦ The high-quality narrative review conducted by Guetter et al. contained 37 studies but reported that most were opinion papers, white papers and small case studies and more empirical data is required;⁶⁴
- ✦ A low-quality systematic review by Bali and Flesher found 40 papers for full text review but no papers containing empirical data or impact evaluation.⁶⁰

Specific types of data recommended were environmental impact assessments including life cycle analysis^{54,71} and economic evaluation of return on investment.^{44,54} Although a number of primary studies were cited in the included reviews, they were not quality-appraised within the reviews and therefore the strength of this research evidence cannot be established. The volume of primary studies is modest given that at least some will be cited in multiple reviews.

Supplementary primary studies

The four primary studies from Australia and AoNZ (presented in Appendix 5) illustrate responses in the local context. A survey of 71 dialysis facilities in Victoria reported limited climate change preparedness, with good performance on waste separation but limited efforts to address transport-related emissions or improve procurement processes.⁴² Another survey of 47 ophthalmologists in AoNZ revealed high awareness of the challenge of climate change, the need to reduce waste, and their public health advocacy role, but limited uptake of sustainability practices and staff awareness-raising activities.⁶⁹

McGain (2016) examined steam steriliser use in a hospital surgery setting, finding that although sterilisers were idle for approximately half of the year, they were only turned off 15% of the time. The researchers calculated that switching off idle sterilisers would save over \$13800 and reduce of 80 tonnes of CO2 emissions.⁷⁰

Finally, Tonmoy (2020) examined an innovative engagement process used to develop climate adaptation policy with the health and wellbeing sector in Queensland. A number of transferable factors contributing to engagement and co-development were identified including adopting a holistic definition of the health and wellbeing sector; focusing on the co-benefits of mitigation and adaptation; ensuring governance, regulatory and reporting mechanisms are clearly understood; long-term and ongoing engagement to ensure effective implementation); use of an interdisciplinary approach through participation of service managers, researchers, clinicians and practitioners; acknowledging diverse challenges among different care settings and tailoring adaptation solutions accordingly.⁴⁸



Discussion

This is the first known overview of reviews to systematically identify, appraise and synthesise information about health system responses to climate change from review-level studies. The review identified and appraised 17 reviews of health system responses to climate change. The review found published evidence supporting a range of health system responses to climate change across multiple review and primary studies. This evidence is primarily at the level of individual hospitals, health services or communities; if the reported outcomes were achieved at scale, there is potential for substantial reductions in carbon footprint and costs associated with delivering healthcare. There are few published studies at this system level. Achieving this requires health system-level transformation, requiring strong health system leadership as well as wider policy and regulatory support. Barriers that need to be overcome to achieve this include lack of or limits to existing regulations the need to shift procurement policies and practices; and policy discordance. The review also found that more research is required, especially studies quantifying the effectiveness of climate change action strategies or performing environmental impact / life cycle assessments. This would complement existing evidence on the impact of healthcare on emissions, which broadly mirrors the sectors in which there is most evidence for response strategies – surgery and anaesthetics in particular – but also highlights other areas including renal, pathology and asthma inhalers as having substantial carbon footprints.⁵³

This review had a number of strengths. A review protocol was developed a priori in close consultation with experts in the field and pre-registered. A systematic and comprehensive literature review was undertaken to identify review-level evidence pertaining to health systems responses to climate change. Article screening was undertaken by two independent reviewers to reduce bias in study selection. Finally, eligible literature was appraised using recognised quality appraisal tools for systematic and narrative



reviews. These methodological strengths mean that a high degree of confidence can be placed in the review findings. However, limitations of the review also warrant mention. The parameters of the project meant that the research team did not undertake dual data extraction and quality appraisal, meaning that these elements may have been subject to some bias. A general limitation of rapid literature reviews is that there is potential overlap between the primary studies included across all systematic reviews. This inflates the apparent volume of primary research covered by the reviews. In this review, the limitation is in part offset by the breadth of climate change responses within the reviews. Finally, there are reviews and grey literature reports that may be relevant but were not identified in searching. We limited the year range to 2016, coinciding with the Paris climate change summit; and many reports and other sources of grey literature are not indexed in academic databases which focus on peer-reviewed studies. However, grey literature was not specifically excluded, and the research team had knowledge of relevant major reports to aid interpretation of the findings of the included reviews.

In addition to community pressures, healthcare entities and associations calling for action on climate change is critical to driving health system-level transformation. Recent work by the Climate and Health Alliance (CAHA) explored health professionals'

“

‘Winning hearts and minds’ at the level of individuals is an important precursor to system-level transformation...

views on climate change through a national survey of 875 people representing a broad range of disciplines. This revealed widespread concern about climate change; observed impacts on health professionals’ workplaces; a desire to learn more about health impacts of climate change and a need for training on how to communicate this information to others.⁴⁹ This reflects findings of a review of this topic⁷² as well as similar surveys conducted by the American Thoracic Society;⁷³ a major multinational survey of over 4,000 health professionals⁷⁴ and a survey of over 700 health professionals in China.⁷⁵ Subsequently CAHA have released a practical guide to aid health professionals,⁴⁹ building on the few comparable examples in peer-reviewed literature.⁷⁶ Another key finding of the CAHA survey was the need to receive information from their union or professional organisations to enable them to communicate the value of climate change action. Numerous professional societies and organisations have issued position statements regarding the need for climate change action including the European Respiratory Society;⁷⁷ the American College of Physicians;⁷⁸ The Victorian branch of the Australian Nursing and Midwifery Federation.⁷⁹

These are reflected by similar calls to action at sectoral levels in community health, general practice and private practice settings;^{80–83} mental health;^{84,85} pharmacy;⁸⁶ nursing;⁸⁷ anaesthetic practice;^{88,89} obstetric care;⁹⁰ emergency care;⁹¹ including in Low and Middle Income Countries;⁹² and paediatric intensive care.^{93,94}

The ample evidence of calls to action and position statements raises an important question — what do we know about the effectiveness of advocacy efforts to spark meaningful and impactful action based on the evidence base described in this review? Behavioural psychology and implementation science offer theories and insights that can aid advocacy and implementation efforts. Although beyond the scope of this review, some consideration of implementation and behaviour change challenges is warranted given the urgency of the climate change challenge.

‘Winning hearts and minds’ at the level of individuals is an important precursor to system-level transformation involving multiple actors. Hathaway and Maibach (2018)⁷² systematically reviewed literature on how health professionals and the public around the world view the health implications of climate change. The review found evidence that people view climate change as harmful to health but lack knowledge of specific health impacts. Importantly, their conclusion that *‘health professionals feel the need to learn more, and the public appears open to learning more’* suggests that the door is open to health professionals sharing knowledge and promotion action on this issue. Public sentiment is a key influence on policymakers and has been demonstrated to drive legislative change in a number of areas, for example the introduction of seat belt and other road safety laws.⁹⁵

Hornsey et al. (2021)⁹⁷ offer a thought-provoking critique of the reasoning processes that are thought to drive pro-environmental behaviour. The central idea is that beliefs about efficacy to address climate change are a central behavioural driver. There is evidence that five factors underpin perceptions of efficacy — climate-related distress and threat; social norms (others are taking action therefore I should); social desirability (taking action is an expression of my identity and concerns); difficulty in changing behaviour using explicit instruction; and responsiveness to imagery. Implications of these five factors are discussed and the surprising conclusion is that evidence-based arguments and information are not a reliable influence on perceived efficacy.



This implies that non-analytic, intuitive and socially normed strategies may be more effective.⁹⁶ This paper is reflected in part in the review by van Velkengoed (2019) who found in a meta-analysis of 106 studies that descriptive norms, negative affect, perceived self-efficacy (belief that people are capable in engaging in adaptive actions) and outcome efficacy (the extent to which people believe that adaptive actions will be effective in protecting them from climate-related hazards) were most strongly associated with climate change adaptation behaviour. Echoing Hornsey, the authors concluded that knowledge and experience, commonly assumed barriers to adaptation, were less influential than efficacy beliefs.⁹⁷ A primary study examining the effect of analogies of climate change to more familiar domains found that although analogies did not inform knowledge, there was a weak effect of a medical analogy describing climate change as a disease where readers play the role of the patient's guardian on recognition of the issue, especially amongst conservative voters. Although an isolated study, this has particular resonance with the issue of health professionals communicating climate change.⁹⁸

When moving from individual to organisational levels, literature dealing with group deliberation and decision-making processes can add further insights to those directed at understanding individuals. Arvai et al. (2012)⁹⁹ systematically reviewed 60 years of decision-making research on how to balance social, economic and environmental considerations when making sustainability decisions. The review presents models for supporting decision-making based upon this research and uses worked examples to illustrate them in two prototypical decision-making scenarios. Strategies for **active decision-making** – high-stakes, complex decisions often involving uncertainty and multiple stakeholders – are based on breaking decisions down into manageable steps; identifying and avoiding biases arising from 'shortcuts' (heuristics); explicitly addressing consequences and trade-offs; and incorporating subjective values. Conversely, **passive decision-making** – where decisions are

low-stakes / small and are made at an individual level – employ different techniques such as goal-setting, 'nudges' and setting defaults that make decisions and actions easier. This framing is useful for considering the transformational challenges identified in this review, which clearly fall into the active / group decision-making space, where acknowledging complexity and incorporating stakeholder values are critical. Another review from the Network for Business Sustainability presents evidence-based approaches to embedding sustainability into organisational culture – although it should be noted that like the review by Arvai, the frameworks and strategies presented are based on literature reviewed at least 10 years ago.¹⁰⁰

These behavioural and implementation insights are fertile ground for new research to continue building knowledge not just of 'what works' to address climate change, but what works to implement these strategies through behaviour, cultural and organisational change. However, there is also a need to build the primary evidence base supporting action by health systems. Reviews reported ample opinion, commentary and 'call to action' articles, in many cases substantially outnumbering articles that empirically evaluate the effectiveness of mitigation and adaptation actions. This means that future research needs to address the dual goals of building evidence to support action as well as evidence to support implementation. As with all areas of research, funding is heavily skewed to empirical research when compared with implementation studies. Given the increasing urgency of climate change action and the need to mobilise organisations and populations to commit to meaningful responses, future research funding should strike a balance between discovery and implementation research on this critical issue.





Policy and Institutional Analysis

SUMMARY AND FINDINGS



Summary

This section comprises a high-level review of the policy and institutional responses of the health system to climate change: outlining risks, progress, gaps and opportunities to advance climate-smart healthcare. Our analysis draws on a semi-systematic review of (grey and peer-reviewed) literature, and interviews with experts as key informants. It is intended to be exploratory and insightful, but not exhaustive. Further details about the study design and methods are provided in Appendix 6.

Climate change affects the health system in many ways, impacting healthcare infrastructure, operations, workforce, and service demand, as described by the case studies section of this report. There are many health gains available by taking action to address climate change with potential for win-win-win outcomes from strategies to reduce emissions, improve health and realise savings. The national response to COVID-19 demonstrates a recognition that desirable, rapid system change is possible in the face of a serious threat. Our economic and social recovery from the pandemic presents an opportunity that should not be wasted: to build back better for value-based, low-emission, climate resilient healthcare.

Despite a lack of policy drivers, there are strong signs of emerging leadership across individual health services and networks. This includes developing programs and initiatives for staff engagement, institutional environmental management and climate response plans. Many of these initiatives are delivering (or have the potential to deliver) significant fiscal and public health benefits.

Progress is strongest in jurisdictions where there is underlying supporting legislation which creates the enabling conditions for action to occur at service and institutional levels. This authorising environment to support action is a key ingredient in creating the conditions for innovation and action for leadership by institutions and individuals alike. This can be complemented with clear, experience-based, data-supported case studies to communicate the benefits for health service delivery, population health, and environmental and financial gains to influence political, policy and health-system positions and practice.

There is also evidence of positive change where the conditions for leadership exist at the level of the individual. Support and empowerment of health professionals to develop a sense of agency and responsibility in relation to their role in responding to the health impacts of climate change can support wider institutional change, and build momentum for action. Examples to guide action are critical here, as are supportive communities of practice, where people can learn, share ideas, and develop confidence to innovate.

There is however evidence of a clear need for education and information for health professionals from all disciplines on the relationship between climate change and health and the role of the health professions in response. Despite some important examples of leadership, there remains a knowledge and awareness gap among the health and medical professions, healthcare service managers and executives, as well as policymakers, about the nexus between climate change and health. This is a gap which must be addressed before we can mount an effective national response.



“

There remains a knowledge and awareness gap among health professionals, service managers, executives and policymakers about the nexus between climate change and health.

Context

As we have seen above, stronger climate action is urgent and imperative. We need climate-smart and ultimately net zero emissions health systems and services, designed to anticipate, respond to, cope with, and recover from climate shocks, so that they can continue to provide safe, quality care for Australian communities.¹⁰¹ And we need to ensure those communities — especially the most vulnerable — are themselves as resilient as possible, including by reducing inequity and other root causes of ill-health.

Australia's health system is world class, but policymakers and providers face enormous headwinds, including an aging population, a rising incidence of chronic diseases, more complex and costly interventions, and problems recruiting skilled people in the right places.¹⁰²

Hospitals and health services already struggle to contain mounting costs while maintaining quality, accessibility, and affordability. From 2000 to 2018 total healthcare spending doubled to \$185 billion,¹⁰³ consuming a quarter of combined federal and state government revenue. Very little revenue — less than 2% — is invested in prevention, with spending decisions heavily weighted against the long-term health needs of the population.¹⁰⁴

At the same time, healthcare is a substantial source of carbon emissions, meaning hospitals and other services are contributing to increasing the climate risks in the very communities they serve. Fortunately, as more and more health policymakers and providers are discovering, lightening health's carbon footprint can also lighten the load on healthcare budgets.¹⁰⁵

International evidence and emerging practice in Australia's health sector demonstrates there is enormous potential for substantial transformation of healthcare's climate footprint as well as a strong appetite for exercising this important lever for change. Many resources and examples of best practice now exist to guide action in the healthcare sector to play its part in reducing emissions to help limit the impacts of climate change on the population and health system.



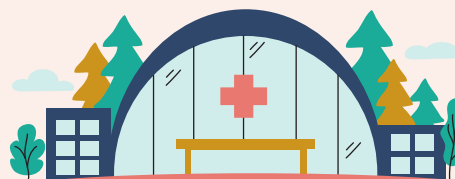
Box 1. Case study: Greener NHS

One of the most notable examples of leadership on climate change from healthcare internationally comes from England's National Health Service (NHS). UK Government targets for reducing carbon emissions and the formation of a Sustainable Development Unit (SDU) in the NHS has matured into a larger Greener NHS national program. Led by Australian doctor, Nick Watts, Greener NHS's mission is to reach net zero emissions under the direct control of the NHS by 2040, and across the entirety of emissions by 2045.⁵³

In its first year, Greener NHS grew from 7 staff to 150. Over 155 hospital trusts and integrated care systems now have their own local net zero strategies, and all NHS services will have a net zero plan in place by April 2022.

From 2026, the NHS will require all suppliers to its £60 billion per annum purchasing of medicines and consumables to have net zero plans in order to secure contracts. Every NHS trust is shifting to purchasing 100% renewable energy.¹⁰⁶

The ambition of the NHS more broadly has emboldened individual health services inspired by the practical illustration of progress in this seemingly complex and challenging area. This serves to underline the importance of case studies and real-world examples in guiding action.



There is much to be learned from the leaders such as Greener NHS (see Box 1 above), along with other examples of evidence-based health system-wide guidance, including strategies and resources that can be adapted for the Australian context. A *Global Roadmap to Health Care Decarbonisation* has been developed by global engineering firm, Arup, and international non-government organisation, Health Care Without Harm, which identifies seven high-impact actions across three intersecting pathways which are key to achieving healthcare decarbonisation¹⁰⁷. The WHO has developed guidance for climate resilient and environmentally sustainable healthcare facilities (2020),¹⁰⁸ and climate vulnerability checklists to support building climate resilience in healthcare facilities (2021).¹⁰⁹

The rapid growth in Australian and AoNZ membership of Global Green and Healthy Hospitals Network indicates keen interest and appetite in the region for authentic, credible peer support, information and guidance, as well as a strong desire for support for action within the sector towards climate resilient and environmentally sustainable health services.

While reducing emissions now is critical to avoid climate change impacts decades into the future, this is not the only driver or rationale for action now. There are local, immediate benefits to health from strategies that reduce emissions, which can be realised much sooner, and underpin the health and economic arguments for action. As The Lancet has identified, "*Tackling climate change could be the greatest global health opportunity of the 21st century.*"

There is substantial evidence that many strategies to reduce greenhouse gas emissions will also result in significant co-benefits to health, if carefully designed. For example, in 2018, *The Lancet Planetary Health* found that savings from health benefits alone would compensate for the costs of meeting the goals of the Paris Agreement.¹¹⁰ But while there is a good public-health and fiscal case for climate action and for using the health co-benefits to frame political commitments, these are not always apparent to key stakeholders, including key policy actors.^{111,112} As shown in the literature review, more research is needed to quantify these co-benefits for Australia, to support the business case for action to reduce emissions, and to use these, in addition to knowledge from behaviour change and implementation science, to guide policy so we might realise the savings from avoided ill-health and productivity gains.



An analysis of climate & health governance in Australia

Policy literature and evidence relating to the impacts of climate change on the health system in Australia reveals considerable variation in the approach across the jurisdictions to addressing the impacts of climate change on the health sector. Most notable is a lack of leadership from the Commonwealth, despite considerable evidence about the risks to health from climate change.

Given the scale and severity of climate impacts on health, there has been insufficient effort to assess and quantify the risks to health from climate change by national, state/territory, local governments, as well as at service and clinical level, and a lack of funded research to fill this gap. At the federal level, responses are largely limited to reactive health protection and disaster response. State and territory efforts range from jurisdiction-wide adaptation plans, to departmental-led guidance for hospitals and health services. These include emerging tools for climate risk assessment, support for greener healthcare buildings, adoption of renewable energy, waste management programs, and guidance for agencies on tackling climate change in the context of public health and wellbeing. Many local governments and community health agencies are developing programs to address the health impacts of climate change in their communities, but much more is required.

Australia's climate health performance in an international context

Australian healthcare stakeholders, together with the international climate and health community, have been calling for all nations to prioritise health in the context of their national climate change response since 2011.¹¹³ As a signatory to the Paris Agreement, Australia now has international obligations to consider health in the context of its national climate change response. This Agreement was a historic win for public health, as the WHO declared in 2015: *"The world now has a climate treaty that will become a public health treaty as countries take action."*

Some progress is being made: an analysis of 101 countries published in the 2019 Lancet Countdown found that most had a national climate and health strategy, including the United States, France, and Germany.¹¹⁴ Australia, however, did not. A 2021 analysis by the Global Climate and Health Alliance of how nations are including health in their commitments under the Paris Agreement gave Australia a score 0/15.¹¹⁵ This is despite widespread calls from health experts and health stakeholders since 2010 for a coordinated national response to the health impacts of climate change,^{116,117} calls that have intensified in recent years.^{118,119}

Climate and health policy in Australia

As a federal system, responsibilities for governance of climate change and health related issues are distributed across national, state/territory and local governments.

The Commonwealth

The Australian Government has ratified the Paris Agreement, under the United Nations Framework Convention on Climate Change (UNFCCC) which obliges parties to consider ‘citizen’s right to health’ in their national climate change response. Under this Agreement, Australia has committed to an economy-wide emissions target to reduce emissions by 26–28% below 2005 levels by 2030. Australia also has an obligation to contribute funding to the \$100bn pa Green Climate Fund to help low-income countries deal with climate change and cut their emissions, however has not contributed any funding since 2019. A 2021 report reveals state and territory energy and climate policies, and action by households to install rooftop solar, are putting Australia on track for emissions reductions of 37–42% below 2005 levels, well beyond the stated federal ambition.¹²⁰

At time of writing, the Commonwealth Department of Health does not have any specific programs targeting climate change and health. Funding for research in this field has been limited and is funded largely via very competitive grants from the Australian Research Council and the National Health and Medical Research Council (NHMRC). While many NHMRC

Centres of Research Excellence exist, none have yet been established on climate change and health¹²¹ — although a one-off \$10m Special Initiative in Human Health and Environmental Change has been awarded in 2021.¹²²

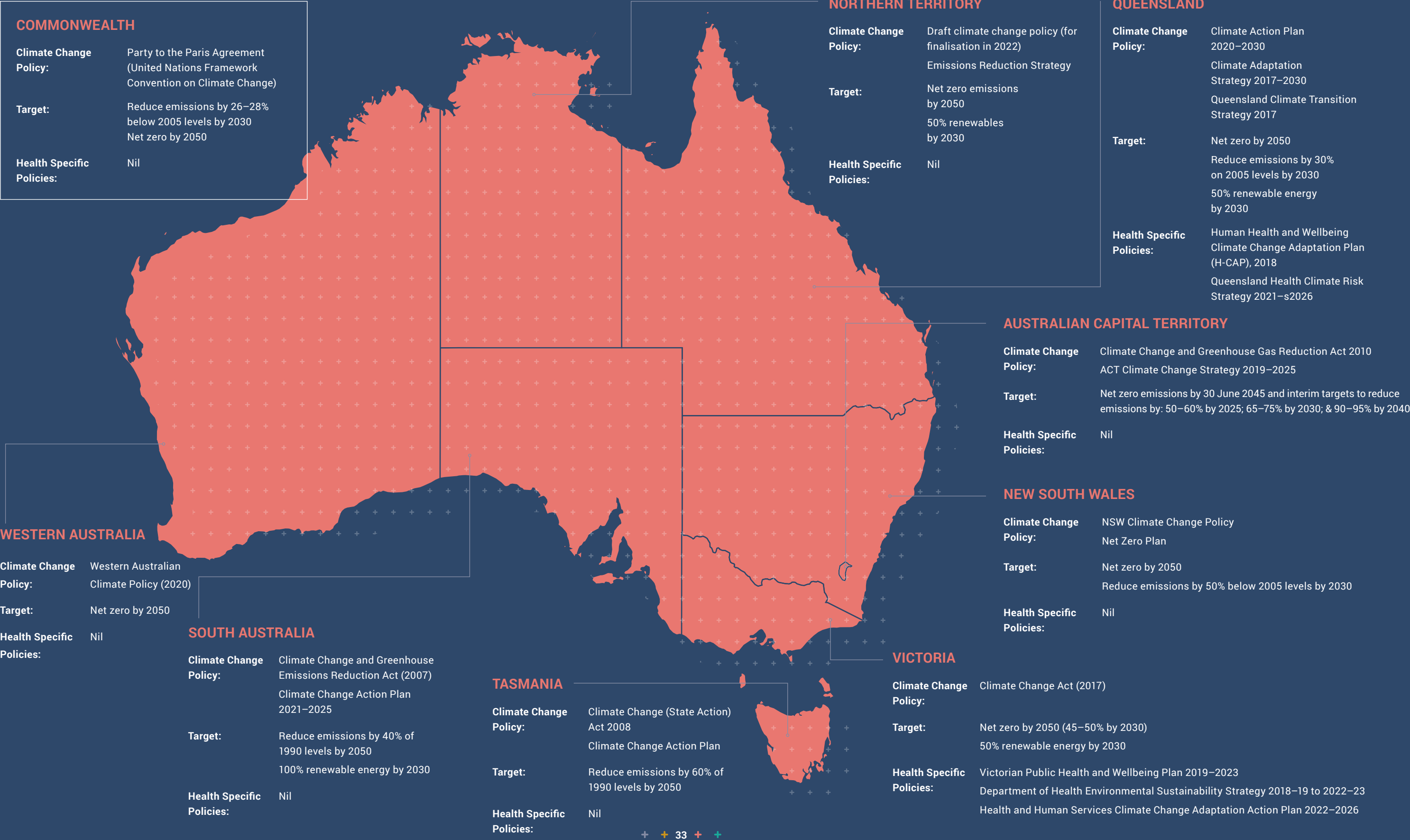
Adaptation funding has declined: the National Climate Change Adaptation Research Facility (NCCARF) was established in 2008 with \$50 million over 5 years but funding was cut to \$9 million during 2014–2017. There has been no further funding since 2018.

While the Department of Health states that its vision is ‘better health and wellbeing for all Australians, now and for future generations’, climate change is not mentioned in Australia’s Long-term National Health Plan, nor is it listed as a national health priority. The draft *National Preventive Health Strategy* (2020) does acknowledge climate change, however its commitment to developing a national environmental health strategy by 2030 is insufficient given the pace and scale of the climate crisis.

Without national coordination and leadership from the Commonwealth on climate change and health, policies to guide mitigation and adaptation with respect to human health vary widely across state and territory jurisdictions.

Below is a summary graphic of major climate policies and emissions targets by Australian jurisdiction (full tables in Appendix 7). Following this is a summary of state and territory-level policies and programs relevant to health and climate change.

Major climate change mitigation policies and targets by jurisdiction





Climate change mitigation and adaptation policies and programs relevant to health by jurisdiction

Victoria (VIC)

The Victorian Public Health and Wellbeing Plan 2019–2023 sets ten priorities for public health and wellbeing in Victoria, and four focus areas, one of which is ‘tackling the health impacts of climate change’. A guidance for local councils was released in 2020 to assist them to consider climate change in municipal public health and wellbeing plans.

The Department of Health Environmental Sustainability Strategy 2018–19 to 2022–23 included a pledge to join the Global Green Healthy Hospitals (GGHH) network, and to encourage all Victorian public health services to join and actively participate in the network.

A Health and Human Services Climate Change Adaptation Action Plan 2022–2026 (in development) includes short, medium and long-term objectives to address current and future climate change impacts on health and build social and economic resilience.¹²³

Queensland (QLD)

Queensland has a state-wide Climate Adaptation Strategy 2017–2030, and seven Sector Adaptation Plans, including a Human Health and Wellbeing Climate Change Adaptation Plan (H-CAP) developed in 2018.

In 2020, Queensland Health joined the GGHH network and committed to promote GGHH across Queensland Hospitals and Health Services. In 2021, Queensland Health created an Office of Hospital Sustainability (OHS), and the Queensland Government committed to implementing a \$30 million program to install solar generation (solar panels) at 50 hospital sites.

In 2021, Queensland Health released a Climate Risk Strategy 2021–2026 ‘to foster a climate ready and environmentally sustainable public health system’, and Climate Change Adaptation Planning Guidance to support hospitals and health services to undertake climate risk assessment and adaptation planning.

New South Wales (NSW)

A NSW Government adaptation research hub includes a human health and social Impacts node. Many Local Health Districts in NSW are members of the GGHH network. An environmental sustainability plan for NSW Health is in development.

Australian Capital Territory (ACT)

As per its commitment in the ACT Climate Change Strategy, the ACT Health Directorate has joined the Global Green and Healthy Hospitals network (in 2020) as a means to “improve sustainability performance and reduce emissions from ACT Health facilities”. In September 2020, the ACT Government announced that the Canberra Hospital Expansion (to be completed in 2024) will run on 100% renewable electricity.

South Australia (SA)

SA has no state-wide climate adaptation strategies, although there are 11 regional adaptation plans across the state. The Department of Health (Public Health) is leading the development of a climate change adaptation plan.

SA Health’s buildings account for around half of the government’s greenhouse gas emissions. Since 2000, the energy efficiency of SA Health buildings has improved by more than 27%. A new Women’s and Children’s Hospital in Adelaide (due for completion in 2026) has been announced as the first all-electric hospital in Australia, and no fossil fuels used for heating, hot water or in kitchens within the building.

Northern Territory (NT)

The NT Government’s Towards 2050 draft policy identifies climate resilience and preparedness as key actions, but has not yet commenced work in these and most other priority areas. The Health Department has appointed a climate change and health advisory committee. All NT health services are members of the GGHH network.

Tasmania (TAS)

Tasmania’s Public Health Unit conducted the state’s first Roundtable on Climate Change and Health in 2019. The subsequent report outlined a framework for action, based on the seven key areas of policy action identified in the 2017 Framework for a National Strategy on Climate, Health and Wellbeing for Australia. The Department of Health is also currently developing the Tasmanian preventive health strategic plan for the next 5 years, which has climate change and health as a key focus area.

Western Australia (WA)

The WA Climate and Health Inquiry report in 2020 laid out a path to protect the health of West Australians from climate health impacts. A key recommendation of the Inquiry, the establishment of a Sustainable Development Unit, is underway. Many health services in the state have joined the GGHH network. (Refer to Box 2 for more about the Inquiry).





Box 2. Case Study: The WA Climate Health Inquiry

In 2019, the WA Health Minister announced the world's first statutory inquiry into climate change and health, appointing the state's former Chief Health Officer, Dr Tarun Weeramanthri, as Chair.

In Western Australia, as in much of the rest of the country, extreme weather is increasing the burden on human health, healthcare workers, and health budgets, already 31% of state expenditure.

"We had the one chance to do an in-depth, statutory inquiry," Dr Weeramanthri says. The Inquiry team proactively invited submissions from premier and peak health organisations, including medical colleges. It held multiple public forums across the state and workshops designed especially for people from diverse backgrounds and those most vulnerable, including Indigenous communities. As Inquiry Chair, Dr Weeramanthri describes his job as "curatorship", weaving together and communicating diverse expert opinions from almost 160 submissions: "We thought our first task would be convincing people that climate change is a health issue, but the 2019–20 fires did that."

In the Inquiry's final report, released in November 2020, the team endeavoured to ground the scientific climate-and-health story in more relatable, human stories. The Aboriginal Health Council of WA, for instance, describes: *"The ripple effects of climate change... [with] far-reaching direct impacts..."* on Aboriginal community health services, which *"bear witness to these impacts on Aboriginal people and their communities on a daily basis"*.

The result is a comprehensive but accessible report, which includes a ten-point action plan, and which seeks to *"make hope practical, not despair convincing"*. The report points to many "green shoots": the exemplary hospitals and services already working to simultaneously shrink health's carbon footprint, cut unnecessary costs, build resilience, and improve patient care. But it warns that attention *"has been markedly insufficient"* during the last "lost decade". The coming decade demands *"a shift in culture and power within the sector"* and action that is *"top-down, bottom-up, and peer-to-peer"*.

The WA Government has since accepted, *in principle*, the Inquiry's recommendations, the Minister has asked WA Health to prepare an implementation plan, and a Sustainable Development Unit is in development. But, Dr Weeramanthri says, more needs to be done *"to close the gap between words and actions"*. Real progress, he says, is unlikely unless people in health champion it, including by using the Inquiry to bolster the case for action.

The WA Climate Health Inquiry is widely praised for calling attention to the problem, amplifying marginalized voices, marking out a path forward, highlighting existing networks and partnerships for change, and seeding new ones. Above all, it tells governments: *"You have a strong and broad mandate for action from all of us in the health sector,"* Dr Weeramanthri says. *"Just start moving!"*



The carbon footprint of healthcare in Australia

In order to address the significant impacts of climate to health and health systems, we need to address the underlying causes of climate change – by committing to strong targets and actions to reduce emissions to at least net zero. This requires action across all sectors, including healthcare.

Globally, healthcare accounts for about 4.4% of net emissions – equivalent to the annual emissions of more than 500 coal-fired power plants. If global healthcare were a country, it would rank fifth in emissions.¹²⁴

Australia's health system, still largely reliant on coal-power, is roughly 7% of the nation's carbon footprint - equivalent to that of South Australia.²⁸ Hospitals and health services are typically a state or territory's biggest user of electricity and account for 44% of the sector's national emissions. Pharmaceuticals account for 18% of emissions, while other sources including specialist and General Practice (GP) services account for 10%, followed by capital works at 8%.

Most of Australian healthcare's emissions are embedded in its supply chains, i.e. the production, transport, and disposal of goods and services, particularly pharmaceuticals, but also food, medical devices, instruments, and hospital equipment.

Despite the absence of guiding policy, there is widespread leadership emerging across the sector, in every jurisdiction, where hospitals, health services, and health systems are taking responsibility for their carbon and environmental footprint and working to reduce emissions in the sector and build climate resilience through healthcare focused climate mitigation and adaptation actions.

Over 200 health systems, health networks, and individual hospitals and health services (representing approximately 1,700 individual facilities / services) are part of the Australian and AoNZ region of the Global Green and Healthy Hospitals (GGHH) network. In joining, these institutions have made a voluntary commitment to reduce their carbon and environmental footprint and promote public and environmental health by working on at least two of ten sustainability goals (energy, waste, water, buildings, transport, food, pharmaceuticals, chemicals, procurement, leadership). Many are working on more than two, and many have all ten goals at the centre of their environmental sustainability strategies.

As both a regional and international collaborative community of practice, the GGHH network provides members with access to tools, resources, and guidance documents to support them to reduce their carbon and environmental footprints. Members also share strategies and practices, including through regular member meetings, publication of case studies, and an annual forum.

Examples include Ambulance Victoria (AV), a distributed service provider with 260 locations, providing emergency response services across the state, who have entered into a power purchase agreement with a renewable energy farmer. This arrangement is enabling AV to reduce its greenhouse impact and providing the wind farmer assurance to invest and develop the project. This will reduce AV's emissions by 7% and is part of its commitment to source 100% of its electricity from renewable sources by 2025.¹²⁴

In Middlemore Hospital in AoNZ, as in Western Health in Victoria, efforts are being made to reduce anaesthetic gases, targeted due to their high global warming potential.^{125,126}





Box 3. Case Study: Hunter New England Health

The Hunter New England Local Health District (LHD) in New South Wales (NSW) is the region's largest employer and a keystone in the local regional economy. In 2020, in an Australian first, Hunter New England declared they would be carbon and waste neutral by 2030.

The District's broader sustainability plan includes investment in clean renewable power, ambitious commitments to collect and conserve water, eliminate general waste, and switch to all-electric vehicles. All of it is backed up by a sound business case, accountability at board level, and strong staff support.

Dr Ramsey Awad, the District's Director of Infrastructure, Planning and Sustainability says: *"all our actions have saved money, and all our savings are invested back into patient care."*

Former Hunter New England Board Chair, A/Prof Lyn Fragar AO, said: *"lightbulbs kept coming on,"* as the Board realized that an ambitious sustainability agenda was smart risk management, and entirely 'doable'. A/Prof Fragar said nobody in the industry seemed to be talking about the governance risks of inaction on emissions.

"I knew the Board needed a business case, so I asked the Executive to prepare one." The evidence was compelling and the goals and pathway clear. Even before the plan was signed off, the Board began to set the tone by modelling simple sustainable behaviours, such as car-sharing and avoiding unnecessary plastic utensils.

Staff engagement is vital to the plan's success. Dr Awad says: *"The best thing for me was the staff response to our call for sustainability champions."* Since early 2020, more than

150 staff members including clinicians have joined "communities of interest", with high-level support to "push the envelope" of what is possible in sustainable healthcare. Using a mix of incentives, from salary sacrifices for electric bikes to strategic procurement, the District is making it easier for staff to be part of the wider effort both at work and in relation to their own carbon footprint.

The District is learning by doing - and no-one pretends they have all the answers right now. Following the lead of the UK's Sustainable Development Unit, the District has made sustainable procurement a priority; using its purchasing power to drive innovation in supply chains — the source of a big chunk of health's carbon footprint. But, says Dr Awad, bureaucratic and commercial hurdles often get in the way. *"Recycling facilities are located in major cities,"* he says, *"making recycling cost-prohibitive in many rural areas."* And decisions made at the state level, such as contracting a single provider of energy or waste management, can stifle innovation at the District level.

"We see ourselves as leading a movement for sustainability in the sector," says Dr Awad, and his team keeps looking for gaps and opportunities in the current system to do what they need to do to hit their targets. There are also signs that the District's pledges are changing the game, with other LHD Boards showing a keener interest in sustainability, and NSW Health has begun work on a sustainability plan. More broadly, Hunter New England LHD is demonstrating to the health sector what ambitious climate policy can look like.



Key Findings

Insights from policy and institutional analysis and interviews

Informant key

PM: Policymaker

HCP: Health Communications Professional

HSR: Health Systems Researcher



Prevention — upstream and downstream opportunities

As well as working to reduce emissions in healthcare through the kinds of measures described above, a key pathway to improving both climate and health outcomes is through prevention — and the avoidance of 'low-value' and 'no-value care'. That is, eliminating care that produces little to no benefit to patients, or even has the potential to cause them harm.

Low and no-value care is estimated to make up 40% of total care given in Australia (30% and 10%, respectively), and includes things such as over testing, overdiagnosis, and overtreatment. Low value and no value care are also an unnecessary use of time, money, and resources — as well as an avoidable increase in healthcare's carbon footprint.

By reducing low and no-value care, there can be a win-win-win.

1. Patients will only be receiving effective, high-value healthcare;
2. Money will not be spent on ineffective care;
3. The environment will benefit from a reduction in the carbon footprint of healthcare.

Prevention of ill-health in the population is an obvious pathway to reducing emissions in healthcare — and better public health outcomes. As noted above, Australia spends far too little on prevention, despite the evidence that every \$1 invested in prevention can save as much as \$12 in health spending.¹²⁷ Investing in upstream health promotion programs to encourage healthy behaviours and practices can reduce pressure on health services, avoid carbon intensive and costly procedures and hospital admissions. Other methods to reduce healthcare emissions and improve patient outcomes include regular medication reviews to reduce polypharmacy, and improving access to community care and telehealth services, providing care which can be better, cheaper and lower carbon.¹²⁸

The prevention agenda in healthcare is analogous to the need to invest in upstream strategies to reduce greenhouse gas emissions and avoid the costly and damaging impacts of climate change. This is becoming increasingly apparent to many in the health sector — as one informant noted:

“Mitigation [of health’s carbon footprint] is preventive care.” (HCP)



Risk management and legal liability

Climate change is increasingly understood as a corporate governance issue in the form of legal risk, including in the health sector, presenting as it does foreseeable and material risks to which directors of boards are required to respond as part of their fiduciary duty.¹²⁹

Health service boards and managers should inform themselves of the risk the impact of climate change poses to their organisation in their governance of strategy and risk, and as part of acting ‘in the best interests’ of their organisation.¹³⁰ This is relevant to all boards and managers, whether they are regulated under the *Corporations Act*, state and territory incorporated associations laws, or public entity governance laws.

“Importantly, directors of public authorities — such as the chairs and boards of public hospitals and health services — have similar, if not more stringent duties of care and diligence.”¹³¹

Directors may be found to have breached their duty if they do not appropriately disclose the risks posed by climate change to the entity they govern — and may even be found personally liable in a court for failing to give appropriate consideration to climate change risks.¹³²

Our analysis, however, suggests that there still is little grasp of health services’ legal liability with respect to climate change. None of our key informants raised it unprompted, and (with one exception) the common view was that it is not a problem for public hospitals and health services.



The funding challenge — and an opportunity through purchasing

Investment is considered one of the major barriers to action, and there is a strong case from the literature, as well as key informant interviews, for significantly scaled up funding to support climate mitigation and adaptation actions to reduce health risks and support health services to mitigate and adapt. As one informant remarked:

“Funding is a barrier. Health competes with other portfolios and the scale of the [climate] challenge is huge.” (PM)

However, it has also been noted that among all the many strategies available to reduce healthcare’s climate footprint, many informants pointed to health’s purchasing power as a way to drive systemic change, within and without the system. As with Greener NHS, as a significant purchaser of goods and services, the health sector in Australia has the potential to drive change across its supply chain — which is the largest source of greenhouse gas emissions in the health sector. This could be done by requiring suppliers to meet environmental criteria and having net zero plans to secure healthcare procurement contracts. Among informants, this was considered one of the most powerful levers of change.

“There is an enormous potential to use healthcare’s purchasing power and influence to accelerate change.” (HSR)



Building capacity for action

Health and medical professionals are concerned and want information and support

According to a 2020 Victorian survey of more than 700 GPs, specialists, and allied health practitioners¹³³ concern for the impact of climate change on the health system is high. Most respondents considered they had a duty of care to inform their patients and clients about climate risks to their health, yet only one-in-three felt sufficiently informed to speak with confidence.

This is reinforced by the 2021 Real, Urgent and Now national survey of 875 physicians, nurses, midwives, public health and health promotion professionals and medical students. 72% of respondents to this survey indicated climate change was already having an adverse impact on public health in Australia, and over half (56%) reported their health service or healthcare institution had been adversely affected by a climate related extreme weather event in the 12 months prior to the survey. Over half of respondents (54%) said they wanted more information from their professional association on climate change to support their practice.

While many universities are beginning to include climate change in undergraduate and postgraduate health sciences curricula, there remains a huge gap in the existing workforce about the nature of the problem, the available solutions, and the role of the health professions in responding.



Leadership and collaboration for change

Leadership is key to achieving effective outcomes on climate change and health: this is perhaps the strongest, most consistent message from key informants to this analysis and from our reading of the literature. Initiative and a willingness to take risks — or to enable others to do so — are considered essential ingredients. As one informant (SPM3) put it: *“Leadership is required at many levels- state, district, clinical, academic and personal — from the organisational head to the most junior staff member. In our experience mid-ranking managers and junior nursing and medical staff are often the most innovative and engaged drivers of sustainability initiatives.”*

There is a need for ‘joined-up action’ across government departments and portfolios, especially given that many drivers of ill-health (including those associated with climate change) are the result of activities in sectors other than health.

As *The Lancet* said in its 2015 Health and Climate Commission: we need mechanisms to *“facilitate collaboration between Ministries of Health and other government departments, empowering health professionals and ensuring that health and climate considerations are thoroughly integrated in government-wide strategies”*.

Despite limited progress on climate health policy to date in Australia, there is considerable leadership from the health professions in advocacy for action. The last decade has seen rising awareness of climate risks within the health workforce, with strong calls to action by a growing number of organisations — from grassroots groups to learned academies.

For example, over 50 health groups produced a framework for a national strategy on climate, health and wellbeing for Australia in 2017 to guide governments, and the health sector in taking action. In 2019, the AMA declared climate change a health emergency, and called for a National Strategy for Health and Climate Change.

In 2020, the Australian Indigenous Doctors Association released a policy statement on climate change and Aboriginal and Torres Strait Islander people’s health, and in 2021, twelve medical groups released an Open Letter to the Prime Minister, calling for a commitment to an ambitious national plan to protect health by cutting Australia’s greenhouse gas emissions this decade. These and many other groups are building a powerful case for action, and have consulted on, thought through, and set out ideas, benchmarks and roadmaps for progress.^{134,135} These efforts inform and guide, as well as hold governments to account, and are growing a vibrant, broad and increasingly influential national and international health movement for climate action.



The way forward

The analysis here, together with the case studies and literature review, point to clear directions to tackle the impacts of climate change on the health system in Australia. Strategies to limit the cause of climate change — greenhouse gas emissions — will reduce future threats to the population and the health system. Actions to prepare health systems, and reduce climate change risks, as well as reduce the contribution of the health sector to the problem, are vital. Therefore strong national and subnational emissions reductions targets, coupled with plans and programs to deliver them, are needed. This must include plans to guide (and strategies to accelerate) the decarbonisation of healthcare to meet those targets.

An authorizing policy and legislative framework is needed to guide action. This must include science-based policies, strategies, plans and practical guidance on climate change adaptation and mitigation at national, state, regional and local scales. It should also facilitate collaboration between health departments and other departments, to ensure health and climate considerations appear in government wide policies and approaches.

This framework can provide clarity on roles and responsibilities and support effective and transparent governance. Implementation will require financial investment to support climate change mitigation and adaptation action. This must include resources to build capacity to address climate change in the sector, as well as evaluate risks, assess vulnerability, and develop evidence-informed and innovative

solutions. It will also require practical actions such as changes to energy contracts to support purchasing of renewable energy and procurement contracts to help healthcare suppliers transition towards net zero supply chains. Strengthening and building resilience to climate change across the population, and particularly in priority communities, will reduce pressures on the health system, reduce the risks of harm, and help avoid the human and economic costs of climate-related disasters. Prevention, therefore, is key: investing in upstream health promotion and illness prevention is already a national priority, but requires far greater resourcing to realise system-wide benefits. Too much of the response to climate change in Australia currently relies on reactive response measures — much more is required to prepare for and avoid harm before it occurs.

As *The Lancet* Commission on Health and Climate Change has emphasised, many climate mitigation and adaptation actions are 'no-regrets' strategies when it comes to health i.e. they can help reduce the burden of ill-health, enhance community resilience, and address existing health inequities.

With an engaged and empowered health and medical workforce, sufficient investment, and the enabling vehicles of policy, legislation and regulation, along with political and institutional leadership, the Australian health system can, and must, become an international leader in the global effort to tackle climate change. There is much to gain, and everything to lose.





Case Studies

SUMMARY AND FINDINGS



Summary

The Case studies illustrate the real life impact of climate change on the health of Australians, and the healthcare system. They point to the need for greater preparedness among communities and within the health system for future climate fuelled disasters. They also demonstrate the need for urgent action to reduce greenhouse gas emissions to avoid locking in further disastrous climate change.

Case studies were identified through experts and key persons in the field, including representatives of the medical colleges involved in this project. Case studies were selected using selection criteria that relate to the substantive properties of the cases themselves and on the basis that they illustrated the impacts of climate change on the Australian healthcare system.

Key selection criteria included:

- ✦ A cross-section of socioeconomic and geographic areas and different contexts and stakeholders;
- ✦ Indigenous peoples' health status and flow on impacts on health; and
- ✦ Rural and remote communities' health status and flow on impacts for health via the impact on health systems.

The case studies demonstrate that climate change poses a significant risk to the healthcare system in Australia. There have already been severe impacts to the healthcare system from drought, bushfires, extreme heat, flood, coastal inundation and other climate-related events. These events are predicted to become more frequent and extreme as the Earth continues to warm.

Climate change affects the health system in many ways and can impact healthcare infrastructure, operations, workforce, and service demand. There is a danger of workforce burnout and disenfranchisement in the face of existing and projected climate and health challenges, and in the absence of vision, direction and collaborative, coordinated action. Furthermore, climate change associated events can disrupt health system energy supply, communications systems, and supply chains. These impacts can be sudden and cause major challenges to the delivery of safe, quality care.

The case studies illustrate the real-life impact of climate change on the health of Australians, and the healthcare system. They point to the need for greater preparedness among communities and within the health system for future climate fuelled disasters. They also demonstrate the need for urgent action to reduce greenhouse gas emissions to avoid locking in further disastrous climate change.



Based on the findings of these case studies, several insights have emerged:

- ✦ The health system is generally not prepared for the impacts of climate change;
- ✦ A nationally coordinated approach is needed to ensure appropriate responses to climate change across all jurisdictions;
- ✦ Aboriginal and Torres Strait Islander voices need to be clearly heard and should be central in the development of plans to guide climate preparedness, as well as disaster and emergency response affecting their communities. They should have access to community-driven, culturally safe, and properly resourced responses to disasters and equally to resilience building and preparedness for future impacts. Indigenous- and community-led or co-led approaches that embrace all sectors are vital and promising approaches;
- ✦ Likewise, in rural and regional settings, consultation with local stakeholders including those within the health system should be part of climate change responses as well as disaster preparedness and planning;
- ✦ Flexible and secure, long-term funding arrangements are needed before, during and after disasters so that health services can prepare for and respond to demand surges;
- ✦ Responding to the threat of climate change requires strategic imagination to transform a reactive system to one that is proactive: focused on the delivery of high-value, low carbon, and sustainable healthcare, increasing community self-care, prevention and early intervention to prevent serious adverse clinical outcomes and keep people out of hospitals; and
- ✦ Health leaders, and health professionals more generally, have a key role to play in advocacy to all levels of government for greater action on climate change. Equally important, they can help empower communities to make the necessary adaptive and mitigative changes to respond to climate change. Health practitioners want information and support to be able to do this.



Key Findings





Stanthorpe, QLD: Compounding Impacts

Context

Stanthorpe is a regional town located roughly 215 km south-west of Brisbane (QLD) in the Southern Downs Regional Council ¹³⁶. Agriculture, tourism and hospitality are all important industries in the region which is well known for its wineries and fresh produce.¹³⁷

In May 2018, the Southern Downs council was officially declared 'in drought'.¹³⁸ A failed wet season the following summer triggered fears that Stanthorpe's standalone water supply, Storm King Dam, would reach its minimum operating level before the next wet season.¹³⁹ This would lead to a Day Zero event where the water supply runs out and residential taps are turned off.¹⁴⁰

Medical Superintendent of Stanthorpe Hospital, Dr Dan Halliday owns a grazing property himself and believes it was *"the worst drought that developed in anyone's living memory"*.

Fruit trees and vineyards were dying, and farmers were having to destock, losing generations worth of work. With people in the community desperate for employment, the drought and its economic consequences took an enormous toll on mental health.

Amidst the drought and fears of a Day Zero event, bushfires struck Stanthorpe in September 2019.¹⁴¹ While the immediate threat to the town only lasted days, fires burned in the area for weeks, leaving many in the town on edge and anxious. Poor air quality from the bushfire smoke lasted months, having a significant impact on respiratory patients, the elderly, and asthmatics in the community.

Not long after the smoke cleared, Stanthorpe officially ran out of water. As a result, the town was dependent on daily deliveries of 40 to 50 truckloads of water from over 60km away.^{139,140} To make matters worse, the COVID-19 pandemic hit Australia and serious concerns were raised over the ability to ensure community safety with such limited water supply. While water restrictions were eased, it meant that even more water had to be trucked in to meet the town's needs.

Impact to the health system

With the community facing a drought, the bushfires, and then a pandemic, Stanthorpe's health services were impacted. The most obvious example was the increased need to provide mental health support to patients following the onset of the drought.

Former rural practice registrar, Dr June Brundell said, *"it got to the point where every single general practice consult I did started with a mental health check to make sure I didn't have someone suicidal sitting there"*.

"When you sit through 30 or 40 or 50 patients a day telling you how tough it is and how their mental health is, it's really hard not to take that trauma home and internalise it because you can't do anything". Dr Brundell said there was *"not enough room in the [health] system to provide the support to the doctors that they needed"*.

The rural GPs were already stretched and had the additional workload from the mental health effects of the drought. This meant that getting a GP appointment could be difficult for patients at times. As a result, people were turning up to the hospital emergency department with issues that would usually be resolved by their general practitioner.



Stanthorpe, QLD: Compounding Impacts

Dr Halliday noted an increase in people presenting with skin diseases due to bathing less to conserve water. Presentations of gastroenteritis increased because of poor quality drinking water, generally coming from the bottom of their water tanks.

The bushfires also impacted the health system. During the peak of the bushfire threat, the town and hospital were left without power for more than 24 hours. The hospital ran on backup generators, but urgent fuel supplies had to be trucked in to maintain power.

The roads leading to and from the hospital were also intermittently cut off by the fires making

the hospital emergency plan impossible to enact. Emergency evacuations, such as a critical patient run over by a fire truck, were delayed.

Inside the hospital, patients were distressed as the bushfire smoke seeped into the wards. Dr Brundell said that the air quality was so poor she *"couldn't see to the end of the corridor"*.

Poor air quality was an ongoing issue in the following months and increased the demand by respiratory patients for GP time. Providing care in an environment of poor air quality was challenging, as vulnerable patients were unwilling to come out of their homes. This meant that home visits or telehealth were required.





Stanthorpe, QLD: Compounding Impacts

While telehealth is now the new normal, these appointments were difficult to bill pre-COVID-19. Dr Brundell is pleased by the shift towards telehealth, and said *“the ability to deliver telehealth from general practice is a big deal when you live rural... it’s a way of being able to deliver safe care in a changing climate”*.

Health system response

As the drought worsened, Dr Halliday and Dr Brundell could both see the emerging crisis resulting from the region’s water shortage. Their reaction was to investigate potential public health responses, and compile locally relevant policy measures that could be implemented. For example, providing rebates for the installation of hydropanels (a technology that uses the power of the sun to extract drinking water from the air).

Despite initial engagement by local government stakeholders, Dr Halliday said they weren’t able to attain higher level endorsement. He noted that metropolitan decision makers don’t always understand the needs of rural communities.

Dr Halliday points to the importance of local staff initiative and connectedness on the ground in being able to respond effectively to the bushfires, even when the emergency plan had failed. An example was that the hospital had integrated primary care services, such as GP clinics that could act as back-up treatment facilities if the road to the hospital was cut off. This was possible due to the good relationships between the clinics and hospital, with many GPs working across both.

Lessons and implications

Since the fires in 2019, Dr Halliday said that there had been almost no change that would allow health services to respond more effectively if they experienced fires again. He said that the short news cycle that affects government policymaking had moved on.

Dr Brundell explained, *“our health services are stretched to start with, and now they’re involved in a pandemic response, so getting buy-in in terms of time, money, resources, and mental space from people who make decisions and who set policy in the current climate is challenging”*.

Dr Halliday suggests that there must be preparation and planning for when COVID-19 stabilises and there is a firm agenda back on climate change.

When that time comes, both he and Dr Brundell believe that stakeholder engagement must be integrated into policy development moving forward. Dr Brundell said that a *“major lesson learnt [from the bushfires] across Australia is that we need to better involve rural and regional areas in their own disaster planning”*.

To allow communities and local clinicians to be empowered when responding to climate emergencies, Dr Halliday believes that *“resources need to be put into local communities – local primary care providers and councils – people they [the community] know and trust.”*





Canberra, ACT: Bushfire Smoke

Context

The Australian bushfires of 2019–20 were unprecedented, both in scale and duration. In addition to the death and injury caused by the bushfires themselves, the smoke from the fires affected large parts of Australia, and travelled as far around the globe as South America.¹⁴²

Research has estimated that the smoke alone was responsible for more than 400 excess deaths, and over 3,000 hospitalisations for cardiovascular and respiratory problems.¹⁴³ Other common health issues associated with the smoke were irritation of the eyes and throat, coughing, and headaches.¹⁴⁴ Total health costs from the bushfire smoke are estimated to be \$1.95 billion, with longer-term health impacts still unknown.

The Australian Capital Territory experienced particularly poor air quality over several months, with Canberra recording the worst air quality in the world in early January. At its peak, PM2.5 (very fine particles) concentrations were more than 26 times the hazardous level (or 200 times the 'safe' level), forcing a number of institutions and government departments in Canberra to shut down due to health and safety concerns.¹⁴⁵

Many homes were inundated with smoke. Those most fortunate were able to access air purifiers. However, the accompanying heatwave, well in excess of the temperature many homes in Canberra are built for, meant that managing the heat and smoke was a balancing act between passive cooling (e.g. opening windows) and maintaining indoor air quality.

Canberra gynaecologist Dr Steve Robson says "Scorching temperatures made...our homes almost intolerable".¹⁴⁶ Those with significantly reduced financial resources were most likely to



be impacted, especially in homes without proper insulation or air conditioning, and who weren't able to afford an air purifier.

Impact to the health system

The air filtration system in Canberra Hospital was unable to deal with the unprecedented levels of smoke leading to unhealthy levels of PM2.5 inside the buildings.¹⁴⁷

Medical equipment including pathology, MRI and CT machines failed from the smoke and heat. Sterilised equipment in the hospital was also contaminated, and staff themselves were affected by the smoke.¹⁴⁷

Dr Robson wrote about his experience at the time, he said *"Canberra's operating theatres and birth suites were infiltrated by smoke, as it metastasized into the inner sancta where our new generation were born and our most vulnerable were undergoing surgery. For the first time...I was beginning to hear things I hadn't heard in 30 years of O&G practice – that people were apprehensive about having children because they were worried about the future"*.¹⁴⁶

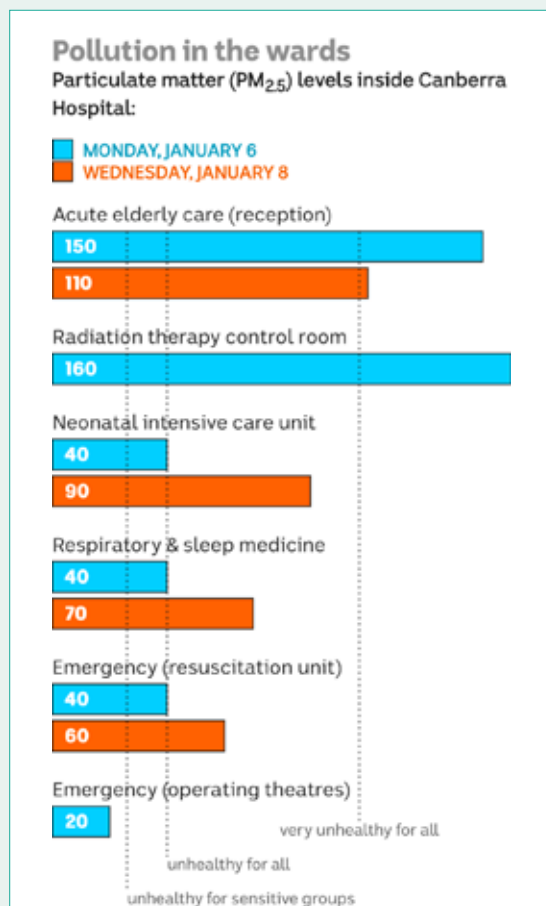


Canberra, ACT: Bushfire Smoke

Health system response

Canberra Health Services responded to the smoke by installing air purifiers in wards and providing 'comfort packs' to staff that contained eye drops and throat lozenges. They maintained that even on days with "unhealthy air" inside the hospital, the wards were safe for patients.¹⁴⁷

Cardiologist Dr Arnagretta Hunter questions why health services didn't predict the smoke despite many experts predicting a potentially catastrophic bushfire season. *"Unprecedented is not an excuse for being unprepared,"* said Dr Hunter. She said that if health services were regularly performing climate risk assessments, the risk could have been anticipated and the health system could have prepared much better.



Lessons and implications

Dr Hunter said *"the only way that we can increase and improve our preparation moving forward is if we use some strategic imagination...which will take science, creativity and interdisciplinary work"*. Using our strategic imagination is vital so that we can think through future scenarios, like what might happen if Melbourne experienced temperatures of 55°C.

As well as strategic imagination, Dr Hunter believes that a paradigm shift in the healthcare system needs to take place to be able to deal with the health impacts of climate change in the future. She said that *"biology, society and environment all have key roles in our health and wellbeing. This should be reflected in our health system."* She said that we need *"a paradigm shift away from looking after people reactively to thinking much more proactively."*

She said *"it is tremendously important that we recognise that we can take a much more proactive approach to risk reduction into the future and that focusing on mitigation and adaptation will only have benefits for us as the climate continues to change."*

Image credit: ABC News Online, 25/5/2020





South Coast, NSW: Bushfires

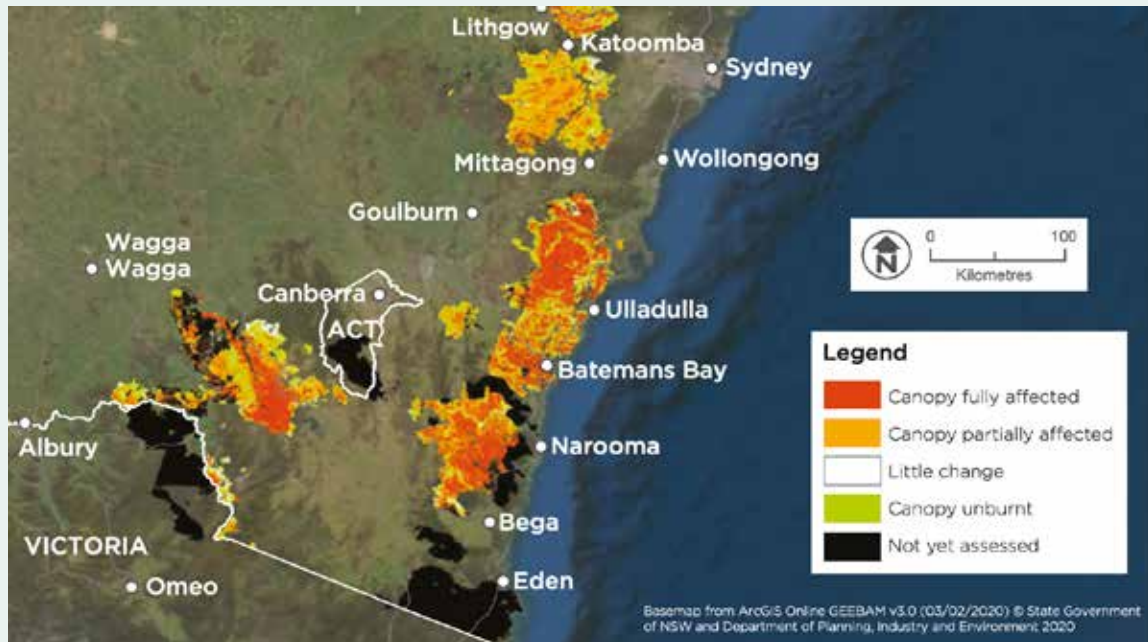


Image credit: CSIRO - Climate change in the Northern Territory | State of the science and climate change impacts, 2020

Context

By the end of 2019, most of NSW, including the South East, was in 'intense drought' after more than two years of drought conditions.¹⁴⁸

The drought, together with high temperatures, low humidity, and high fuel loads proved to be the perfect conditions for bushfires, which ravaged the South Coast of NSW, over several months in late 2019 and early 2020.

As the fires moved through forested areas towards coastal towns, thousands of holiday makers found themselves in life threatening danger on several occasions.

Many describe their experience of the Black Summer fires as 'apocalyptic'. Skies were red and filled with smoke, and the world was out of reach as power, telecommunications, and roads were cut off by the fires.

As local General Practitioner, Dr Michelle Hamrosi put it, *"normal life stopped and you were in survival mode."*

Dr Michael Holland, specialist Obstetrician Gynaecologist for the Eurobodalla region said, *"women felt their babies were safer inside than outside, so they held onto them until the danger had passed."*

Excessive smoke and heat created hazards for people's physical health. Nursing home residents sweltered through forty-plus degree days without air conditioning when their facility lost power and had no back-up generator.

Waminda South Coast Women's Health and Welfare Aboriginal Corporation said that the bushfires *"affected health, wellbeing and safety, and destroyed sacred sites, the habitats of culturally significant animals, and big swathes of Country."*¹⁴⁹



South Coast, NSW: Bushfires

The building that housed the Mogo Aboriginal Land Council also went up in flames, destroying cultural and legal documentation and historical artifacts within it.

Dr Holland speaks to the overwhelming psychological effect of an impending disaster and said that *“the impact on people’s mental health is still present.”*

Dr Hamrosi said that the bushfires also re-traumatised people whose lives had previously been threatened by fires, such as in the South Coast township of Tathra 18 months earlier.

Not long after the bushfire recovery process had started, the COVID-19 pandemic struck Australia. For people already experiencing anxiety from the bushfires, the pandemic was yet another external threat to their health.

“It has certainly left people more isolated and lonely and socially distanced at a time where coming together was really important for recovery,” said Dr Hamrosi.

Impact to the health system

The bushfires had a direct impact on the health system, coming dangerously close to the local hospitals and leaving other services without power. *“It highlighted vulnerabilities of local health services for any sort of major disaster,”* said Dr Holland.

He said, *“there was concern that we would be overrun with people coming to the hospital seeking care we couldn’t provide.”* He further explained that emergency departments were in desperate need of oxygen supplies, while the backup generators for the hospital could not produce enough power to run an emergency CT scan.

In the primary health setting, Dr Hamrosi said, *“we ran the general practice without power or phones or internet. We just tried to use the natural light through the windows and had head torches when needed.”* Without access to patient records, Dr Hamrosi explained that it was difficult to determine whether patients had heart or lung problems when they came in with shortness of breath and chest pain, or if it was due to smoke inhalation.

Other issues began to emerge in communities after the immediate threat had passed. Waminda said there were *“spikes in respiratory issues from smoke and haze, and an increased need for mental health support for trauma and anxiety.”*⁴⁹

Angela Stewart, a Carer Advocate for One Door Mental Health in the Eurobodalla said *“once I went back to work, every single client had a bushfire story.”*

Manager for Psychosocial Supports for Grand Pacific Health in Bega, Nikki Jordan agreed, saying that the months following the fires was when *“service capacity became stretched.”*

On top of the increased demand was the impact of the bushfires to health workers. *“What was really tough was staff who were in it [the bushfires] were providing counselling to people who were also in it,”* said Ms Jordan.

“We lived through this too,”
said Ms Stewart



South Coast, NSW: Bushfires

“Not only has the community been affected, but I think a lot of the medical staff are fatigued by the stress of that experience,” said Dr Holland.

Health system response

As the bushfires became more threatening to the Moruya hospital, a Director of Acts of Emergency instituted an emergency plan.

Instead of ward rounds inside the hospital with patients, staff did a ward round outside the hospital to see where the vulnerabilities were. Hospital staff went above and beyond their normal roles and responsibilities, one doctor coming to work even after losing his own home.

In the community, Waminda responded immediately, *“checking that people were safe, purchasing and distributing emergency supplies, and extending operations beyond its boundaries and core business.”*¹⁴⁹

However, not all responses to the bushfires were constructive. Members of Aboriginal communities along the South Coast reported *“poor, culturally unsafe services being provided by some mainstream services and charities during the bushfires.”*¹⁴⁹

Lessons and implications

Many lessons have come out of the bushfires that provide pathways for the health system to better respond to such disasters in the future.

Coordination between local and central disaster response can be improved. In the hospital, Dr Holland said that the *“management on site seemed to be overruled by management elsewhere”* for reasons unknown to them.

Consultation and integration of local GPs in disaster planning is needed. Dr Hamrosi noted that GPs whose clinics had been closed could have been utilised in the response, for example at evacuation centres, but some were even turned away when they offered their services.

Aboriginal and Torres Strait Islander health organisations say *“they must be consulted in the development of emergency plans affecting their communities... The bushfires highlighted injustices and inequity in Australia’s disaster management systems, and the critical need for Aboriginal and Torres Strait Islander people to have access to community-driven, culturally safe, and properly resourced responses to disasters.”* Waminda South Coast Women’s Health and Welfare Aboriginal Corporation¹⁴⁹

Ms Jordan also indicated that there have been some changes within her organisation in response to the bushfires. She and her staff now have satellite phones in case of power outages and a new policy around leave during extreme weather events to assure staff of their job. However, her vision for a better health system is one that is proactive, preventative, and prepared for a changing climate.





Northern Territory: Extreme Heat and Workforce Issues

Context

The vast and sparsely populated Northern Territory is already experiencing the impacts of climate change, including extreme heat and record breaking temperatures, particularly during summer months.¹⁵⁰

Over the summer of 2019–20, temperatures were almost 4 degrees higher than the long-term average.¹⁵⁰ Temperatures are expected to increase further in the future, with rainfall patterns set to be more variable.¹⁵¹

Extreme heat can cause heat stress and dehydration, which can exacerbate cardiovascular, renal, and other chronic health issues.¹⁵² Dr Simon Quilty, a Senior Staff Specialist at Alice Springs Hospital, said that climate change is “an extremely urgent threat” and the “implications for all communities across the Northern Territory are extremely severe.” A long historical legacy of injustice and ongoing health inequities means that Aboriginal and Torres Strait Islander people will be disproportionately affected.

Dr Catherine Pendrey, a General Practitioner who has worked for several years in the Northern Territory suggests that the frequent and extreme heat is “exacerbating health problems caused by inequitable access to housing, energy security, and cooling, among other challenges...When it gets hotter, people get sicker and those experiencing chronic health issues and socio-economic disadvantage are most likely to be affected.”

“

Dr Quilty said that “Indigenous households have severe energy insecurity.” He said, “this impacts peoples’ ability to shelter from extreme heat. On a hot day, the inside of a house can go over 50°C and there is nowhere to shelter. Insulin and other medications cook. The health implications are immediate and severe.”





Northern Territory: Extreme Heat and Workforce Issues

In addition to the extreme heat and energy issues, the Northern Territory is also experiencing severe water insecurities. Dr Quilty explained that last year the town of Yuendumu came within weeks of running out of water. He said *“in some places, there is a very real risk of climate change drying up fragile aquifers and causing forced displacement from Traditional Homelands.”*

Dr Josie Douglas, Manager for Policy at Central Land Council said, *“Central Australian Aboriginal people are very resilient. They have evolved to cope with the harsh and variable desert climate, but there are limits.”*¹⁵³ She said *“without action to stop climate change, people will be forced to leave their country and leave behind much of what makes them Aboriginal. Climate change is a clear and present threat to the survival of our people and their culture.”*¹⁵³

Impact to the health system

The impact of extreme heat and water insecurity is having very real impacts on health services in the Northern Territory already.

Dr Quilty, who is also a Medical Advisor to Northern Territory Aboriginal health service, Purple House, explains that in the last five years the Indigenous-owned and run health service has had to buy chillers to cool the water used for their remote dialysis program. Water coming from the pipes is hotter than it's ever been before, which means it needs to be cooled before use.

Seven of the 19 remote communities that Purple House works in are also facing extreme water insecurity. In some cases, Purple House is forbidden from providing dialysis due to the quantity of water required for each dialysis session. Dr Quilty said that as a result, *“Purple House’s capacity to meet the increasing need for more dialysis is being rapidly eroded.”*

There is also the threat of increased workforce shortages in the Northern Territory as a result of climate change. A paper by Dr Pendrey, Dr Quilty and colleagues indicates that approximately one third of the 362 doctors surveyed suggested that climate change is already causing or likely to cause them to consider leaving the Northern Territory.

The paper warns *“if even modest numbers of medical practitioners in the Northern Territory did so [left], health-care workforce shortages, staff turnover, and reliance on short-term staff would be greatly exacerbated, leading to less effective care, higher hospitalisation rates, and higher costs of healthcare.”*¹⁵⁴

Dr Pendrey said that *“not only is there going to be a greater need for healthcare workers, but our study suggests that there may well be less healthcare workers in those areas.”*



Northern Territory: Extreme Heat and Workforce Issues

Health system response

Both Dr Pendrey and Dr Quilty expressed their concern that the health system was not responding to the risk of climate change at the pace or scale needed to protect the health of Territorians.

Dr Quilty said that in the Northern Territory *“there is a desire to mitigate carbon emissions from healthcare but there is little action.”*

Dr Pendrey also expressed concern that there is currently no heat health response plan, inadequate public messaging about extreme heat, and many people in public housing do not have access to air conditioning or cool spaces. She said *“the Northern Territory really shows how much of a public health emergency climate change is”* and *“we need to respond now.”*

Lessons and implications

Dr Douglas said *“people are already mitigating climate change through traditional burning and they are investing their income from land use agreements to install solar power, plant bush tucker gardens in communities and operate swimming pools, but all that counts for little in the face of the lack of climate leadership from the government.”*¹⁵³

Both Dr Pendrey and Dr Quilty emphasised the immediacy of the threat and the urgency to act now. Dr Pendrey asserts that there should be heat health plans developed in partnership with communities and put in place before summer arrives. Improving public housing infrastructure and making sure people have energy security and consistent access to cool spaces no matter where they live are also important.

Her recent paper suggests that *“climate-related concerns should feature in the national health workforce strategy”* while a *“comprehensive National Plan for Health and Climate Change would address the challenges faced by remote and Indigenous communities, who are at particular risk, and by the workforce that supports their health needs.”*¹⁵⁴

“

There is a desire to mitigate carbon emissions from healthcare but there is little action.”



Torres Strait: Rising Sea Levels, Culture, Identity and Health



Context

The Torres Strait is on the front line of rising sea levels and increasing storm surges, among other severe climate impacts. Many of the seventeen inhabited Torres Strait Islands are low-lying coral cays or 'mud islands', already regularly affected by coastal erosion and saltwater inundation. This is causing extreme distress in the community.

Torres Strait Islander peoples want to stay on their traditional lands for the long term, and to maintain their cultural responsibilities, identity and kinship connections. However, climate change is increasingly harming country, culture and health.

Socio-economic disadvantage and high levels of chronic disease in this 70% Aboriginal and/or Torres Strait Islander population means average life expectancy is nearly fifteen years shorter than that of mainland Queenslanders. Climate-sensitive infectious diseases including tuberculosis, dengue, Ross River virus and melioidosis are present at high rates.¹⁵⁵

About 80% of electricity and transport is powered by imported diesel and many communities rely on diesel-powered desalination plants to secure water supply. Housing stock is often aging and poorly designed for heat. Family ties and mobility between Torres Strait Island communities and neighbouring under-resourced Papua New Guinea villages adds pressure to resources and services.

A 2018 climate and health risk assessment identified expected health impacts including increased heat-related health impacts, death and injury from extreme weather events, spread of vector-borne and other diseases, declines in the quality and availability of local food sources, declines in the availability, safety and quality of drinking water, increased impacts on mental health, displacement of people from their homes, and forced migration.

Impact to the health system (and community)

Clinical treatment needs arising from the region's high burden of chronic disease are being exacerbated by climate impacts, amplifying social and environmental health inequities. This increases pressure on the already stressed clinical services.

Health service infrastructure at climate-risk includes jetties, airports, roads and telecommunications relied upon by staff and patients for frequent travel between Queensland Health Service facilities on the islands and across the region. Ella Kris from the Torres Strait Regional Council said *"even the hospital on Thursday Island, it's built right on the edge of the sea. In time to come, the water is going to be at the hospital's front door."*



Torres Strait: Rising Sea Levels, Culture, Identity and Health

Mental health and cultural impacts are severe. For Indigenous Australians, health is more than individual physical wellbeing, and includes the social, emotional and cultural well-being of the whole Community.¹⁵⁶ In 2019, coastal erosion and king tides washed away ancestral graves on Masig Island. Traditional Owner Yessie Mosby said his community had grown increasingly fearful of being forced to leave their island homes.¹⁵⁷ He said *"That's our history and to lose that we lose our identity...We didn't contribute anything to what's happening, but we're on the front line."*

John Rainbird from the Torres Strait Regional Authority notes additional health concerns, saying: *"Sea level is a big stress factor for people whose communities may be at risk. But it also has other impacts. The waste treatment plants often have to be shut down because salt water gets into the system...raw sewage is pumped out, normally just onto the waterway in front of the community. That creates a health risk as well...Some of the landfill sites get flooded in the low lying communities and then you get health risks with mosquito issues and leaching into groundwater."*

“

Sea level is a big stress factor for people whose communities may be at risk."

Health system response

In 2019, twenty-three medical professionals working in the Queensland government's Torres and Cape Health and Hospital Service region made an emergency call for increased attention to climate change and health impacts on Torres Strait Islander peoples.¹⁵⁸ Calling for rapid transition to a low carbon economy, and greater investment in primary preventative healthcare, Dr Ineke Wever said: *"We need to prepare our community to be as healthy as possible for the coming changes and reduce the amount of chronic disease we take with us into the future."*

Five years ago in 2016, health personnel contributed to the collaborative development of the Torres Strait Regional Adaptation and Resilience Plan. Development of this innovative, forward-looking plan was led by the Torres Strait Regional Authority, with local and state government partners and community workshops. It took an integrated climate change risk and vulnerability assessment approach across the Natural, Financial, Human, Social and Physical capitals. It put forward a holistic pathway of actions that could be undertaken over coming years, both to build community resilience, and to adapt to climate impacts.¹⁵⁹

Torres Strait Islander Researchers' Community of Practice Meriba buay-ngalpan wackaythoemamy, commended the Regional Adaptation and Resilience Plan as a significant way forward and an opportunity to establish a Torres Strait Islander-driven agenda to inform climate change policy and practice at all government levels. They lament that despite this work, programs that address health and wellbeing in a holistic sense are still not in place.¹⁶⁰



Torres Strait: Rising Sea Levels, Culture, Identity and Health

Lessons and implications

A culturally safe and holistic approach that is community-led and addresses the cultural, social and ecological determinants of health is needed.

Continuing support and resourcing is needed to implement community- and systems-informed plans such as the Torres Strait Regional Adaptation and Resilience Plan.

Indigenous researchers say *“Securing a better future for Torres Strait Islanders requires sustained commitment....and importantly, stable financial support. The current short-term funding environment is misaligned with the type of longer-term partnership required to properly address positive health for the Torres Strait.”*⁶⁰

Addressing health and wellbeing in a holistic sense includes working towards shared cultural and wellbeing goals with other sectors and services. This requires better coordination and collaboration between agencies.

To strengthen the healthcare system, the wellness promotion end of the healthcare continuum needs to be equally prioritised and resourced in balance with treatment and care.

“

Securing a better future for Torres Strait Islanders requires sustained commitment...and importantly stable financial support.”





Western Sydney, NSW: Extreme Heat

Context

Extreme heat is particularly severe in Western Sydney where geography and weather patterns intensify the Urban Heat Island effect, trapping hot air in the region. In January 2020, Penrith was the hottest place on Earth at 48.9°C and in 2019 Parramatta sweltered through 47 days with temperatures over 35°C.

Chief Executive of Western Sydney Regional Organisation of Councils, Charles Casucelli said *"this is a liveability issue. It's not about being comfortable, it's about asking if I can or can't live in Western Sydney."*¹⁶¹ Western Sydney is also one of the fastest growing urban populations in Australia with more than 2.5 million residents, who are typically of a lower socio-economic background.

Sleep, school, and work are already being impacted. However, heat also has a "domino effect" on peoples' health which increases the health inequality gap already seen in Sydney's west. Living in warm neighbourhoods increases the heat-related mortality risks of residents by nearly 6% compared to those living in cooler suburbs, and older people are particularly vulnerable.¹⁶²

Riverstone General Practitioner Dr Kim Loo says she has a sense of dread about the days of forecast high temperatures. She is concerned vulnerable people will not be able to manage their health during heatwaves.

Dr Loo says a lot of people who've lost their jobs due to the pandemic have moved back home to Western Sydney and are now living in multi generation, low-income homes that are not thermally efficient. She said: *"many of my patients cannot afford it [air conditioning]"* and *"people are forced to choose to go without food or medications in order to be cooler, or they will buy food and medications and not be (cool enough)"*.



Image credit: Climate Council

Heat has significant detrimental impacts on young children which can have lifelong impacts. Being outside in nature or parks is important for children's healthy development. Dr Sebastian Pfautsch, Associate Professor of Urban Studies at Western Sydney University said *"playgrounds at public parks may be children's only regular access to nature. It's the place where kids' gross motor activities take place"*. However, Dr Pfautsch regularly logs surface temperatures upwards of 80°C and says play equipment can be hot enough to sear skin. He said *"...we need [playgrounds] to help these new citizens become Earth stewards...but we're seeing a shift indoors"*¹⁶¹. Parents also justifiably worry their kids won't do well at school when they're exhausted after not sleeping well on hot nights.

The COVID-19 crisis has hit Western Sydney hard in 2021, but the community is already worrying about this year's expected high summer temperatures, with the added pressure of the pandemic. Dr Loo said, *"there's so much anxiety in the Community at the moment"*.



Western Sydney, NSW: Extreme Heat

Impact to the health system

A community-based project called Sweltering Cities surveyed 700 residents about what it's like to live, work and travel around Western Sydney on days of extreme heat. The survey found that 11.2% of people have been to a doctor or sought medical care because they felt unwell in the heat. In addition to this 23.5% of people have a health condition made worse by extreme heat and yet 31.4% of people said that they did not have access to information on how to be safe and well in heat waves.¹⁶³

This is reflected within the health system, with hospital admissions and rates of morbidity and mortality increasing well above the norm after two to three extremely hot nights. This includes significant increases in mental health-related mortality and morbidity during heatwave days.

Health system response

"As a doctor you feel like there's only so much you can do in primary care when the environment around you is fundamentally changing," says Dr Loo, who foresees a future of rapidly escalating health costs due to summer heat.

Resilience Sydney's Beck Dawson believes Western Sydney will remain habitable, but people will have to live there in very different ways from how they live now. She suggests a daily heat-risk rating system, similar to the one used for bushfires, could be introduced. *"When we get to extreme heat, we have to respond as if it's an emergency,"* she says.¹⁶⁴

Solutions required go far beyond the capacity of the health system. Local councils and community organisations have begun working together to better plan for heat. The Western Sydney Regional Organisation of Councils'

Turn Down the Heat Strategy was developed by 55 organisations working together to create cooler, more resilient communities.¹⁶⁵

Emma Bacon, the Founder and Coordinator of Sweltering Cities envisages large scale solar installations on affordable housing, public housing and low-income housing, to power the necessary air conditioning, as part of the solution.

Lessons and implications

The impacts described in this Case Study are beyond the health system's capacity to treat and require comprehensive, multisectoral and "radical" solutions. This includes collaboration between the health system, developers, urban planners and different levels of government.

The Sweltering Cities community survey also identified four categories of heat responses needed. These relate to more thermally efficient homes; public infrastructure including cooling centres; better emergency services during heatwaves; and justice for residents through having a greater say in creating a sustainable, climate-smart city.¹⁶³

Comprehensive adaptation strategies are needed now to maintain liveability in Western Sydney. In addition to this, timely, locally relevant data on the impacts of current and projected heat on Western Sydney residents is required to more accurately quantify health impacts from heat.

Western Sydney is a glimpse into the future for the rest of urban Australia, without assertive transformational mitigation and adaptation strategies at local and national levels.



National: Mental Health Workshops for Rural and Remote Health Workers in Bushfire Affected Areas



Image credit: CRANaplus

Context

Rural and remote health practitioners in areas affected by the widespread 2019–20 bushfires across Australia have been through the same traumas and challenges as their patients, and haven't been able to take a break to look after their own wellbeing.¹⁶⁶ With high levels of stress and exhaustion in the health workforce, they feel they've been forgotten.

Impact to the health system

Mary Jackson, a Mental Health and Wellbeing educator at CRANaplus said, *"many are still struggling to get back into their own homes after the bushfires. Services are struggling to get their workforce back on track, and COVID's taken over the agenda."*

The need for support was clear to Kristy Hill and Ms Jackson of CRANaplus, the peak professional body for the remote and isolated health workforce in Australia. Even before COVID-19

and the bushfires, the pair indicated that health professionals felt they were working in a 'broken' system, and were now being asked to take on a lot of extra work and extra caseloads.

Ms Jackson said, *"one organization told us their workforce were like zombies.... lots of sick leave, and people just not being able to function at work."*

Health system response

CRANaplus developed a range of mental health, wellbeing and self-care workshops and resources including webinars and podcasts. In all, 61 workshops have been delivered to 815 health professionals, reaching all states and territories following the 2019–2020 bushfires. When possible, workshops were delivered face-to-face by state-based CRANaplus educators.

Emergent priorities such as COVID outbreaks impacted workshop delivery, particularly for Indigenous organisations. However, flexible virtual modes of delivery enabled access, when, and how, participants were ready and able to attend, sometimes at very short notice.

Initially it was hard for health workers to step out of their caring roles and to understand that the workshops were being offered for their own mental health, not their clients'. However, attendance numbers grew steadily as workshops were rolled out in different regions.

One participant wrote: *"It has been a tough year from fires to COVID. Earlier in the year...I probably wouldn't have been able to take in your recommendations, but now....your workshop ideas have helped. I now know I need to look after myself, which will help all around me."*



National: Mental Health Workshops for Rural and Remote Health Workers in Bushfire Affected Areas

Some organisations reported that the message about staff mental health and self-care needed to come from a trusted external source, not from their employers. Ms Hill, the Education and Resource Lead at CRANaplus credits the fact that CRANaplus staff have shared experience of droughts and bushfires and understand the impact on communities.

On healthcare system readiness for climate change impacts, Ms Hill said, *"Certainly on the ground level it feels like the system is not ready for any more disasters. It really needs high level strategic input to be able to support people on the ground, to even consider that conversation"*.

The bushfires prompted people to make the connection between climate change and health, but *"it's just been put on the back burner because of COVID"* said Ms Jackson. However, Ms Hill and Ms Jackson both believe that rural health practitioners can be good advocates to help lead community climate change preparation and adaptation.

"In rural areas where they're really connected to the country, and have a better understanding of the connection between the environment and health, there's a real opportunity to engage with them, to have strategies that empower health workers in the rural health workforce to put it [climate change] on the agenda, and to work with communities to look at how they can adapt and prepare".

Lessons and implications

Rural and remote health practitioners have been under prolonged stress along with the communities they serve and show signs of exhaustion and burnout.

In providing valuable, effective mental health support to healthcare providers, important factors include the authenticity, flexibility and responsiveness of the messenger.

The health system is deeply under-prepared. To build health system capacity and resilience to climate change will require significant, sustained strategic leadership, governance, guidance, training and resources.

Rural and remote health practitioners can be engaged and empowered to help their communities understand and build resilience to climate health impacts.



In rural areas where they're really connected to the country...there's a real opportunity...to work with communities to look at how they can adapt and prepare."



Queensland: 'Stepped Care' and Partnerships for Mental Health After Disasters

Context

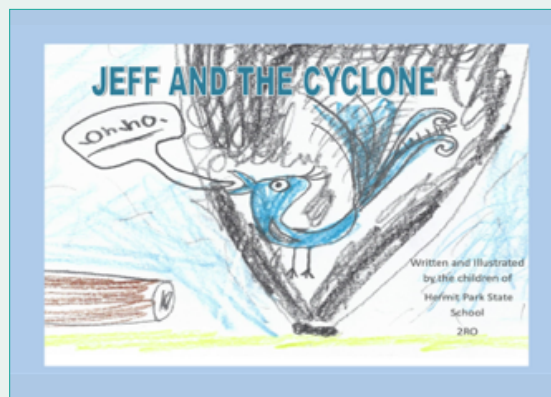
Unacceptable rates of rural suicide during the millennium drought led Queensland Health to establish a rural mental health support scheme to provide a more comprehensive approach to tackling mental health issues in disaster-affected rural communities.¹⁶⁷ Despite recent rains, 65% of Queensland is still drought declared,¹⁶⁸ and for many farmers there is “no water, no growth, and no end in sight”.

Queensland communities continue to struggle with the physical and psychological impacts of drought, overlaid by the impacts of severe cyclones, bushfires, and monsoonal flooding. Communities are now further impacted by the COVID-19 pandemic.

Impact to the health system

Primary health clinicians have seen an increase in complex, trauma-related mental health presentations linked to repeated severe weather events and other disasters, including the pandemic. Already struggling to recruit skilled mental health practitioners, and with high staff turnover rates in remote areas, mental health clinicians say their workforce has no “surge capacity” to deploy in response to disasters. But climate-related trauma will only continue to grow. COVID-19 has further significantly disrupted recruitment and service delivery.

Dr Andrea Baldwin, Clinical Consultant, Child and Youth Mental Health Service, says child and youth mental health clinicians also saw a sharp increase in babies and children with emotional and behavioural disturbances linked to extreme weather events. Children require age-appropriate mental health treatment, but existing clinical capacity could not address the needs



Illustrations from a book written as part of the Birdie's Tree Visiting Program. In group story-making workshops, a Birdie story is used as a model, and the children then create their own story about someone getting through a hard time with help from those around them.

of every affected child and family experiencing distress, especially in rural, remote and isolated areas. Clinicians recognised new resources and services were needed to meet increasing community-wide needs.

Health system response

Set up under joint Commonwealth and State disaster arrangements, the Queensland Mental Health Disaster Recovery Program (MHDR) provides funding for two years' mental health support in officially disaster-declared locations. Queensland Health MHDR Manager Ben Norris says the program has been in “constant response and recovery mode” since it began in 2015.

The support, for both adults and children, is delivered by small teams comprising psychologists, social workers, occupational therapists, and mental health nurses, and facilitated by staff with community engagement and development skills and local peer workers. MHDR Manager, Mr Norris says different types of care are needed along the pathway towards recovery, so a ‘stepped care’ model



Queensland: 'Stepped Care' and Partnerships for Mental Health After Disasters

aims to connect people to “the right care at the right time”. This starts with low intensity psychological interventions and moves up to more advanced trauma-specific treatment where needed.

The initial response phase is about psychological first aid for highly aroused, distressed people, to help them feel safe and connected. It fosters self-reliance so they don't 'get stuck' in a state of helplessness. Then, the 'restoration and recovery' phase aims to build mental health awareness and capacity in the community. It helps people recognise danger signs to look out for, such as sleep issues, prolonged anxiety and stress, being angry a lot of the time, and increased use of alcohol and other drugs, and encourages them to access available help.

As used by Child and Youth Mental Health clinicians through the program, the 'stepped' care approach includes a growing suite of practical and appealing Birdie's Tree resources¹⁶⁹ developed to help families prepare for, cope with, and recover from extreme weather events. Progressive care levels include screening (in schools and kindergartens), early intervention, a diagnostic assessment, and trauma treatment. The Queensland Centre for Perinatal and Infant Mental Health (QCPIMH) is working on the best way to roll out each of these steps and recognises that partnerships are key.

Dr Baldwin said, “we call it *upskilling the informal front line*. Building the capacity of anyone who has a role in helping children to get back on track. There are ways that they can use the Birdie's Tree resources to help”.

Mr Norris said, “one of the key lessons between Cyclone Debbie and the Queensland bushfires was that people just don't turn up to get treatment for mental health services after a disaster. You actively have to...encourage them to seek help”.

Key to this is building trust between the mental health team and community. Experience shows employing 'peer workers' or trusted local figures in the team, is vital. In areas where there are culturally and linguistically diverse groups impacted by an event, teams employ people who can speak the languages. MHDR teams also work closely with existing health services and other local agencies such as Lifeline, Red Cross, the Department of Agriculture and Fisheries, and the Royal Flying Doctor Service.

Finally, the program also provides grants and projects to build overall community resilience aimed at better preparing individuals and communities to deal with current and future climate risk events.



This is 'Jeff and the Cyclone' by a group of Year 2 students at Hermit Park State School in Townsville – an area impacted by the monsoonal floods of 2019, with a long history of cyclones.



Queensland: 'Stepped Care' and Partnerships for Mental Health After Disasters



Another illustration from 'Jeff and the Cyclone'.

Lessons and implications

New approaches to mental health are needed to address the growing impact of climate-related distress and trauma, recognising that "the new normal" will be increasingly risky.

There needs to be significantly more investment in building preparedness and capacity to adapt to ongoing climate change, in both the community and the health system, to better balance the prevalent reactive emphasis on treatment and restoration. The 'stepped' approach modelled by this MHDR Program is one example of an emerging model of care.

Establishing and maintaining MHDR support in affected communities is often delayed by recruitment challenges and exacerbated by high staff turnover rates in remote areas. MHDR Program leads grapple with the pros and cons of bringing in "outside experts" following disaster. While grateful for the much-needed intermittent funding and opportunity to boost services, they argue that permanent funding for new positions, rather than temporary support is needed.

Key to program success is inclusion of trusted local community members as "peer workers" who can bridge community and service provision, and ensure need is matched to appropriate care.

Partnerships and collaboration are vital for success, but some communities are still hard to reach, including remote and isolated, Indigenous communities, migrant and refugee families, and families with parents or children with disabilities.

Mr Norris said the more serious clinical need tends to show up late in the two-year funding cycle. Except for recurrent funding, three years of more flexibly staged funding would better match community needs.

Children and young people need to be understood and treated differently from adults. Upskilling the informal front line, or building the evidence-based capacity of all kinds of people who come into contact with children, is the foundation for success.





Economic Analysis



Economic Analysis

Aim

The present analysis sought to estimate the burden of bushfires in Australia over ten years from 2021 to 2030 inclusive, in terms of:

- ✦ Deaths directly caused by bushfires and attributable to bushfire-related smoke;
- ✦ Years of life lost to bushfires;
- ✦ Healthcare costs associated with hospital presentations due to bushfire-related smoke;
- ✦ Broader economic costs of the bushfires; and
- ✦ Value of statistical life lost to bushfires

These figures provide the basis upon which the cost-effectiveness of interventions to reduce the health burden from future bushfires can be evaluated.

Methods

Model

A dynamic model with yearly cycles was constructed to simulate follow-up of the entire Australian population over the ten years from 2021 to 2030. The model tracked the number of deaths occurring in each of the ten years, as well as the total years of life lived by the whole cohort. The dynamic nature of the model meant that the population was updated each year by taking into account births, deaths and net inward migration. The methods used for dynamic modelling have been published.¹⁷⁰ (Note: the model is generic and can be adapted to evaluate the health and economic burden of any events related to climate change.)

Data sources: demographics and mortality

The model population was profiled on the Australian population in 2020, stratified by sex and age in single years, as published by the Australian Bureau of Statistics (ABS).¹⁷¹ This 2020 population represented the model population in the year before the baseline year of 2021. To estimate the numbers of people in each sex-and-age stratum from 2021 onwards,

the 2020 population was evolved, taking into account expected births, deaths and numbers of net immigrants each year.

To estimate the number of deaths occurring each year, the numbers of people in each sex-and-age stratum were multiplied by relevant sex-and-age specific risks of death (from all causes). The latter were estimated using mortality data from 2019, the latest year for which data were available.¹⁷¹ It was assumed that across the entire time horizon of the model, sex-and-age specific risks of death would remain constant. (For example, the annual risk of death for 70 year-old males will stay the same in all 10 years.)

Future numbers of births, as well as net inward migrations within each sex-and-age stratum, were based on estimates published by the ABS.¹⁷² The ABS provided three sets of figures for births and net inward migrations: low, medium and high estimates. Medium estimates were used in the model.

Data sources: health burden due to bushfires

Borchers-Arriagada et al¹⁴³ estimated the number of deaths attributable to the 2019–2020 bushfires in Australia arising from smoke-related conditions. These were in addition to the 33 deaths directly caused by the fire. The authors also estimated the number of cardiovascular and respiratory hospitalisations, and presentations to hospital emergency departments for asthma, attributable to the fire. These are summarised in Figure 1, which is a reproduction of a table in the publication by Borchers-Arriagada.¹⁴³ Although this estimate covers eastern Australia, it is the most robust data available to support this modelling which is Australia-wide.

The data presented in Figure 1 were used as a reference for estimating the health burden associated with future Australian bushfires in the model.

**Figure 1. Estimated health burden attributable to bushfire smoke, QLD, NSW, ACT and VIC.
1 Oct 2019–10 Feb 2020**

Outcome	Estimate number of cases (95% confidence intervals)				
	QLD	NSW	ACT	VIC	TOTAL
Excess deaths (any cause)	47 (17–77)	219 (81–357)	31 (12–51)	120 (44–195)	417 (153–680)
Hospital admissions (cardiovascular)	135 (25–246)	557 (108–1050)	82 (15–149)	331 (62–602)	1124 (211–2047)
Hospital admissions (respiratory)	245 (0–513)	1050 (0–2204)	147 (0–308)	585 (0–1227)	2027 (0–4252)
Emergency department attendance, asthma	113 (61–165)	702 (379–1026)	89 (48–131)	401 (217–586)	1305 (705–1908)

In each year from 2021 to 2030 inclusive, it was assumed that there would be one bushfire of varying relative magnitude as the 2019–2020 bushfires in Australia, in recognition of the fact that this was a significant event. Professor David Karoly, Chief Research Scientist and the CSIRO Climate Science Centre, estimated that over the ten-year period from 2021 to 2030, there would be “one year with impacts like 2019–2020, three years with impacts 50% the scale of 2019–20, five years with impacts 10% the scale of 2019–20, and one year with 2% impact... (to represent the wet spring-summertime like this year ...)” (personal communication, 12 November 2021). Therefore, over the ten years from 2021 to 2030, the health burden per capita was assumed to exert an impact that was either 2% (one year), 10% (five years), 50% (three years) or 100% (one year) of the 2019–2020 bushfires. The specific years in which these relative impacts occurred were selected randomly. After adjustment for the impact relative to the reference 2019–2020 bushfire, the burden was then proportionally up-adjusted by the size of the population in each year relative to the population in 2020. In a sensitivity analysis (see below), the magnitude of future bushfires was assumed to be the same as the 2019–2020 events.

To estimate the number of bushfire-related deaths in each year, the risk of such a death for each sex-and-age stratum was multiplied by the number of people in the relevant stratum. The risk was calculated by dividing half the total number of deaths in the 2019–2020 bushfires (total 450, 33 direct and 417 smoke-related) by the total population in 2020 (25,693,342), which equated to 0.000876%. It was assumed that the risk of dying due to a bushfire was the same across both sexes and all ages.

To estimate the number of hospitalisations for cardiovascular and respiratory conditions and emergency department presentations for asthma, the estimated numbers in 2019–2020 were first halved, and then adjusted by the size of the population in each year relative to the population in 2020. For example, in 2019–2020, there were 1124 cardiovascular

hospitalisations. In 2021, the estimated total population was 26,117,572. Hence the bushfire that would occur in 2021 was assumed to lead to 571 cardiovascular hospitalisations.

The model did not estimate the health burden of bushfire smoke due to non-physical conditions, such as mental health, nor the burden borne by community-based healthcare services. Furthermore, the opportunity costs of devoting healthcare resources away from other conditions were not considered. Hence overall, the model’s estimates of the health burden of bushfires were very conservative.

Data sources: costs of hospitalisations

The unit costs of hospitalisations for cardiovascular and respiratory conditions were estimated from data pertaining to relevant diagnostic related groups (DRGs) contained in the National Hospital Cost Data Collection, Round 22, 2017–18 (173), the latest available. Cardiovascular-related DRGs have the prefix F, and respiratory DRGs have the prefix E. For cardiovascular hospitalisations, DRGs for stroke (B69A, B69B, B70A, B70B, B70C and B70D) were also included.

Weighting by the number of separations for each DRG, the weighted-average cost for cardiovascular (including stroke) DRGs was \$6830. Using the health price index published by the Australian Institute of Health and Welfare in 2019 (174), this value was updated to a 2021 value of \$7175. The weighted-average cost for respiratory DRGs was \$6357, which was updated to a 2021 value of \$6679.

Data sources: healthcare costs of deaths

The healthcare costs of each death occurring directly due to bushfires was assumed to be zero, based on the conservative assumption that health services would not be used by affected individuals. The cost of each death attributable to smoke-related conditions was assumed to be the weighted-average of all cardiovascular (including stroke) and respiratory DRGs. This was \$6637, which was updated to a 2021 value of \$6973.

Data sources: broader economic cost of bushfires

In 2020, a report by SGS Economics and Planning (175) estimated the impact of the 2019–2020 bushfires on the gross domestic product of the three affected local government areas (LGAs): East Gippsland, Victoria (\$1,466 million), Kangaroo Island, South Australia (\$234 million) and Wingecarribee, NSW (\$2,226 million). The total was \$3,926 million. With each bushfire (of half the magnitude as the 2019–2020 events), its broader economic cost was first considered to be half of that if the 2019–2020 events, and then proportionally up-adjusted by the size of the population in each year relative to the population in 2020. Given the uncertainty regarding inflation in the current economic climate, GDP was not inflated over the time horizon. However, this was likely a conservative assumption.

The analysis was also conservative in not considering the impact of bushfires on the GDP of other areas outside of bushfire-affected LGAs. In reality, there would be significant compounding effects on the broader economy. Researchers from the Australian National University estimated that the total economic costs of the 2009 Victorian Black Saturday fires, the insurance costs of which were similar to the 2019–2020 bushfires, might have reached \$7.4 billion (2019 dollars) (176).

Data sources: value of statistical life

In 2021, the Office of Best Practice Regulation from the Department of the Prime Minister and Cabinet assigned the value of statistical life year at \$222,000.¹⁷⁷ This is the value in monetary terms that is ascribed to each year lived by an Australian and used to help with public policy and planning. As with GDP, this value was also not inflated over time, which was likely conservative.

Calculating years of life lived and lost

Calculation of the years of life lived in any year by people within a sex-and-age stratum was based on the following formula:

$$tx = (nx-1+nx)/2$$

where:

tx = time spent alive in a sex-and-age stratum during year x

$nx-1$ = number of people residing in that stratum at the start of year x

nx = number of people residing in that stratum at the end of year x

Implicit in the formula was the assumption that any transition into and out of that stratum occurred halfway through cycle x .

Years of life lost to bushfire-related deaths were calculated by creating a cohort of individuals who died, and simulating their follow-up as if they had not died due to bushfires. Rather, they experienced sex-and-age specific mortality as per the general population.

The value of statistical life lost was derived from multiplying each year of life lost by the value of statistical life year (\$222,000).

Discounting

A 5% annual discount rate was applied to all costs incurred and life years lived from 2022 onwards. In economic evaluations, discounting takes into account the fact that the value of goods and services are progressively reduced the further into the future they are consumed. A 5% annual discount rate was selected based on current Australian guidelines.¹⁷⁸

Annual discounting was applied according to the formula:

$$XD = XU * [1/(1+d)]^t$$

where:

XD = discounted value

XU = undiscounted value

d = annual discount rate

t = time elapsed in years since 2021

Sensitivity analyses

Two one-way sensitivity analyses were undertaken, with variation to the following key input variables (while other inputs remained at 'base case' values):

1. In each year of the model, the relative impact of bushfires was assumed to be 100% of that of the 2019–2020 bushfires. This variation assumed that future bushfires on average would as impactful as the 2019–2020 events (compared to the base case assumption of bushfires having half the impact).
2. The estimated impact of a bushfire equivalent to that of the 2019–2020 bushfires on the Australian gross domestic product was increased to \$7,000 million.

Results

Future burden of bushfires in Australia

The results of the modelled analysis are summarised in Table 3.

Over the ten years from 2021 to 2030 inclusive, the modelled analysis predicted that 1,480 lives would be lost to bushfires, as well as 4,024 years of life (discounted). (Note that in each successive year, the years of life lost increased because the cohort of people who died as a consequence of bushfires increased over time. For example, in 2022, years of life were lost by the 46 people who died prematurely in that year as well as the 45 people who died prematurely in 2021.)

Healthcare costs arising from deaths for smoke-related conditions, hospitalisations for cardiovascular and respiratory conditions, and emergency department presentations with asthma amounted to \$69 million (discounted). The impact on gross domestic product totalled \$10 billion (discounted). In terms of value of statistical life, \$893 million (discounted) was lost.

Table 3. Predicted future health and economic burden of bushfires in Australia

Year	Relative impact*	Deaths	Healthcare costs*	Impact on GDP#	Years of life lost#	VoSL lost#
2021	10%	45	\$2,756,811	\$399,088,523	22	\$4,993,776
2022	10%	46	\$2,668,271	\$386,271,092	64	\$14,311,161
2023	2%	9	\$516,260	\$74,736,176	86	\$19,066,316
2024	10%	47	\$2,496,008	\$361,333,430	106	\$23,435,819
2025	50%	240	\$12,061,508	\$1,746,078,737	218	\$48,343,347
2026	100%	486	\$23,302,818	\$3,373,421,980	490	\$108,829,307
2027	10%	49	\$2,249,921	\$325,708,835	663	\$147,193,135
2028	50%	250	\$10,858,587	\$1,571,938,467	733	\$162,657,747
2029	10%	51	\$2,095,646	\$303,375,262	794	\$176,211,544
2030	50%	257	\$10,108,208	\$1,463,310,125	849	\$188,384,506
Total		1,480	\$69,114,039	\$10,005,262,627	4,024	\$893,426,658

* Relative to the reference 2019–2020 bushfire # Values discounted at 5% annually from 2022 onwards GDP = gross domestic product, VoSL = value of statistical life

Sensitivity analyses

The results of the sensitivity analyses are presented in Table 4.

Table 4. Results of the sensitivity analyses

	Deaths	Healthcare costs*	Impact on GDP*	Years of life lost*	VoSL lost*
<i>Base case</i>	1,480	\$69,114,039	\$10,005,262,627	4.024	\$893,426,658
Health impact of bushfires same as 2019–2020 event	4,824	\$237,823,761	\$34,428,449,229	17,142	\$3,805,572,323
Impact on GDP of 2019–2020 bushfire = \$7 billion	1,480	\$69,114,039	\$17,839,235,453	4,024	\$893,426,658

* values discounted at 5% annually from 2022 onwards GDP = gross domestic product, VoSL = value of statistical life

Cost-effectiveness of interventions to reduce health burden from bushfires

There are many interventions to reduce the risk or impact of bushfires on health. Furthermore, these interventions have variable effectiveness that are challenging to measure. Therefore, it is difficult to evaluate the cost-effectiveness of these interventions accurately. However, the above figures provide useful context for decisions to invest in such interventions.

For example, based on the conservative assumption that bushfires will cost the broader Australian economy \$10 billion (discounted) over the next ten years, any amount of expenditure on bushfire interventions less than this would still be cost-saving, assuming that they are 100% effective (which is very unlikely). If the interventions were expected to reduce the impact of bushfires on health by 10%, then up to \$1 billion could be invested. Of course, wider benefits to the healthcare system, human health and the health of the environment need also to be considered.



References

- 1 Intergovernmental Panel on Climate Change. Climate Change 2021: The Physical Science Basis Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In: Masson-Delmotte V, Zhai P, Pirani A, Connors S, Pean C, Berger S, et al., editors.: Cambridge University Press; 2021 [in press].
- 2 Ripple WJ, Wolf C, Newsome TM, Gregg JW, Lenton TM, Palomo I, et al. World Scientists' Warning of a Climate Emergency 2021. *Bioscience*. 2021 Sep 1;71(9):894–8.
- 3 Bureau of Meteorology (BOM) & CSIRO. State of the Climate 2020. Commonwealth of Australia; 2020.
- 4 Grose M, Meinshausen M, Canadell P, Nicholls Z. IPCC says Earth will reach temperature rise of about 1.5 in around a decade. But limiting any global warming is what matters most: The Conversation; 2021 [Available from: <https://theconversation.com/ipcc-says-earth-will-reach-temperature-rise-of-about-1-5-in-around-a-decade-but-limiting-any-global-warming-is-what-matters-most-165397>].
- 5 Grose MR, Narsey S, Delage F, Dowdy AJ, Bador M, Boschat G, et al. Insights from CMIP6 for Australia's future climate. *Earth's Future*. 2020;8(5):e2019EF001469.
- 6 Australian Academy of Science. The risks to Australia of a 3° C warmer world. Australian Academy of Science; 2021. Report No.: 0858477645.
- 7 IPCC. Special Report: Global Warming of 1.5°C: Summary for Policymakers. Geneva: Intergovernmental Panel on Climate Change; 2018.
- 8 Tong S, Ebi K. Preventing and mitigating health risks of climate change. *Environmental research*. 2019;174:9–13.
- 9 Zscheischler J, Westra S, Van Den Hurk BJ, Seneviratne SI, Ward PJ, Pitman A, et al. Future climate risk from compound events. *Nature Climate Change*. 2018;8(6):469–77.
- 10 USA: Climate Action Tracker; 2021 [Available from: <https://climateactiontracker.org/countries/usa/>].
- 11 Ferris N. How far along are the G7 nations in their journeys to net zero? : Energy Monitor; 2021 [Available from: <https://energymonitor.ai/policy/net-zero-policy/how-far-along-are-the-g7-nations-in-their-journeys-to-net-zero>].
- 12 Höhne N, Gidden MJ, den Elzen M, Hans F, Fyson C, Geiges A, et al. Wave of net zero emission targets opens window to meeting the Paris Agreement. *Nature Climate Change*. 2021:1–3.
- 13 The Paris Agreement: United Nations Framework Convention on Climate Change. United Nations; 2015.
- 14 Lowy Institute Poll 2021. Climate change and energy: Lowy Institute; 2021 [Available from: <https://poll.lowyinstitute.org/themes/climate-change-and-energy/>].
- 15 Dewan A. Australia is shaping up to be the villain of COP26 climate talks: CNN; 2021 [Available from: <https://edition.cnn.com/2021/09/12/australia/australia-climate-cop26-cmd-intl/index.html>].
- 16 Abbondanza G. Australia the 'good international citizen'? The limits of a traditional middle power. *Australian Journal of International Affairs*. 2021;75(2):178–96.

- 17 O'Gorman D. Australia's standing in Pacific has plummeted because of our climate change failure: The Guardian; 2019 [Available from: <https://www.theguardian.com/environment/commentisfree/2019/jun/08/australias-standing-in-pacific-has-plummeted-because-of-our-climate-change-failure>].
- 18 Jervis-Bardy D. Insufficient on its own: US warns Morrison about relying on technology to achieve net zero emissions: Canberra Times; 2021 [Available from: <https://www.canberratimes.com.au/story/7221033/when-is-not-the-question-anymore-morrison-resists-pressure-to-set-new-climate-target/>].
- 19 Sachs JD, Traub-Schmidt G, Kroll C, Lafortune G, Fuller G. Country Profiles: Australia. The Decade of Action for the Sustainable Development Goals: 2021 Sustainable Development Report. Cambridge: Cambridge University Press; 2021.
- 20 OECD. Economic Survey of Australia. Organisation for Economic Co-operation and Development; 2021.
- 21 OECD Environmental Performance Reviews: Australia 2019 [press release]. Paris: OECD Environmental Performance Reviews, OECD Publishing 2019.
- 22 World Resources Institute. Adaptation Action Coalition Washington DC: World Resources Institute; n.d. [Available from: <https://www.wri.org/initiatives/adaptation-action-coalition>].
- 23 Muller F, Saddler H, Melville-Rea H. Carbon Border Adjustments. What are they and how will they impact Australia? Discussion paper. The Australia Institute; 2021.
- 24 Malik A, Padget M, Carter S, Wakiyama T, Maitland-Scott I, Vyas A, et al. Environmental impacts of Australia's largest health system. *Resources, Conservation and Recycling*. 2021;169:105556.
- 25 Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler P-P, et al. The environmental footprint of healthcare: a global assessment. *The Lancet Planetary Health*. 2020;4(7):e271–e9.
- 26 Tennison I, Roschnik S, Ashby B, Boyd R, Hamilton I, Oreszczyn T, et al. Healthcare's response to climate change: a carbon footprint assessment of the NHS in England. *The Lancet Planetary Health*. 2021;5(2):e84–e92.
- 27 McGain F, Muret J, Lawson C, Sherman JD. Environmental sustainability in anaesthesia and critical care. *British journal of anaesthesia*. 2020;125(5):680–92.
- 28 Malik A, Lenzen M, McAlister S, McGain F. The carbon footprint of Australian healthcare. *The Lancet Planetary Health*. 2018;2(1):e27–e35.
- 29 Health Care Without Harm. Healthcare's Climate Footprint. Health Care Without Harm in collaboration with Arup; 2019.
- 30 World Health Organization. COP26 Special Report: The Health Argument for Climate Action. Geneva: World Health Organization; 2021.
- 31 World Health Organization. Expert meeting on measuring greenhouse gas emissions and other environmental sustainability concerns in healthcare facilities. Meeting report. World Health Organization; 2021.
- 32 Improvement NEaN. Delivering a 'Net Zero' National Health Service. 2020.
- 33 The Global Climate & Health Alliance. Healthy NDCs: NDC Scorecards. Are national climate commitments enough to protect our health? : Global Climate and Health Alliance; 2021 [Available from: <https://climateandhealthalliance.org/initiatives/healthy-ndcs/ndc-scorecards/>].
- 34 Australia joins coalition for climate adaptation action [press release]. Australian Government: The Hon Sussan Ley MP, Minister for the Environment, 19 March 2021.

- 35 Health Care Without Harm. A reflection on climate, health, and equity in the new Biden-Harris administration 2021 [Available from: <https://noharm.medium.com/a-reflection-on-climate-health-and-equity-in-the-new-biden-harris-administration-de4578eed5ee>.
- 36 U.S. Office of the Federal Chief Sustainability Officer. Federal Climate Adaptation Plans n.d. [Available from: <https://www.sustainability.gov/adaptation/>.
- 37 U.S. Department of Health & Human Services. Climate Change and Health Equity: Office of the Assistant Secretary for Health; 2021 [Available from: <https://www.hhs.gov/ocche/climate-change-health-equity/index.html>.
- 38 Centers for Disease Control and Prevention. CDC's Climate and Health Program: U.S. Department of Health & Human Services; n.d. [Available from: <https://www.cdc.gov/climateandhealth/default.htm>.
- 39 US Global Change Research Program. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. In: Balbus JL, Gamble CB, Beard JE, Bell D, editors. Washington, DC: US Global Change Research Program; 2016. p. 312.
- 40 Department of Environment Land Water and Planning. Climate Change Act 2017. Victorian Government; 2021.
- 41 Barraclough KA, Agar JWM. Green nephrology. *Nature Reviews Nephrology*. 2020;16(5):257–68.
- 42 Barraclough KA, Gleeson A, Holt SG, Agar JW. Green dialysis survey: Establishing a baseline for environmental sustainability across dialysis facilities in Victoria, Australia. *Nephrology (Carlton, Vic)*. 2019;24(1):88–93.
- 43 Dupraz J, Burnand B. Role of Health Professionals Regarding the Impact of Climate Change on Health-An Exploratory Review. *International journal of environmental research and public health*. 2021;18(6).
- 44 Yates EF, Bowder AN, Roa L, Velin L, Goodman AS, Nguyen LL, et al. Empowering Surgeons, Anesthesiologists, and Obstetricians to Incorporate Environmental Sustainability in the Operating Room. *Annals of surgery*. 2021;273(6):1108–14.
- 45 Dhillon VS, Kaur D. Green hospital and climate change: Their interrelationship and the way forward. *Journal of clinical and diagnostic research: JCDR*. 2015;9(12):LE01.
- 46 Beloeil H, Albaladejo P. Initiatives to broaden safety concerns in anaesthetic practice: The green operating room. *Best practice & research Clinical anaesthesiology*. 2021;35(1):83–91.
- 47 Brown C, Meals C. Four Ways Plastic Surgeons Can Fight Climate Change. *Plastic and Reconstructive Surgery — Global Open*. 2020.
- 48 Tonmoy FN, Cooke SM, Armstrong F, Rissik D. From science to policy: Development of a climate change adaptation plan for the health and wellbeing sector in Queensland, Australia. *Environmental Science and Policy*. 2020;108:1–13.
- 49 Climate and Health Alliance. Real , Urgent & Now: Communicating the Health Impacts of Climate Change. 2021.
- 50 Association of Medical Device Reprocessing. Reprocessing by the numbers: 2019 Reprocessing annual survey from AMDR 2019 [Available from: http://amdr.org/wp-content/uploads/2021/02/AMDR_ReprocessingByNumbers_FINAL_web.pdf.
- 51 Association of Medical Device Reprocessing. Remanufacturing by the numbers: 2019 Remanufacturing annual survey from AMDR 2019 [Available from: http://amdr.org/wp-content/uploads/2021/02/AMDR_ReprocessingByNumbers_EU_FINAL_web.pdf.

- 52 Pan-European Commission on Health and Sustainable Development. Drawing light from the pandemic: A new strategy for health and sustainable development. Copenhagen, Denmark; 2021.
- 53 Salas RN, Maibach E, Pencheon D, Watts N, Frumkin H. A pathway to net zero emissions for healthcare. *Bmj*. 2020;371.
- 54 Allwright E, Abbott RA. Environmentally sustainable dermatology. *Clinical and Experimental Dermatology*. 2020.
- 55 Khangura S, Konnyu K, Cushman R, Grimshaw J, Moher D. Evidence summaries: the evolution of a rapid review approach. *Systematic reviews*. 2012;1(1):1–9.
- 56 Reynen E, Robson R, Ivory J, Hwee J, Straus SE, Tricco AC. A retrospective comparison of systematic reviews with same-topic rapid reviews. *Journal of clinical epidemiology*. 2018;96:23–34.
- 57 Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *bmj*. 2017;358.
- 58 Baethge C, Goldbeck-Wood S, Mertens S. SANRA — a scale for the quality assessment of narrative review articles. *Research integrity and peer review*. 2019;4(1):1–7.
- 59 Bragge P, Guy S, Boulet M, Ghafoori E, Goodwin D, Wright B. A systematic review of the content and quality of clinical practice guidelines for management of the neurogenic bladder following spinal cord injury. *Spinal Cord*. 2019;57(7):540–9.
- 60 Bali T, Flesher W. BET 1: The clinical impact of policies aimed at reducing the carbon footprint of emergency departments. *Emergency medicine journal : EMJ*. 2020;37(3):170–1.
- 61 Lenzer B, Rupprecht M, Hoffmann C, Hoffmann P, Liebers U. Health effects of heating, ventilation and air conditioning on hospital patients: a scoping review. *BMC public health*. 2020;20(1):1287.
- 62 Purohit A, Smith J, Hibble A. Does telemedicine reduce the carbon footprint of healthcare? A systematic review. *Future Healthcare Journal*. 2021;8(1):e85.
- 63 Bravo D, Gaston RG, Melamed E. Environmentally Responsible Hand Surgery: Past, Present, and Future. *Journal of Hand Surgery*. 2020;45(5):444–8.
- 64 Guetter CR, Williams BJ, Slama E, Arrington A, Henry MC, Möller MG, et al. Greening the operating room. *American Journal of Surgery*. 2018;216(4):683–8.
- 65 Holmner Å, Rocklöv J, Ng N, Nilsson M. Climate change and eHealth: a promising strategy for health sector mitigation and adaptation. *Global health action*. 2012;5(1):18428.
- 66 Molero A, Calabrò M, Vignes M, Gouget B, Gruson D. Sustainability in healthcare: Perspectives and reflections regarding laboratory medicine. *Annals of laboratory medicine*. 2020;41(2):139–44.
- 67 Palinkas LA, O'Donnell ML, Lau W, Wong M. Strategies for Delivering Mental Health Services in Response to Global Climate Change: A Narrative Review. *International journal of environmental research and public health*. 2020;17(22).
- 68 Starup Hansen J, Dunne H, Sadler J, Jones A, Okorie M. Climate change in healthcare: Exploring the potential role of inhaler prescribing. *Pharmacology Research & Perspectives*. 2020;8(6):e00675.
- 69 Chandra P, Gale J, Murray N. New Zealand ophthalmologists' opinions and behaviours on climate, carbon and sustainability. *Clinical and Experimental Ophthalmology*. 2020;48(4):427–33.

- 70 McGain F, Moore G, Black J. Hospital steam sterilizer usage: could we switch off to save electricity and water? *Journal of health services research & policy*. 2016;21(3):166–71.
- 71 McGain F, Ma SCY, Burrell RH, Percival VG, Roessler P, Weatherall AD, et al. Why be sustainable? The Australian and New Zealand College of Anaesthetists Professional Document PS64: Statement on Environmental Sustainability in Anaesthesia and Pain Medicine Practice and its accompanying background paper. *Anaesthesia and Intensive Care*. 2019;47(5):413–22.
- 72 Hathaway J, Maibach EW. Health implications of climate change: a review of the literature about the perception of the public and health professionals. *Current environmental health reports*. 2018;5(1):197–204.
- 73 Sarfaty M, Kreslake J, Ewart G, Guidotti TL, Thurston GD, Balmes JR, et al. Survey of international members of the American Thoracic Society on climate change and health. *Annals of the American Thoracic Society*. 2016;13(10):1808–13.
- 74 Kotcher J, Maibach E, Miller J, Campbell E, Algodmani L, Maiero M, et al. Views of health professionals on climate change and health: a multinational survey study. *The Lancet Planetary Health*. 2021;5(5):E316–E23.
- 75 Yang L, Liu C, Bi P, Vardoulakis S, Huang C. Local actions to health risks of heatwaves and dengue fever under climate change: Strategies and barriers among primary healthcare professionals in Southern China. *Environmental Research*. 2020;187:109688.
- 76 Chadwick AE. Climate change, health, and communication: A primer. *Health communication*. 2016;31(6):782–5.
- 77 Ayres J, Forsberg B, Annesi-Maesano I, Dey R, Ebi K, Helms P, et al. Climate change and respiratory disease: European Respiratory Society position statement. *European Respiratory Journal*. 2009;34(2):295–302.
- 78 Crowley RA. Climate change and health: a position paper of the American College of Physicians. *Annals of internal medicine*. 2016;164(9):608–10.
- 79 Morgan RE. Determined action to tackle health determinants: A collaborative response to the challenge of climate change mitigation in practice settings. *Creative nursing*. 2019;25(3):195–200.
- 80 Behera MR, Behera D, Satpathy SK. Planetary health and the role of community health workers. *Journal of Family Medicine and Primary Care*. 2020;9(7):3183.
- 81 Blum S, Buckland M, Sack TL, Fivenson D. Greening the office: Saving resources, saving money, and educating our patients. *International Journal of Women's Dermatology*. 2021;7(1):112–6.
- 82 Pendrey CGA, Beaton L, Kneebone JA. General practice in the era of planetary health: Responding to the climate health emergency. *Australian Journal of General Practice*. 2020;49(8):520–3.
- 83 Tait PW, Allan S, Katelaris AL. Preventing heat-related disease in general practice. *Australian journal of general practice*. 2018;47(12):835–40.
- 84 Bourque F, Cunsolo Willox A. Climate change: the next challenge for public mental health? *International Review of Psychiatry*. 2014;26(4):415–22.
- 85 Coverdale J, Balon R, Beresin EV, Brenner AM, Guerrero AP, Louie AK, et al. Climate change: a call to action for the psychiatric profession. *Academic Psychiatry*. 2018;42:317–23.
- 86 Gahbauer A, Gruenberg K, Forrester C, Saba A, Schauer S, Fravel M, et al. Climate care is healthcare: A call for collaborative pharmacy action. *Journal of the American College of Clinical Pharmacy*. 2021;4(5):631–8.
- 87 Nicholas PK, Breakey S. Climate change, climate justice, and environmental health: Implications for the nursing profession. *Journal of Nursing Scholarship*. 2017;49(6):606–16.

- 88 Petre M-A, Malherbe S. Environmentally sustainable perioperative medicine: simple strategies for anesthetic practice. *Canadian Journal of Anesthesia*. 2020;67(8):1044–63.
- 89 Van Norman GA, Jackson S. The anesthesiologist and global climate change: an ethical obligation to act. *Current Opinion in Anesthesiology*. 2020;33(4):577–83.
- 90 Roa L, Velin L, Tudravu J, McClain CD, Bernstein A, Meara JG. Climate change: challenges and opportunities to scale up surgical, obstetric, and anaesthesia care globally. *The Lancet Planetary Health*. 2020;4(11):e538–e43.
- 91 Nicholas PK, Breakey S, McKinnon S, Eddy EZ, Fanuele J, Starodub R. A CLIMATE: A Tool for Assessment of Climate-Change–Related Health Consequences in the Emergency Department. *Journal of Emergency Nursing*. 2021;47(4):532–42. e1.
- 92 Rublee C, Bills C, Sorensen C, Lemery J, Calvello Hynes E. At Ground Zero — Emergency Units in Low-and Middle- Income Countries Building Resilience for Climate Change and Human Health. *World Medical & Health Policy*. 2021;13(1):36–68.
- 93 Shepley MM, Song Y, Marshall-Baker A. Creating an environmentally sustainable neonatal intensive care unit. *Newborn and Infant Nursing Reviews*. 2016;16(4):213–7.
- 94 Wooldridge G, Murthy S. Pediatric critical care and the climate emergency: our responsibilities and a call for change. *Frontiers in pediatrics*. 2020;8:472.
- 95 Bragge P, Gruen R. *From Roadside to Recovery: The Story of the Victorian State Trauma System*. 1st ed. Clayton, Victoria: Monash University Publishing; 2018.
- 96 Hornsey MJ, Chapman CM, Oelrichs DM. Why it is so hard to teach people they can make a difference: climate change efficacy as a non-analytic form of reasoning. *Thinking & Reasoning*. 2021:1–19.
- 97 van Valkengoed AM, Steg L. Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change*. 2019;9(2):158–63.
- 98 Raimi KT, Stern PC, Maki A. The promise and limitations of using analogies to improve decision-relevant understanding of climate change. *PloS one*. 2017;12(1):e0171130.
- 99 Arvai J, Campbell-Arvai V, Steel P. *Decision making for sustainability: A Systematic Review of the Body of Knowledge*. Network for Business Sustainability; 2012.
- 100 Bertels S, Papania L, Papania D. *Embedding sustainability in organizational culture: A Systematic Review of the Body of Knowledge*. Network for Business Sustainability; 2010.
- 101 Corvalan C, Villalobos Prats E, Sena A, Campbell-Lendrum D, Karliner J, Risso A, et al. Towards Climate Resilient and Environmentally Sustainable Healthcare Facilities. *International Journal of Environmental Research and Public Health*. 2020;17(23):8849.
- 102 Australian Institute of Health and Welfare. *Australia's Health 2020*. Canberra: AIHW; 2020.
- 103 Australian Institute of Health and Welfare. *Health expenditure Australia 2018–2019*. Canberra: AIHW; 2020. Report No.: 66 Cat. no HWE 80.
- 104 Devlin N, Scuffham P. Health today versus health tomorrow: does Australia really care less about its future health than other countries do? *Australian Health Review*. 2020;44(3):337–9.
- 105 Haines A. Health co-benefits of climate action. *The Lancet Planetary Health*. 2017;1(1):e4–e5.
- 106 Watts N. Personal communication. 2021.

- 107 Health Care Without Harm. Global Road Map for Healthcare Decarbonization. Health Care Without Harm in collaboration with ARUP; 2021.
- 108 World Health Organization. WHO guidance for climate resilient and environmentally sustainable healthcare facilities. Geneva: World Health Organization; 2020.
- 109 World Health Organization. Checklists to assess vulnerabilities in healthcare facilities in the context of climate change. Geneva: World Health Organization; 2021.
- 110 Markandya A, Sampedro J, Smith SJ, Van Dingenen R, Pizarro-Irizar C, Arto I, et al. Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study. *The Lancet Planetary Health*. 2018;2(3):e126–e33.
- 111 Scovronick N, Vasquez VN, Errickson F, Dennig F, Gasparrini A, Hajat S, et al. Human health and the social cost of carbon: a primer and call to action. *Epidemiology*. 2019;30(5):642–7.
- 112 Workman A, Blashki G, Karoly D, Wiseman J. The role of health co-benefits in the development of Australian climate change mitigation policies. *International journal of environmental research and public health*. 2016;13(9):927.
- 113 Health leaders call for urgent action on climate [press release]. Durban: Climate and Health Summit, December 6 2011.
- 114 Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, Boykoff M, et al. The 2019 report of *The Lancet* Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*. 2019;394(10211):1836–78.
- 115 The Global Climate & Health Alliance. Are national climate commitments enough to protect our health? [Available from: <https://climateandhealthalliance.org/initiatives/healthy-ndcs/ndc-scorecards/>].
- 116 Climate and Health Alliance. Previous work towards a National Strategy on Climate, Health and Well-being for Australia n.d. [Available from: https://www.caha.org.au/previous_work_national_strategy].
- 117 Climate and Health Alliance. 2013 Federal Election Policy Priorities n.d. [Available from: https://d3n8a8pro7vnm.cloudfront.net/caha/legacy_url/472/CAHA-Election-Platform-2013_v-8.pdf?1439938510].
- 118 Climate change is a health emergency [press release]. Australian Medical Association, 3 Sep 2019.
- 119 Climate and Health Alliance. National Consultation regarding a National Strategy on Climate, Health and Wellbeing for Australia: Final Consultation Report. 2017 May.
- 120 ClimateWorks Australia. State and territory climate action: leading policies and programs in Australia. 2021.
- 121 Zhang Y, Beggs PJ, Bambrick H, Berry HL, Linnenluecke MK, Trueck S, et al. The MJA–Lancet Countdown on health and climate change: Australian policy inaction threatens lives. *Medical Journal of Australia*. 2018;209(11):474–.
- 122 National Health and Medical Research Council. NHMRC Special Initiative in Human Health and Environmental Change: NHMRC; 2020 [Available from: <https://www.nhmrc.gov.au/funding/find-funding/nhmrc-special-initiative-human-health-and-environmental-change>].
- 123 Victorian Department of Health. Health and Human Services Adaptation Action Plan 2022–2026: Victorian Department of Health; 2021 [Available from: <https://engage.vic.gov.au/aaps-healthandhumanservices>].

- 124 Global Green and Healthy Hospitals. Targeting 100% Renewable Energy by 2025: Ambulance Victoria, Australia 2020 [Available from: <https://www.greenhospitals.net/wp-content/uploads/2020/11/GGHH-Case-Study-Targeting-100-Renewable-Energy-by-2025-Ambulance-Victoria-Australia.pdf>].
- 125 Global Green and Healthy Hospitals. Reducing the Carbon Footprint of Anesthesia: Middlemore Hospital, Counties Health Board, Auckland, New Zealand 2018 [Available from: https://www.greenhospitals.net/wp-content/uploads/2018/06/Middlemore-Hospital_Reducing-the-Carbon-Footprint-of-Anesthesia.pdf].
- 126 Global Green and Healthy Hospitals. Anaesthetic Gases — Greenhouse Gas Reductions Melbourne, Australia: Western Health; 2016 [Available from: <https://www.hospitalesporlasaludambiental.net/wp-content/uploads/2016/07/Waste-and-Chemicals-Anaesthetic-Gases-Greenhouse-Gas-Reductions-Western-Health-Australia.pdf>].
- 127 Woodley M. Saving lives and money: Report provides 'powerful economic argument' for primary care funding: RACGP; 2020 [Available from: <https://www1.racgp.org.au/newsgp/professional/global-report-provides-powerful-economic-argument>].
- 128 Tomson C. Reducing the carbon footprint of hospital-based care. *Future hospital journal*. 2015;2(1):57.
- 129 Hutley N, SC., Hartford Davis S. Further Supplementary Memorandum of Opinion: "Climate Change and Directors' Duties". Centre for Policy Development; 2021.
- 130 Barker S, Turner C. Climate risk governance guide. An introductory resource for directors on climate risk governance. Minster Ellison: Australian Institute of Company Directors; 2021.
- 131 Dibley A, Hurley S, Sheppard J. Public Authority Directors' Duties and Climate Change. Centre for Policy Development; 2019.
- 132 Bateman B, Reid J, Brady S, Taylor F, Cavallaro A. It's not just the climate that's warming up: new heat on directors. Clayton UTZ; 2019.
- 133 Sustainability Victoria. Linking Climate Change and Health Impacts. Sustainability Victoria; 2020.
- 134 Duckett S, Mackey W, Stobart A. Climate Change and Health: Preparing for the next disaster: Grattan Institute; 2020.
- 135 Climate and Health Alliance. Framework for a national strategy on climate, health and well-being for Australia. Climate and Health Alliance; 2017.
- 136 Department of Energy and Water Supply. Stanthorpe regional water supply security assessment. Queensland Government; 2016.
- 137 Southern Downs Regional Council. Stanthorpe 2020 [Available from: <https://www.sdrc.qld.gov.au/our-region/region-information/stanthorpe>].
- 138 Queensland Government. Queensland Drought Situation: Department of Agriculture and Fisheries; 2018 [Available from: <https://data.longpaddock.qld.gov.au/Drought/2018/20180517.pdf>].
- 139 McKenzie S. Supplying over 5000 people with water when the dam runs dry-the Stanthorpe water supply story. Queensland: Institute of Public Works Engineering Australasia; 2020.
- 140 Page D, Marinoni O. Day Zero and pathways to water security for regional towns. *Ecos*. 2020;263:27.
- 141 Inspector-General Emergency Management. Queensland Bushfires Review. Report 2: 2019–20. Queensland Government; 2019.

- 142 World Meteorological Organization. Australia suffers devastating fires after hottest, driest year on record 2020 [Available from: <https://public.wmo.int/en/media/news/australia-suffers-devastating-fires-after-hottest-driest-year-record>].
- 143 Borchers Arriagada N, Palmer AJ, Bowman DM, Morgan GG, Jalaludin BB, Johnston FH. Unprecedented smoke related health burden associated with the 2019–20 bushfires in eastern Australia. *Medical Journal of Australia*. 2020;213(6):282–3.
- 144 Duckett S, Mackey W, Stobart A. The health effects of the 2019–20 bushfires. Submission to the Royal Commission into National Natural Disaster Arrangements. Melbourne: Grattan Institute; 2020.
- 145 Johnston FH, Borchers-Arriagada N, Morgan GG, Jalaludin B, Palmer AJ, Williamson GJ, et al. Unprecedented health costs of smoke-related PM 2.5 from the 2019–20 Australian megafires. *Nature Sustainability*. 2021;4(1):42–7.
- 146 Robson S. Climate and Health: the Future is Now. *Canberra Doctor*. 2020(5).
- 147 Evans J. Canberra Hospital's intensive care ward smoke-filled, surgical stock contaminated during horror bushfire season: ABC News; 2020 [Available from: <https://www.abc.net.au/news/2020-05-25/canberra-hospitals-wards-filled-with-toxic-smoke-this-summer/12279384?nw=0>].
- 148 NSW Department of Primary Industries. NSW State Seasonal Update — December 2019: NSW DPI; 2019 [Available from: <https://www.dpi.nsw.gov.au/climate-landing/ssu/december-2019>].
- 149 Lowitja Institute. Close the Gap. The Close the Gap Campaign Steering Committee. 2021:30–1.
- 150 Australian Government Bureau of Meteorology. Northern Territory in 2019: A very warm and dry year: Bureau of Meteorology; 2020 [Available from: <http://www.bom.gov.au/climate/current/annual/nt/archive/2019.summary.shtml>].
- 151 NESP Earth Systems and Climate Change Hub. Climate Change Science for Northern Australia. National Environmental Science Programme; 2017.
- 152 NESP Earth Systems and Climate Change Hub. Climate change in the Northern Territory: State of the science and climate change impacts. Melbourne: National Environmental Science Programme; 2020.
- 153 Allam L, Evershed N. Too hot for humans? First Nations people fear becoming Australia's first climate refugees: *The Guardian*; 2019 [Available from: <https://www.theguardian.com/australia-news/2019/dec/18/too-hot-for-humans-first-nations-people-fear-becoming-australias-first-climate-refugees>].
- 154 Pendrey CG, Quilty S, Gruen RL, Weeramanthri T, Lucas RM. Is climate change exacerbating health-care workforce shortages for underserved populations? *The Lancet Planetary Health*. 2021;5(4):e183–e4.
- 155 Hall NL, Barnes S, Canuto C, Nona F, Redmond AM. Climate change and infectious diseases in Australia's Torres Strait Islands. *Australian and New Zealand Journal of Public Health*. 2021;45(2):122–8.
- 156 National Aboriginal Community Controlled Health Organisation. Constitution for the National Aboriginal Community Controlled Health Organisation Canberra, Australia: NACCHO; 2011 [Available from: <http://www.naccho.org.au/wpcontent/uploads/NACCHO-CONSTITUTION-RatifiedVer-151111-for-ASIC-.pdf>].
- 157 Faa M. Torres Strait 8 could set 'global precedent' with United Nations human rights fight linked to climate change 2020 [Available from: abc.net.au/news/torres-strait-islanders-fight-government-over-climate-change/12714644].

- 158 Smith A. Torres Strait doctors issue call to arms over climate change impact on Indigenous health 2019 [Available from: <https://www.theguardian.com/australia-news/2019/dec/08/torres-strait-doctors-issue-call-to-arms-over-climate-change-impact-on-indigenous-health>].
- 159 Torres Strait Regional Authority. Torres Strait Adaptation and Resilience Plan 2016–2021. Torres Strait Regional Authority; 2016.
- 160 Cheer K, Watkin Lui F, Shibasaki S, Harvey A, Grainger D, Tsey K. The case for a Torres Strait Islander driven, long term research agenda for environment, health and wellbeing. Australian and New Zealand journal of public health. 2020;44:177–9.
- 161 Rachwani M. 'Extremely dangerous': how much of the heat can western Sydney bear? : The Guardian; 2021 [Available from: <https://www.theguardian.com/australia-news/2021/mar/08/extremely-dangerous-how-much-of-the-heat-can-western-sydney-bear>].
- 162 Climate Council. Untouchable playgrounds: Urban heat and the future of western sydney: Climate Council; 2021 [Available from: <https://www.climatecouncil.org.au/urban-heat-island-effect-western-sydney/>].
- 163 Sweltering Cities. Sydney Summer 2020–21 Survey Report: Sweltering Cities; 2021 [Available from: <https://swelteringcities.org/community-survey/>].
- 164 Purtill J. Heatwaves may mean Sydney is too hot for people to live in 'within decades': ABC Science; 2021 [Available from: <https://www.abc.net.au/news/science/2021-01-24/heatwaves-sydney-uninhabitable-climate-change-urban-planning/12993580>].
- 165 WSROC. Turn down the heat: WSROC; 2018 [Available from: <https://wsroc.com.au/projects/project-turn-down-the-heat>].
- 166 Mental health support available for rural frontline nurses [press release]. <https://crana.org.au/our-community/media-releases/2020/mental-health-support-available-for-rural-frontline-nurses>: CRANAPlus; 2020.
- 167 News 2015: National Centre for Farmer Health; 2015 [Available from: <https://farmerhealth.org.au/category/news-and-media/news/news-2015>].
- 168 McCosker M. Drought status revoked for five Queensland LGAs as state has 'unusual wet season': ABC Rural; 2021 [Available from: <https://www.abc.net.au/news/rural/2021-05-29/queensland-drought-declarations-2021/100165674>].
- 169 Children's Health Queensland Hospital and Health Service. Birdie's Tree: Growing together through natural disasters: Queensland Government; 2021 [Available from: <https://www.childrens.health.qld.gov.au/natural-disaster-recovery/>].
- 170 Menon K, de Courten B, Liew D, Ademi Z, Owen AJ, Magliano DJ, et al. Productivity Benefits of Preventing Type 2 Diabetes in Australia: A 10-Year Analysis. Diabetes Care. 2021;44(3):715–21.
- 171 Australian Bureau of Statistics. Quarterly Population Estimates (ERP) by State/Territory, Sex and Age [Available from: https://stat.data.abs.gov.au/Index.aspx?DataSetCode=ERP_QUARTERLY].
- 172 Australian Bureau of Statistics. Population Projects, Australia, 2017–2066: ABS; 2018 [Available from: https://stat.data.abs.gov.au/Index.aspx?DatasetCode=POP_PROJ_2011#].
- 173 Independent Hospital Pricing Authority. National Hospital Cost Data Collection Report, Public Sector, Round 22 (Financial year 2017–18). IHPA; 2020.

- 174** Australian Institute of Health and Welfare. Health expenditure Australia 2017–18. Canberra: AIHW; 2019. Report No.: 65 Cat. no. HWE 77.
- 175** SGS Economics and Planning. COVID-19 and summer bushfires: The economic impact on your suburb and pathways to recovery 2020 [Available from: <https://www.sgsep.com.au/assets/main/SGS-Economics-and-Planning-COVID-19-and-summer-bushfires-May2020-update.pdf>].
- 176** Biddle N, Bryant C, Gray M, Marasinghe D. Measuring the economic impact of early bushfire detection. ANU Centre for Social Research and Methods; 2020.
- 177** Australian Government Department of the Prime Minister and Cabinet. Best Practice Regulation Guidance Note: Value of Statistical Life. Office of Best Practice Regulation; 2021.
- 178** Pharmaceutical Benefits Advisory Committee. Overview and rationale of the economic evaluation 2016 [Available from: <https://pbac.pbs.gov.au/section-3a/3a-1-overview-and-rationale-of-economic-evaluation.html>].
- 179** Northern Territory Government. Northern Territory Climate Change Response: Towards 2050. Office of Climate Change, Department of Environment and Natural Resources; 2020.
- 180** Northern Territory Government. Large Emitters Policy: Department of Environment, Parks and Water Security; 2021 [Available from: https://depws.nt.gov.au/environment-information/large-emitters-policy/large-emitters-policy?SQ_VARIATION_1042148=0].
- 181** Zhang Y, Barratt A, Rychetnik L, Breth-Petersen M. An Australian glossary on Health and Climate Change. Prepared for: The Human Health and Social Impacts (HHSI) Node, The NSW Adaptation Hub. 2021. Available at: <https://www.sydney.edu.au/content/dam/corporate/documents/faculty-of-medicine-and-health/research/centres-institutes-groups/sustainability-climate-and-health-collaboration/australian-glossary-on-health-and-climate-change.pdf>.

Appendix 1: Literature Review Methods

Search strategies

The search terms used included combinations of keywords (and associated synonyms) that belonged to 5 categories:

- ✦ Healthcare system
- ✦ Climate change
- ✦ Interventions
- ✦ Reviews (to identify global review-level literature on healthcare system responses)
- ✦ Australia (to identify local primary studies on healthcare system responses)

Keywords were entered into appropriate syntax for each individual database and combined with appropriate wildcards. All search strategies are provided below:

Medline via Ovid and Global Health via Ovid strategy

String	Search terms
1	("health care" or healthcare or "health* system*" or "health* service*" or "health* sector*" or "health* facilit*" or "health* network*" or "health* center*" or "health* centre*" or "health* unit*" or "health* department*" or "health* delivery" or "health* infrastructure*" or "health* operations" or hospital* or clinic* or "general practice" or "specialist health*" or "allied health*" or "primary health*" or "primary care" or "secondary care" or "secondary health*" or "tertiary health*" or "tertiary care" or "community health*" or medicine or medical or prescription* or prescrib* or "health* personnel" or "health* professional*" or clinician* or doctor* or nurs* or physician* or "general practi*" or GP or surgeon* or surgery or psychiatr* or obstetric* or gynaecolog* or ophthalmolog* or anaesthe* or anesthe* or "emergency department*" or "emergency care" or "emergency health*" or ED or "intensive care" or ICU or intensivist*).mp.
2	((climat* or "global warming" or sustainab* or emission* or carbon or "net zero" or "greenhouse gas*" or GHG) adj10 (intervention* or program* or strateg* or experiment* or campaign* or trial or initiative* or policy or policies or action* or respon* or adapt* or mitigat* or advoca* or recommendation* or resolution or "position* statement*")).mp.
3	(review* or overview or synopsis or "literature review" or "concept synthesis" or "conceptual framework synthesis model" or "conceptual review" or "critical interpretive synthesis" or "critical literature review" or "evidence synthesis" or "integrative review" or "integrative literature review" or "interpretive synthesis" or "knowledge synthesis" or "meta-aggregation" or "meta aggregation" or "meta-analys*" or "meta analys*" or "meta-ethnography" or "meta ethnography" or "meta-interpretation" or "meta interpretation" or "meta-interpretive" or "meta interpretive" or "meta-narrative" or "meta narrative" or "meta-review" or "meta review" or "meta-narrative" or "meta narrative" or "meta study" or "meta-synthesis" or "meta synthesis" or "mixed-methods review" or "mixed methods review" or "mixed-methods synthesis" or "mixed methods synthesis" or "mixed-methods systematic review" or "mixed methods systematic review" or "mixed studies review" or "mixed-studies review" or "narrative review" or "narrative synthesis" or "rapid review" or "realist review" or "realist synthesis" or "research synthesis" or "review of qualitative studies" or "scoping review" or "systematic literature review" or "systematic review" or "systematic synthesis" or "thematic review" or "thematic synthesis" or "qualitative meta-synthesis" or "qualitative meta synthesis" or "qualitative review" or "qualitative synthesis" or "horizon scan").mp.
4	(Australia* or "New South Wales" or Victoria or Tasmania or Queensland or "Northern Territory" or "South Australia" or "Western Australia" or "Australian Capital Territory" or NSW or ACT or SA or WA or QLD or NT).mp.
5	1 AND 2 AND 3
6	1 AND 2 AND 4
7	5 OR 6
8	Limit 7 to (english language) and yr="2016-Current"

Scopus strategy

String	Search terms
1	TITLE-ABS-KEY("health care" or healthcare or "health* system*" or "health* service*" or "health* sector*" or "health* facilit*" or "health* network*" or "health* center*" or "health* centre*" or "health* unit*" or "health* department*" or "health* delivery" or "health* infrastructure*" or "health* operations" or hospital* or clinic* or "general practice" or "specialist health*" or "allied health*" or "primary health*" or "primary care" or "secondary care" or "secondary health*" or "tertiary health*" or "tertiary care" or "community health*" or medicine or medical or prescription* or prescrib* or "health* personnel" or "health* professional*" or clinician* or doctor* or nurs* or physician* or "general practi*" or GP or surgeon* or surgery or psychiatr* or obstetric* or gynaecolog* or ophthalmolog* or anaesthe* or anesthe* or "emergency department*" or "emergency care" or "emergency health*" or ED or "intensive care" or ICU or intensivist*)
2	TITLE-ABS-KEY((climat* or "global warming" or sustainab* or emission* or carbon or "net zero" or "greenhouse gas*" or GHG) w/10 (intervention* or program* or strateg* or experiment* or campaign* or trial or initiative* or policy or policies or action* or respon* or adapt* or mitigat* or advoca* or recommendation* or resolution or "position* statement*"))
3	TITLE-ABS-KEY(review* or overview or synopsis or "literature review" or "concept synthesis" or "conceptual framework synthesis model" or "conceptual review" or "critical interpretive synthesis" or "critical literature review" or "evidence synthesis" or "integrative review" or "integrative literature review" or "interpretive synthesis" or "knowledge synthesis" or "meta-aggregation" or "meta aggregation" or "meta-analys*" or "meta analys*" or "meta-ethnography" or "meta ethnography" or "meta-interpretation" or "meta interpretation" or "meta-interpretive" or "meta interpretive" or "meta-narrative" or "meta narrative" or "meta-review" or "meta review" or "meta-narrative" or "meta narrative" or "meta study" or "meta-synthesis" or "meta synthesis" or "mixed-methods review" or "mixed methods review" or "mixed-methods synthesis" or "mixed methods synthesis" or "mixed-methods systematic review" or "mixed methods systematic review" or "mixed studies review" or "mixed-studies review" or "narrative review" or "narrative synthesis" or "rapid review" or "realist review" or "realist synthesis" or "research synthesis" or "review of qualitative studies" or "scoping review" or "systematic literature review" or "systematic review" or "systematic synthesis" or "thematic review" or "thematic synthesis" or "qualitative meta-synthesis" or "qualitative meta synthesis" or "qualitative review" or "qualitative synthesis" or "horizon scan")
4	TITLE-ABS-KEY(Australia* or "New South Wales" or Victoria or Tasmania or Queensland or "Northern Territory" or "South Australia" or "Western Australia" or "Australian Capital Territory" or NSW or ACT or SA or WA or QLD or NT)
5	1 AND 2 AND 3
6	1 AND 2 AND 4
7	5 OR 6
8	LIMIT 7 TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) AND (LIMIT-TO (LANGUAGE, "English"))

Cochrane Library strategy

String	Search terms
1	"health care" OR healthcare OR "health* system*" OR "health* service*" OR "health* sector*" OR "health* facilit*" OR "health* network*" OR "health* center*" OR "health* centre*" OR "health* unit*" OR "health* department*" OR "health* delivery" OR "health* infrastructure*" OR "health* operations" OR hospital* OR clinic* OR "general practice" OR "specialist health*" OR "allied health*" OR "primary health*" OR "primary care" OR "secondary care" OR "secondary health*" OR "tertiary health*" OR "tertiary care" OR "community health*" OR medicine OR medical OR prescription* OR prescrib* OR "health* personnel" OR "health* professional*" OR clinician* OR doctor* OR nurs* OR physician* OR "general practi*" OR GP OR surgeon* OR surgery OR psychiatr* OR obstetric* OR gynaecolog* OR ophthalmolog* OR anaesthe* OR anesthe* OR "emergency department*" OR "emergency care" OR "emergency health*" OR ED OR "intensive care" OR ICU OR intensivist* in Title Abstract Keyword AND ((climat* or "global warming" or sustainab* or emission* or carbon or "net zero" or "greenhouse gas*" or GHG) NEAR/10 (intervention* or program* or strateg* or experiment* or campaign* or trial or initiative* or policy or policies or action* or respon* or adapt* or mitigat* or advoca* or recommendation* or resolution or "position* statement*")) in Title Abstract Keyword — (Word variations have been searched)

Health Systems Evidence strategy

String	Search terms
1	(climat* or "global warming" or sustainab* or emission* or carbon or "net zero" or "greenhouse gas*" or GHG)

Social Systems Evidence strategy

String	Search terms
1	"health care" OR healthcare OR "health* system*" OR "health* service*" OR "health* sector*" OR "health* facilit*" OR "health* network*" OR "health* center*" OR "health* centre*" OR "health* unit*" OR "health* department*" OR "health* delivery" OR "health* infrastructure*" OR "health* operations" OR hospital* OR clinic* OR "general practice" OR "specialist health*" OR "allied health*" OR "primary health*" OR "primary care" OR "secondary care" OR "secondary health*" OR "tertiary health*" OR "tertiary care" OR "community health*" OR medicine OR medical OR prescription* OR prescrib* OR "health* personnel" OR "health* professional*" OR clinician* OR doctor* OR nurs* OR physician* OR "general practi*" OR GP OR surgeon* OR surgery OR psychiatr* OR obstetric* OR gynaecolog* OR ophthalmolog* OR anaesthe* OR anesthe* OR "emergency department*" OR "emergency care" OR "emergency health*" OR ED OR "intensive care" OR ICU OR intensivist* <i>Filtered by: Climate Action and Document Types: Overview of systematic reviews, Systematic reviews of effects and Systematic reviews addressing other questions</i>

Google Scholar strategy

String	Search terms
1	"Health care" OR healthcare OR "health system" OR "health sector" AND "climate change" AND review

Eligibility criteria

Studies were included if they met the inclusion criteria provided below.

	Include	Exclude
Study Type	Systematic, narrative and scoping reviews Primary studies from Australia — Australian lead author and / or majority authorship team from Australia / intervention conducted in Australia	Book chapters, theses, commentaries, editorials, review protocols
Population	Networks or groups of: Healthcare professionals, health services (at all levels e.g. individual practice, pre-hospital care, inpatient settings), specialist colleges / disciplinary groups, policymakers <i>Australian healthcare systems</i> refers to healthcare infrastructure, personnel and operations in all states and territories, including hospitals, general practice, specialist and allied health services, medical colleges, primary health and local hospital networks, Aboriginal community-controlled health organisations and medicines and prescriptions.	
Study Design	Any	
Study Setting	Reviews based on healthcare settings in any country Primary studies based in Australia	Stand-alone recommendations or policy guidelines from countries other than Australia
Intervention	Actions / responses taken by or based in healthcare systems as defined above to mitigate and adapt to climate change	
Outcome	Any	
Publication status	No restrictions	
Time period	Studies published from 2016 onwards (inception of the Paris agreement)	
Language	English only	Other languages

Appendix 2: Results of Study Selection and Quality Appraisal

Study selection results

Following database searching and deduplication (see Appendix 1), a total of 4409 citations were identified. Following independent dual screening of titles and abstracts, 165 publications were reviewed in full text. A total of 17 reviews met inclusion criteria. These comprised 4 systematic reviews and 13 narrative reviews. One of the included reviews which was not yet indexed in the databases was identified through hand searching.

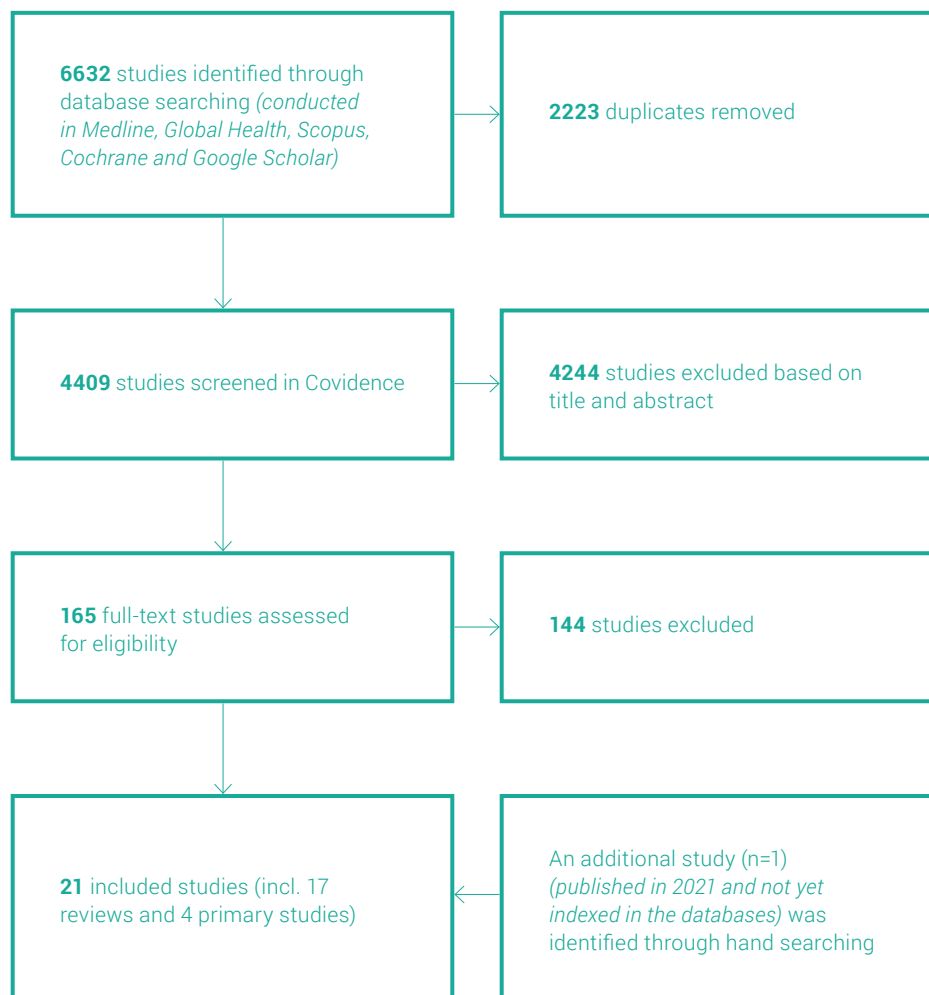


Figure 2. PRISMA flow diagram

Systematic review quality appraisal results

Criterion (AMSTAR 2)	Bali (2020)	Dupraz (2021)	Lenzer (2020)	Purohit (2021)
1. Did the research questions and inclusion criteria for the review include the components of PICO?	Y	Y	Y	Y
2. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?	N	N	Y	N
3. Did the review authors explain their selection of the study designs for inclusion in the review?	N	Y	N	Y
4. Did the review authors use a comprehensive literature search strategy?	PY	PY	Y	PY
5. Did the review authors perform study selection in duplicate?	N	Y	N	N
6. Did the review authors perform data extraction in duplicate?	N	Y	N	N
7. Did the review authors provide a list of excluded studies and justify the exclusion?	N	N	N	N
8. Did the review authors describe the included studies in adequate detail?	N/A	N	Y	N
9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	N/A	N/A	N	N
10. Did the review authors report on sources of funding for the studies included in the review?	N	N	N	N
11. If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?	N/A	N M/A	N M/A	N M/A
12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	N/A	N M/A	N M/A	N M/A
13. Did the review authors account for RoB in individual studies when interpreting/discussing the results of the review?	N/A	N/A	N	N
14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results?	N/A	Y	N	N
15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	N/A	N/A	N/A	N/A
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	N	Y	Y	Y
TOTAL yes / applicable items	2 / 9	7 / 11	5 / 13	4 / 13

PY = Partial Yes; N/A = Not applicable; N M/A = no meta-analysis conducted

Narrative review quality appraisal results

Criterion (SANRA)	Allwright (2020)	Barracough (2020)	Bravo (2020)	Beloeil (2021)	Brown (2020)	Dhillon (2015)	Guetter (2018)	Holmner (2012)	McGain (2020)	Molero (2020)	Palinkas (2020)	Startup – Hansen (2020)	Yates (2021)
1. Justification of the article's importance for the readership	1	2	2	2	1	2	2	2	2	2	2	2	2
2. Statement of concrete aims or formulation of questions	2	1	2	2	1	1	2	1	1	1	2	1	2
3. Description of the literature search	2	0	0	0	1	1	2	0	0	0	2	0	1
4. Referencing	2	2	2	2	2	2	2	2	2	2	2	2	2
5. Scientific reasoning	0	0	0	0	0	0	1	0	0	0	2	0	1
6. Appropriate presentation of data	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL / 12	8	6	7	7	6	7	10	6	6	6	11	6	9

Appendix 3: Summary of Health System Responses Identified Across All Review Studies (High Quality Reviews Bolded)

Hospital-level (n=8)

Intervention	Outcome	Review Source (n studies)
Training and education	Reduced chemical use and improvements in waste disposal; reduced cost of disposable equipment in surgery	Dupraz et. al. 2021 (1); Beloeil 2021 (1); Guetter 2018 (1); Bravo 2020 (1)
Heating, ventilation, air conditioning (HVAC) and fans	Improved blood pressure, respiratory rate and cardiac function (particularly in patients with chronic disease); earlier mobilisation; and reduced length of hospital stay	Lenzer 2020 (11)
Donating unused medical supplies to countries in need	Pilot programs have demonstrated effectiveness	Guetter 2018 (3); Bravo 2020 (1); Brown 2020 (1)
Energy efficiency measures (upgrading and adjusting HVAC; changing to LED lights; shortening operation duration; running multiple ORs; power down when idle; more efficient steriliser usage)	Lower costs; improved surgical outcomes; less glare (LED lights); energy savings; water savings Energy-efficiency plans have saved 800k–USD \$3 million annually	Yates 2021 (4); Bravo 2020 (3); Dhillon 2015 (1); Brown 2020 (2); Palinkas 2020 (4); McGain 2020 (1)
Using hard cases instead of wrap for sterilisation	Reduced cost	Bravo 2020 (1); Brown 2020 (1)
Green building design (site near transport; use local materials; trees on site; natural lighting and ventilation; water harvesting; green roofs)	No difference in overall cost compared to non-green building; improved health of occupants; water conservation	Dhillon 2015 (6); McGain 2020 (2)
Recycling in operating room, hospital and dialysis	Lower carbon footprint; financial savings; circular economy benefits	Beloeil 2021 (2); Bravo 2020 (1); Barraclough 2020 (1); Brown 2020 (1); McGain 2020 (3)
Reduce unnecessary lab test ordering in clinical laboratories (through EMR alerts)	Reduces cost	Molero 2020 (4)

Community-level (n=4)

Intervention	Outcome	Review Source (n studies)
Training and education	Program feasible and high adherence rate	Dupraz et. al. 2021 (1)
Telemedicine	Telemedicine reduces the carbon footprint of healthcare compared to face-to-face consultations where travel-related savings are sufficient to offset the carbon footprint of the telemedicine service; can reduce hospital referrals and face-to-face consultations and create economic savings in dermatology	Purohit 2021 (14); Yates 2021 (2) ; Allwright 2020 (5) ; Holmner 2012 (5); McGain 2020 (1)
Mental health services	Evidence is strongest for interventions following acute climate-related events (e.g. floods, fires); less strong for long-term events (e.g. drought) and weakest for long-term, permanent changes (e.g. higher temperature, sea level rise)	Palinkas 2020 (23)
Energy efficiency measures (solar power)	Reduced power consumption	Barracrough 2020 (5)

Interventions in operating rooms (n=16)

Anaesthesia

Intervention	Outcome	Review Source (n studies)
Anaesthetic gas scavenging	Shown to be efficient; decreased climate impact; limits rebreathing of volatile gases	Guetter 2018 (1) ; Yates 2021 (2) ; Holmner 2012 (2); McGain 2020 (8)
Use isoflurane or sevoflurane instead of desflurane where able	Lower environmental contribution to warming	Yates 2021 (3) ; Beloeil 2021 (3)
Lower the gas flow rate in anaesthesia	Can significantly decrease the yearly amount of volatile agent used, yielding both an environmental and cost benefit; safe	Yates 2021 (2) ; Beloeil 2021 (1) ; McGain 2020 (6)
Use IV anaesthesia	Environmental benefits	Yates 2021 (1) ; McGain 2020 (2)
Wide-awake hand surgery (local anaesthetic)	Reduced cost and reduced waste; no need for preoperative testing	Bravo 2020 (5) ; Brown 2020 (3)
Reusable laryngeal mask airway, rigid laryngoscope handles and blades, BP cuffs	Reduced carbon footprint, reduced cost (however varies depending on country's power source)	McGain 2020 (8)
Change and wash anaesthesia breathing circuits weekly instead of daily	No compromise in patient safety; water savings	McGain 2020 (2)

Surgery

Intervention	Outcome	Review Source (n studies)
No antibiotics in hand surgery, fat grafting, rhinoplasty	No compromise in safety	Brown 2020 (5)
Clean rather than sterile gloves in Mohs surgery	No compromise in safety	Brown 2020 (1)
Reduce use of closed suction drains in breast reduction and abdominoplasty	No compromise in safety	Brown 2020 (5)
Multiple (cataract) surgeries in one room	Reduced waste and reduced infection rates	Bravo 2020 (1)
Environmentally Preferable Purchasing	Can achieve significant GHG reductions without compromising cost, clinical efficacy nor efficiency; reduces expenditure	Yates 2021 (1) ; McGain 2020 (2)
Audit and feedback of operating costs	Reduces expenditure	Brown 2020 (1)
Reducing size of pre-packed surgical instrument bundles	Can cut energy use, reduce waste and save money	Yates 2021 (1) ; Brown 2020 (2)
Surgical hand antiseptic rather than water scrub; use of motion sensors	Reduced water use	Brown 2020 (1); McGain 2020 (1)
Reusable textiles	Can reduce waste and save money; much lower environmental impact	Yates 2021 (1) ; Beloeil 2021 (6) ; Bravo 2020 (1) ; Brown 2020 (2); McGain 2020 (1)
Reprocessing single-use devices	In 2018 reprocessing in the US saved \$471 million and 7000 tons of medical waste; lower carbon footprint; no evidence of patient harm	Yates 2021 (1) ; Beloeil 2021 (1) ; Bravo 2020 (2) ; McGain 2020 (4)

Interventions in specialised settings (n=6)

Dialysis

Intervention	Outcome	Review Source (n studies)
Reverse osmosis reject water recycling	Reduced water use, financial savings	Barracclough 2020 (6)
Reduced dialysate flow rates	Emerging evidence that rates can be lowered without compromising patient safety	Barracclough 2020 (5)
Waste minimisation	Reduction of waste	Barracclough 2020 (1)
Point-of-care dialysate generation	Reduce dialysate transport costs	Barracclough 2020 (2)

Respiratory medicine

Intervention	Outcome	Review Source (n studies)
Use dry powder inhalers instead of pressurised metered dose inhalers where safe to do so	Lower carbon footprint, cost savings / cost neutral	Starup – Hansen 2020 (8)
Dispose of metered dose inhalers correctly	Lower carbon footprint	Starup – Hansen 2020 (1)

Appendix 4: Overview of Included Reviews

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Systematic reviews: higher quality (n=1)				
Dupraz (2021) 7/11 137 studies Oct 2020	To examine the awareness, preparedness and the role of healthcare professionals to inform about the impact of climate change on health and the effectiveness of interventions mediated by health professionals aimed at reducing the environmental impact of human activities	General	General	✦ Only two studies evaluated interventions aimed at changing the decisions, behaviours or habits of patients, healthcare professionals or other stakeholders to mitigate climate change consequences ✦ A training and education intervention targeting housekeeping and food departments within hospitals reported improvements in the use of cleaning chemicals and waste disposal ✦ An adult education program focused on energy use and sustainability and coupled with mindfulness and meditation was found to be feasible and had high adherence ✦ Recommendations targeting healthcare and public health professionals to encourage action against the negative health effects on climate change have been largely unsupported by evidence ✦ Given that healthcare professionals are generally trusted by the public, it is critical that the recommendations and actions they propose are supported by robust evidence

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Systematic reviews: lower quality (n=3)				
Lenzer (2020) Scoping review 5/13 11 studies April 2019	To systematically screen the evidence on heating, ventilation and air conditioning (HVAC) use and associated clinical effects or health-related outcomes in inpatients	Setting-specific (Hospital)	Intervention-specific (heating, ventilation and air conditioning)	- When applied while experiencing heat, reported benefits of HVAC use included improved blood pressure, respiratory rate and cardiac function (particularly in patients with chronic disease), earlier mobilisation and reduced length of hospital stay - Despite the amount of evidence confirming the negative effects of heat on health, research on hospital adaptation and treatment of inpatients is lacking - Further research into the use of HVAC is needed to inform development of evidence-based guidelines
Purohit (2021) 4/13 14 studies May 2020	To review the evidence on the carbon footprint of telemedicine	General	Intervention-specific (Telemedicine)	- Telemedicine was consistently reported to reduce the carbon footprint of healthcare compared to face to face consultations, mostly through travel-related savings - While savings were highly context specific (e.g. dependent on the population density of the region and transport infrastructure), the most comprehensive life cycle analysis estimated that a telerehabilitation service became carbon cost-effective when the patient travel distance exceeded 7.2km - In order to assess whether these programs are carbon-effective, future research should include life cycle analysis for telemedicine equipment and modes of transport to produce accurate estimates of carbon footprint
Bali (2020) 2/9 0 studies January 2020	To establish if strategies to reduce greenhouse gas emissions in the ED could succeed while maintaining comparable care standards	Discipline-specific (Emergency medicine)	General	- The search did not identify any papers containing data or observations of the impact of strategies to reduce greenhouse gas emissions in the emergency department (ED), either clinically or environmentally - This review highlighted the need to observe the impact of efforts to reduce greenhouse gas emissions in EDs

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Narrative reviews: higher quality (n=7)				
Palinkas (2020) 11/12 23 studies October 2020	To identify and describe the different types and characteristics of evidence-informed and evidence-based interventions for the prevention and treatment of mental and behavioural problems associated with the three forms of climate change events	Discipline-specific (Mental health)	General	✦ Mental health service providers are increasingly needed to deal with the consequences of acute, sub-acute and long-lasting changes to the environment due to climate change ✦ Currently utilised services (e.g. mental health first aid, integrated mental health and disaster preparedness and psychological treatment interventions) and those that will be developed in response to acute events will likely have a key role in addressing the mental health consequences of longer term events ✦ As mental health problems associated with climate change begin to impact larger subsets of the population, solutions will likely rely on implementation of policies and programs to mitigate the impact of climate change on the physical environment and mental health professionals are well positioned to advocate for such policies in order to mitigate the likelihood and scale of sub-acute impacts and longer lasting forms of climate change
Guetter (2018) 10/12 37 studies September 2017	To perform a narrative review of the literature around sustainability in the Operating Room to better inform action plans for impactful greening in the operating room	Setting-specific (Operating room)	General (reducing waste)	✦ Surgeon education on waste and cost reduction and energy efficiency plans were identified as strategies to reduce the negative impact of surgery on the environment ✦ Recycling is often not performed adequately within operating rooms – key barriers include lack of recycling facilities and information and staff attitudes ✦ Financial savings and incentives need to be leveraged, as few organisations will be in a position to direct resources away from patient health towards planetary health ✦ While this study provides a comprehensive overview of strategies to reduce operating room waste, relevant literature was limited and most references were opinion papers, white papers and small case studies – further prospective research is required

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Yates (2021) 9/12 Not stated Not stated	To review the existing research on environmentally sustainable surgical practices to enable surgeons, anaesthesiologists and obstetricians to incorporate environmental sustainability in the operating room	Discipline - specific (Surgery, anaesthesia, obstetrics)	General	✦ While previous efforts to improve sustainability in operating rooms have been limited, the majority have resulted in environmental and financial benefits, including those to improve energy use e.g. updating old or inadequate heating, ventilation and air conditioning systems ✦ After energy use within the built environment, consumables are the second major driver of greenhouse gas emissions within surgery ✦ Implementing reusable textiles, reprocessing single use devices, staff education and providing smaller 'red bag' bins can reduce waste and result in cost savings ✦ While there is low adoption thus far, novel technologies for recapturing and recycling expired volatile anaesthetics could decrease the climate impact of each surgery ✦ Much of the research thus far is focused on isolated case studies and further work is required to determine the environmental impact of common surgical procedures and demonstrate cost-savings — improved financial data will address a large barrier ✦ While awareness of sustainable practices is increasing, further advocacy, education and research are need to guide and encourage future interventions
Allwright (2020) 8/12 20 studies April 2020	To systematically investigate lean care systems and low carbon alternatives with a focus on dermatology	Discipline-specific (Dermatology)	General	✦ This review identified examples of evidence-based environmentally sustainable practice applicable to dermatology, however most were theoretical models rather than evaluations of interventions and a number reported the potential contribution of carbon-reducing practices in the absence of outcome data ✦ The annual carbon emissions created from material waste for Mohs micrographic surgery was 644kg for all UK treatment centres — changes have since been implemented to reduce this footprint, including reviewing equipment packs and increasing recycling ✦ Teledermatology in the Catalan region reduced face-to-face consultations by 69% resulting in both economic savings and a reduction in carbon emissions by 21 tonnes over 18 months ✦ More research is required to determine the benefits of evidence-based practices that can be incorporated into dermatology practice, but until then, sustainable travel, and review of equipment packs, pharmaceuticals and waste management should be encouraged

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Beloeil (2021) 7/12 Not stated Not stated	To support and encourage operating room professionals to take an active role in implementing sustainability as an integral part of their practice	Setting-specific (Operating room)	General	✦ Applying the 5Rs rule (reduce, reuse, recycle, rethink and research) to operating room waste management can reduce the environmental footprint ✦ The benefits and costs of disposable and reusable devices should be considered (financial and environmental) ✦ A strategy to reduce greenhouse gas emissions from anaesthetic gases could involve avoiding the use of nitrous oxide, choosing halogenated gas with the lowest environmental impact and incorporating low fresh gas flow ✦ Given that procurement is a major contributor to healthcare facilities' carbon emissions, promoting sustainable purchases sets a positive example ✦ Education, training and staff involvement and partnerships across disciplines are key to reducing waste
Bravo (2020) 7/12 Not stated Not stated	To propose multiple ways to reduce both material and nonmaterial waste-energy consumption, sterilisation techniques, reprocessing of devices, patient transportation, production of surgical supply, anesthesia and sanitation in hand surgery	Discipline-specific (Hand surgery)	General	✦ Determining the magnitude of the impact of hand surgery on the environment and identifying sources of contribution are critical to identify opportunities for waste reduction targeting the highest contributors ✦ Educating surgeons, changing operating room policies and incentivising energy conservation and waste reduction incentives will drive the process forward ✦ Using sustainable vendors within the medical device production industry and working with them to reduce the amount of paper and plastic in packaging and eliminate the use of unnecessary booklets can also drive manufacturing-related air pollution and emissions
Dhillon (2015) 7/12 Not stated Not stated	To understand the meaning of 'green hospital', to identify the many ways in which the health sector is contributing towards climate change, to explore possibilities for countering this grave trend and to look for institutions that are pioneering change	General	General	✦ Green hospitals are those that conserve energy and water; have alternative means of energy generation; manage waste appropriately; reduce transportation costs and provide healthy food ✦ By implementing simple, smart and sustainable measures, hospitals can significantly reduce their negative impact on the environment ✦ Healthcare facilities in India and around the world have demonstrated that high quality patient care and environmental sustainability are not mutually exclusive

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Narrative reviews: lower quality (n=6)				
Barracclough (2020) 6/12 Not stated Not stated	To outline the relationship between environmental change and kidney diseases and discuss the environmental impact of kidney care delivery, with a focus on dialysis. Also to highlight the existing opportunities to reduce the carbon footprint of kidney care as well as areas for future research	Discipline-specific (Nephrology)	General	✦ Dialysis is one of the most carbon intensive areas of healthcare and considering resource use and waste minimisation are insufficient to address this impact ✦ Capturing and reusing reverse osmosis reject water, utilising renewable energy, improving waste management and reducing dialysate flow rates represent opportunities to reduce the environmental impact of haemodialysis ✦ For peritoneal dialysis, opportunities include improving packaging materials and point of care dialysate generation ✦ Within dialysis facilities, baseline auditing of water and energy usage and waste production should be considered as projects such as reverse osmosis water recycling and renewable energy generation have the potential to provide environmental and financial benefits
Brown (2020) 6/12 Not stated Not stated	To survey literature related to climate change and operating room practices	Setting-specific (Operating room)	General	✦ This review identified four types of interventions that a surgeon can consider to reduce their carbon footprint: material (e.g. appropriate disposal of infectious waste, reusing devices and surgical gowns and recycling), energy (e.g. reducing energy consumption), technique (e.g. reducing unnecessary anaesthesia) and dissemination (e.g. appropriate purchasing) — all strategies aim to decrease the manufacturing of new materials, the need to process wastes and ultimately costs ✦ While there may be administrative obstacles to greener operating rooms, these can be overcome given the financial benefits of making environmentally-minded decisions

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Holmner (2012) 6/12 Not stated Not stated	To review and discuss the literature regarding health sector mitigation potential, known and hypothetical co-benefits and the potential of health information technology, such as eHealth, in climate change mitigation and adaptation	General	Intervention-specific (eHealth)	- While knowledge on the environmental impact of eHealth is limited and there are few examples of eHealth as an adaptation strategy – further research to provide an evidence base is required - However national and international trends towards green information and communication technology (ICT) suggest that eHealth is a promising solution to reduce the health sector's carbon footprint and the transition may be easier for countries with well-developed ICT infrastructure - The potential for reducing local carbon footprints will be dependent on the number of technology users, the number of face-to-face appointments that can be replaced with telehealth and the distance and type of transportation that will be avoided - Policies that support the development of technology and sustainable structures and build capacity are the key to change
McGain (2020) 6/12 Not stated Not stated	To survey the 'state of the art' environmental sustainability research in anaesthesia and critical care, addressing why it matters, what is known and ideas for future work	Discipline-specific (Anaesthesia and critical care)	General	- Anaesthesia and critical care contribute considerably to healthcare-attributable pollution but significant progress has been made in recent years to improve research focused on environmentally sustainable healthcare - The following activities should be avoided, where possible: the use of anaesthetic gases with high global warming potential; excessive use of plastic syringes; use of disposable theatre attire; anaesthetic machine use after hours - Changing anaesthetic breathing circuits weekly is as safe as daily changes - Donation of useful anaesthetic equipment to less developed nations can also have environmental benefits - Water required for washing means that reusable equipment can have a slightly higher carbon footprint than single-use items in Australia - Where possible, desflurane should be avoided and the use of other anaesthetic gases should be minimised; excessive use of plastic syringes and use of disposal theatre attire should be avoided

Author(Year) Quality Score N studies Date of most recent search	Aim	Area of focus within the healthcare system	Response to climate change	Key findings / conclusions
Molero (2020) 6/12 Not stated Not stated	To analyse the state of the art in research on healthcare and sustainability by exploring the literature on different care systems and their relations with the environment	General	General	✦ The financial benefits of improving sustainability within hospitals are clear, but there is still a long way to go until environmentally-friendly hospitals and healthcare services and infrastructure become the norm ✦ There is a real focus on individual responsibility and waste management to reduce our environmental footprint, but this is likely to be insufficient and changes need to be made across the entire value chain ✦ Laboratories need to promote operational excellence; responsible use of natural resources; engage their workforce to implement sustainable practices; develop rational test ordering policies; participate in disease prevention and promote emerging technologies and innovative models of care
Starup — Hansen (2020) 6/12 Not stated Not stated	To review the evidence for the environmental impact of pressurised metered dose inhalants (pMDIs)	Discipline-specific (Respiratory)	Inhaler prescribing	✦ The carbon footprint of dry powder inhalants (DPIs) is 18 times lower than that of pressurised metered dose inhalants (pMDIs) but there is currently a lack of clinician awareness of the carbon footprint of different inhaler types — there is scope to increase this through clinician education / implementation of guidelines ✦ pMDIs are often disposed of inappropriately, further contributing to their negative environmental impact ✦ Inhalers with lower global warming potential should be used in cases where they are likely to be equally effective as the alternative

Appendix 5: Overview of Included Australian / AoNZ Primary Studies

Author(Year) N participants Study type	Aim	Key findings / conclusions
Systematic reviews: higher quality (n=1)		
Barracough (2019) 71 dialysis facilities Cross-sectional survey	The green dialysis survey aimed to (i) establish a baseline for environmental sustainability across Victorian dialysis facilities and ii) guide future initiatives to reduce the environmental impact of dialysis delivery	✦ This survey highlighted limited climate change preparedness within Victorian dialysis facilities ✦ While the majority of facilities reported performing well with appropriately separating waste, only a limited number audited waste or provided staff education about appropriate waste management — audits could help to provide information about baseline practice and scope for improvement ✦ Most dialysis services are not actively attempting to address transport-related emissions but can all inform patients and staff about the multiple benefits of active transport ✦ There is a lack of consideration given to the environmental sustainability of procurement processes which could be improved by including measurable sustainability criteria in procurement contracts is required
Chandra (2020) 47 participants Cross-sectional survey	To obtain baseline data in 2019 on the opinions of AoNZ ophthalmologists on climate change, sustainability and the role of ophthalmologists in responding to these issues, as well as information on the extent that ophthalmology practices are acting on sustainability	✦ The majority of responding AoNZ ophthalmologists shared mainstream opinions on climate change, accepting responsibility for reducing waste and advocating for public health within environmental policy ✦ This survey indicated that many suggested sustainability practices (e.g. around reducing waste, emissions, energy use and use of paper) were only taken up by a small number of ophthalmology practices and departments ✦ Sustainability was largely not considered within management practices and fewer than 20% of respondents expressed a position on sustainability, training on sustainability, carbon offsetting or discussions in staff meetings

Author(Year) N participants Study type	Aim	Key findings / conclusions
McGain (2016) N/A Routine data analysis of four steam sterilisers in one hospital	To identify opportunities to improve electricity and water use related to steam sterilisation	✦ The analysis identified that sterilisers were idle for approximately half of the year and were only turned off 15% of the time ✦ Two switch-off strategies provide opportunities to improve steriliser use efficiency and could lead to large environmental savings: ✖ Switching off idle sterilisers would save at least one quarter of electricity use and 13% of water use, resulting in a saving of over \$13800 and reduction of 80 tonnes of CO2 emissions ✖ Switching one steriliser off from 10am and a second one from midnight could also lead to electricity, water and financial savings and a reduction of approximately 35.8 tonnes of CO2 emissions ✦ These scenarios do not require any financial outlay and could have significant financial and environmental benefits and the learnings could be applied to other scenarios within hospitals
Tonmoy (2020) N/A Overview of an engagement process	To demonstrate an innovative engagement process used to develop climate adaptation policy with the health and wellbeing sector of the State of Queensland, Australia	✦ Data were collected on the impact of climate change on human health and wellbeing in Queensland; barriers to successful adaptation in the region; adaptation opportunities and priorities to support successful adaptation ✦ Key elements of the engagement and knowledge co-development strategy, which could be applied to other locations included: ✖ Adopting a holistic definition of the health and wellbeing sector ✖ Co-development of the adaptation policy with sector stakeholders ✖ Focusing on the co-benefits of mitigation and adaptation for the health and wellbeing sector ✖ Governance (i.e. ensuring governance, regulatory and reporting mechanisms are clearly understood) ✖ Engagement (i.e. long-term and ongoing engagement with all parts of the sector to ensure effective implementation) ✖ Interdisciplinary approach (i.e. participation of service managers, researchers, clinicians and practitioners) ✖ Acknowledging diverse challenges among different care settings and tailoring adaptation solutions accordingly

Appendix 6: Study Design & Methods: Policy & Institutional Analysis

Study design & methods

The approach to policy and institutional analysis used a standard qualitative methodology, including a literature review, semi-structured interviews and thematic data analysis, commonly used in health and policy research.

Literature review

This comprises a short, critical scoping review, using a semi-systematic, snowball technique to find ‘press and policy’ material (i.e. media reports, government policy, official reports, public submissions, stakeholder commentaries, corporate reports, etc.), as well as relevant scholarly works. NB: Given resource limits, this will exclude social media, except on expert advice.

High-level analysis of climate–health policy performance began with the CAHA National Framework and The RACP policy. Other ‘thought leaders’ used include the MJA-Lancet Countdown, Health Care Without Harm, Charlesworth et al. (2018), the Grattan Institute, Climate Action Tracker, etc. Together with carbon footprint analyses, these helped identify key stakeholders and additional documents. Texts on qualitative and political economy analysis guided methods. Social media was excluded. In all, around 300 documents were used.

Semi-structured interviews

Invitations to interviews were accompanied by an explanatory statement and consent form, in accordance with Monash University’s ethics procedures. Care was taken to retain the confidence of each informant, including anonymizing their views and being sensitive to any risks to their position from participation. This helps to reduce messenger bias, encourages open discussion, and improves the quality of data collected.

Semi-structured interviews were used to allow informants some latitude and freedom to talk about what is of interest or importance to them, making room for the conversation to go in unexpected directions, rather than the interviewer presuming to know all salient questions a priori.

Sampling

16 informants were selected based on internal expert advice, the literature review, and on the advice of other informants.

Sampling aimed to yield a balanced mix of views, experience, background, roles, and influence, including:

- ✦ Individuals with a good current and historical understanding of healthcare systems, health policies, the political economy of health.
- ✦ A fair to high level of knowledge of and experience in health and climate change (adaptation and/or mitigation)
- ✦ Experience in service delivery, policymaking, research, and/or various clinical professions
- ✦ Perspectives from the public (federal/state/local), community, and private sectors
- ✦ Marginalized and/or non-traditional voices (e.g. Indigenous health, rural health, aged care, nursing, consumers/patients, building management, institutional investment, legal/insurance, pharmaceutical/equipment supplies, procurement, hospital executives, etc.)

Guiding questions

Questions were drafted and tested with internal advisors for relevance, accessibility, and clarity.

- ✦ What's the big problem with climate and health?
- ✦ What does good policy look like? Who is doing climate–health policy well?
- ✦ How and where is policymaking done?
- ✦ Who are the key policy actors? What makes them tick? What hurdles do they face?
- ✦ Where should climate health policy be in three years?
- ✦ Is it the right time? Is there a mandate for reform? Are there any windows of opportunity?
- ✦ What can The RACP and partners contribute? Where are they best to put their efforts?
- ✦ Who should we speak to learn more? Is there anything else you would like us to know?

Informants

Designation	No. in sample	Code used in text
Senior Policymaker	4	SPM
Policymaker	2	PM
Hospital Operations Manager	1	HOM
Health Services Leader	1	HSL
Health Consumer Advocate	1	HCA
Health Communications Professional	1	HCP
Health Systems Researcher	5	HSR
Clinician, Researcher & Advocate	1	CRA

The designations listed here are intended to indicate our best assessment of each informant's current role. Each has held a number of roles, formal and/or informal, which we seek to bring out in the list below.

Sample characteristics

- ✦ All but three informants had at least 5-years' experience in the health sector; nine had at least 20, and five had at least 40
- ✦ Eleven are female
- ✦ To the best of our knowledge, all but one was born/raised in Australia; none identifies as Indigenous
- ✦ At least four have worked in Indigenous health;
- ✦ Nine hold or have held positions at director level or above in the public service; three have served in the APS; at least two in the Department of Health
- ✦ Ten have worked or do work in hospitals and/or health services
- ✦ Two have trained and worked in allied health and one other in aged care
- ✦ Eight are trained medical doctors; one of is a practising clinician; six of which work or have worked in preventive/public health; two of which have/do work/ed in biomedical research
- ✦ Six work or have worked in rural/remote health, including (at least) two in the Northern Territory, on in North Queensland, and on in rural NSW
- ✦ Eleven have experience in climate-related policy development; four in implementation
- ✦ All but one, in some way, have experience in policy advocacy; three professionally
- ✦ At least twelve work or have worked in civil society organizations

Limitations

For practical reasons, coding of interviews was done by a single author (CW), according to a tight schedule, and was done manually. A semi-structured approach to the interviews allowed both interviewer and interviewee considerable flexibility. This made it possible to tailor the order and follow-up questions to the informant's particular expertise. Although this was minimized, it quite possibly influenced responses. Conversely, the technique allows (and deliberately so) informants to take conversations in directions that interested them. Informant selection was guided, initially, by advice by experts at The RACP, CAHA, and MSDI, as well as the chapter author's own initiative. While we endeavoured to recruit a balanced mix of people with expertise on health systems around the country, state and federal, and from the public, research, private, and community sectors – and across clinical, service, and policymaking levels – we were ultimately constrained by time and informants' availability. Naturally, a surge in cases of COVID-19 also affected recruitment. While we gave a firm assurance to keep informants' identity confidential, we were unable to speak to more than one serving, senior Commonwealth official. At least two other informants, however, had served in the APS; one in a senior role in the federal Department of Health. Regrettably, we were unable to speak to anyone in private health. Hence, our sample was not ideal and may have skewed our analysis somewhat.

Appendix 7: Additional Policy and Institutional Analysis Tables

Key agencies administered by the Commonwealth Department of Health and relevant health programs related to climate change

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Australian Commission on Safety and Quality in Healthcare	Climate Risk Module in development	Voluntary application by institutions wishing to include as part of their accreditation	A Sustainable Environment Advisory Group to provide expert technical advice and guidance on the development of a Climate Risk Module only commenced in 2021
Australian Health Protection Principal Committee		Key decision making committee for health emergencies	
National Health and Medical Research Council	Has established the NHMRC Special Initiative in Human Health and Environmental Change (SIHHEC), a \$10 million grant over 5 years for a single, multidisciplinary, nationally focused, collaborative network of researchers across Australia	The work of this network will help to protect the health of the Australian community and build a resilient and responsive health system	Not yet awarded
All Australian Governments	Health Ministers' Meeting Forum (formerly Health Council)	Forum for cooperation on health issues of national importance which require strategic cross-border collaboration	No obligation to consider climate change, nor any workplan that refers to climate change
Federal Department of Health	Australia's Long Term Health Plan	Ten year plan for mental health, primary care, hospitals, preventive health and medical research	Does not reference climate change or environmental health
Federal Department of Health	Aboriginal and Torres Strait Islander Health Plan 2013–2023	Intended to guide policies and programs to improve Aboriginal and Torres Strait Islander health	
Department of Health	Medical Research Future Fund		Does not include any criteria or objectives in relation to climate change
Federal Department of Health	Pharmaceutical Benefits Scheme (PBS)	Lists all of the medicines available to be dispensed to patients at a Government-subsidised price	

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Council of Australian Governments (COAG)	National Agreement on Closing the Gap	Commits to raising the life expectancy of Aboriginal and Torres Strait Islander people to parity with non-Indigenous populations by 2031	
Department of Health	National Preventive Health Strategy (draft in development in 2021)	Intended to provide an overarching, long-term approach to prevention in Australia by building systemic change. To identify areas of focus for the next 10 years and evidence-based approaches to help Australians improve their health at all stages of life, through early intervention, better information, and targeting risk factors and the broader causes of health and wellbeing	Included reference to climate change following targeted advocacy by health and medical groups in response to earlier draft in 2020. Commits to developing a national environmental health strategy by 2030

Key agencies administered by the Commonwealth and relevant programs related to climate, energy and environment

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Climate Change Authority	Independent statutory body established to provide expert advice to the Australian Government on mitigation initiatives	Conducts reviews of emission targets, programs and reporting mechanisms, and produces reports on climate related issues	No review of emissions reduction targets since 2015 Recommended an emissions target of 19% below 2000 levels by 2020, and 40–60% by 2030 To date, no work specifically on climate and health
Clean Energy Regulator	Administers the National Greenhouse and Energy Reporting scheme (NGER), the Emissions Reduction Fund (ERF), the Renewable Energy Target (RET), and the Australian National Registry of Emissions Units.		
Australian Government	Australian Government Disaster and Climate Resilience Reference Group	Comprises senior officials from 22 agencies	
Department of Agriculture, Water and Environment	Climate Compass	Framework to help Australian public servants manage physical climate risks to policies, programs and assets	

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Minister for Energy and Emissions Reduction	Australian Energy Infrastructure Commissioner	Receives and refers about wind farms, large-scale solar, energy storage facilities and new major transmission projects	Originally set up to receive complaints about wind farms, broadened to include solar and storage and transmission infrastructure in March 2021
Australian Renewable Energy Agency (ARENA)	Funds and supports renewable energy projects		
Clean Energy Finance Corporation (CEFC)	Finances commercial, clean energy projects, with a focus on driving innovation		
Department of Agriculture, Water and Environment	National Climate Resilience and Adaptation Strategy (NCRAS)	Mentions health and well-being, while acknowledging that there are no national programs on climate and health	Published in 2015, this is being updated in 2021, and there has been direct consultation with health groups
Department of Energy, Science, Industry and Resources	Climate Active Carbon Neutral Standard	Voluntary business program climate action certifying carbon neutrality	Many Climate Active participants are supporting their carbon neutral claims by purchasing RECs and LGCs, rather than direct abatement
Department of Agriculture, Water and Environment	National Waste Policy Action Plan 2019	Produced with state and territory governments and the Australian Local Government Association. Reports every two years	Large number of responsible stakeholders = limited accountability
Energy National Cabinet Reform Committee (ENCRC) and Energy Ministers' Meeting (EMM). Both chaired by the Minister for Energy and Emissions Reduction	Ministerial forums for the Commonwealth, states and territories and AoNZ to work on priority issues and reforms in the energy sector Ministers oversee: Energy Security Board (ESB) — whole of system oversight through transition Australian Energy Market Commission (AEMC) — the rule maker and market development adviser Australian Energy Market Operator (AEMO) — the system operator Australian Energy Regulator (AER) — the economic regulator and rule enforcer	A sub-committee of the National Cabinet, ENCRC is focused on measures to ensure reliability and security of the grid ahead of the 2020–21 summer; redesign of the National Electricity Market after 2025; reforms to unlock new gas supply	
Department of the Environment and Energy	National Climate Science Advisory Committee (NCSAC)	Provides strategic direction for Australian climate science research and aims to 'boost collaboration across agencies and sectors'	Produced a report & recommendations for a national approach to climate science in 2019, acknowledging health professionals as users of climate science. Government response unclear

Key agencies and programs by State and Territory

Victorian Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Victorian Government	Climate Change Act (2017)	Legislated a net zero emissions target by 2050, and Climate Change Strategy and emissions reduction targets updated every five years. Sector pledges will be produced by relevant Ministers for the following sectors:	Obliges the Ministers of five sector portfolios named sectors (Energy; Industrial Processes and Product Use; Agriculture; Waste; and Land Use, Land Use Change and Forestry) to develop emissions reductions targets (doesn't include health, however, despite health sector emissions being greater than waste and te and industrial processes) and obliges the development of Adaptation Action Plans for key systems that are either vulnerable to the impacts of climate change or essential to ensure Victoria is prepared (from 2021). These are water, transportation, built environment, natural environment, health and human services, education and training, and primary production
Victorian Health and Human Services Building Authority	Environmental Sustainability Strategy 2018–19 to 2022–23	Sets out the department's commitment to improve both the environmental performance of the health system and create resilience in the face of climate change	
Department of Health and Human Services	Pilot Climate Change Adaptation Action Plan 2019–21	Intended to help the sector to further embed climate change considerations into policies, planning and operations, and to respond to the significant risks climate change poses to health and wellbeing and the health and human services system	

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Department of Health & Human Services	Public Health and Wellbeing Plan 2019–2023	Aims to ensure: ✦ resilient and safe communities adapting to the public ✦ health impacts of climate change ✦ decreased health impacts associated with climate change ✦ increased action to reduce greenhouse gas emissions and realise associated health co-benefits	
Department of Health and Human Services	DHHS Heat health plan	Outlines how the department can work with local government and health and human services to promote public health and wellbeing before and during periods of extreme heat	
Emergency Management Victoria	State Extreme Heat Sub-plan	Arrangements for the coordinated response to the impacts and consequences of extreme heat events (including heatwaves) on the community, infrastructure, and services	
Department of Health and Human Services	Guidance for local government: Tackling climate change and its impacts on health through municipal public health and wellbeing planning (2020)	To assist councils in meeting their obligations under the Climate Change Act (2017). It highlights opportunities for councils to protect and improve the health and wellbeing of their communities through climate change action	
Sustainability Victoria	Victorian Healthy Homes Program	Provides free home energy upgrades to up to 1000 Victorians who live with complex healthcare needs	

Queensland Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Minister for Environment and Science	Climate Action Plan	Outlines existing targets, including a commitment to move to 50% renewable energy by 2030 and reach zero-net emissions by 2050	Doesn't address transition away from coal or dire state of the Great Barrier Reef
Department of Environment and Science	Queensland Climate Transition Strategy	To guide transition towards a zero net emissions economy	
Department of Environment and Science	Queensland Climate Adaptation Strategy	To help Queenslanders prepare for current and future climate changes by understanding the impacts, managing the risks and harnessing the opportunities	
Department of Environment and Science	Human Health and Wellbeing Climate Change Adaptation Plan (H-CAP)	To support human health and wellbeing services to be innovative and resilient in managing climate risks. It provides a climate change adaptation framework and guidance for stakeholders across healthcare, aged care, and childcare services	Being used to guide the development of further tools and programs, eg climate risk assessment for hospitals and health services
Queensland Government	Queensland Future Climate Dashboard	Provides access to climate projections, heatwave and rainfall information for Queensland	

NSW Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Department of Planning, Industry and Environment	Climate Change Policy Framework	Defines NSW Government role in ✦ reducing carbon emissions and adapting to the impacts of climate change ✦ sets policy directions to guide implementation of the framework ✦ commits NSW to net zero emissions by 2050 ✦ sets out steps for implementation	
Department of Planning, Industry and Environment	Draft Climate Change Fund Strategic Plan	Sets out priority investment areas and potential actions using \$500 million of funding 2017–2022	
Office of Environment and Heritage (OEH) and NSW Health	Human Health and Social Impacts Node	To understand how climate change will impact human health and social wellbeing	
Department of Planning, Industry and Environment	Net Zero Plan Stage 1	Proposes to: 1. Drive uptake on proven emissions reduction technologies 2. Empower consumers and businesses to make sustainable choices 3. Invest in innovation to ensure economic prosperity from decarbonisation beyond 2030 4. Ensure the NSW Government leads by example eg sustainable procurement and environmental protection	

ACT Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
ACT Government	Climate Change and Greenhouse Gas Reduction Act 2010	Target setting, monitoring and reporting on progress made to meet the targets, facilitating government action and encouraging the private sector to take action to address climate change.	
Environment Planning and Sustainable Development Directorate	ACT Climate Change Strategy 2019–2025	Actions are focused on: ✦ meeting the 2025 target; ✦ building resilience to climate change impacts; ✦ avoiding future emissions; and ✦ laying foundations for net zero emissions	Includes a commitment for ACT Health Directorate to join Global Green and Healthy Hospitals network to improve sustainability performance and reduce emissions from ACT Health facilities
City of Canberra	Living Infrastructure Plan: Cooling the City	Sets direction for maintaining and enhancing trees, soils and waterways to keep the city cool, healthy and liveable	
Environment Planning and Sustainable Development Directorate	Sustainable Energy Policy 2020–25	Goal is to transition to renewable energy and zero greenhouse gas emissions in a way that is fair and equitable, cost-effective and maintains the reliability of the energy system	
ACT Government	ACT Climate Change Council	Advises the Minister for Climate Change and Sustainability on matters relating to reducing greenhouse gas emissions and building resilience and adapting to climate change	

SA Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
SA Government	Climate Change and Greenhouse Emissions Reduction Act 2007	Sets out emissions reduction targets to 2050 (and other targets already achieved). Required two yearly reports by the responsible Minister	First Australian state to legislate targets to reduce greenhouse emissions. In 2019, SA had achieved a 33% reduction in emissions on 2005 levels
Department of Environment and Water	Climate Change Action Plan 2021–2025	Aims to grow climate smart and low emissions industries, create new jobs and attract additional investment, particularly to regional areas	
SA Government	Hydrogen Action Plan	Intended to support SA to take advantage of opportunities created by the emerging global market for hydrogen and its many applications for energy generation, storage and transport	
Department for Energy and Mining	Renewable Technology Fund	Provides grants and loans to assist companies to deliver large scale renewable energy projects	
Department of Environment and Water	Regional Adaptation Plans	Included integrated vulnerability assessments (IVA), which guided priority adaptation options and timescales for implementation	
SA Government	Climate Change Council, established under Climate Change and Greenhouse Emissions Reduction Act 2007	Provides independent advice to the Minister for Environment and Water on reducing greenhouse gas emissions and adapting to climate change	Established in February 2008. The Council is currently in its fifth term, which commenced in September 2020

Western Australian Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Climate Health Inquiry	Sustainable Healthcare Unit in Department of Health		Recommendations accepted in full, but only a single position in WA Health established so far

Tasmanian Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Department of Public Health	Climate and Health Roundtable	Identified 42 actions relevant to climate change and health	Unclear whether any of these actions have been implemented

Northern Territory Government

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Department of Health (NT Health)	Climate and Health Advisory Group		Draft Towards 2050 policy indicates NT Govt examining health risks and management strategies Govt committed to green building design in new social housing¹⁷⁹ No climate-related investment re health or infrastructure yet (see NT Case Study), except for DoH support for research into risks to health workforce in NT¹⁵⁴ Opportunity: ensure draft policy is strengthened with clear health objectives and funding commitment
Top End Health Service	Member of the Global Green and Healthy Hospitals Health Network		
Minister for Climate Change	Office of Climate Change (Climate Change NT, in DEPWS) Commitment to net zero by 2050 Commitment to 50% renewables by 2030	New portfolio Reach uncertain	Promising commitments and show of leadership. Minister called on the Federal Govt to take ambitious action following IPCC 6AR Ministerial powers unclear Opportunity: augment calls for ambitious action citing climate health risks/benefits

Institution	Policy / Program	Application	Progress/ Limitations/ Opportunities
Department of Environment and Natural Resources	Northern Territory Climate Change Response: Towards 2050	Draft policy covering a wide array of actions covering: emissions, resilience, public engagement, and opportunities	Emissions, offsets, and electric vehicle policies/ plans complete. Commitments to net zero by 2050 and 50% renewables by 2030, with a renewable Hydrogen Strategy completed ¹⁷⁹
Department of Environment, Parks & Water Security (DEPWS) (previously Department of Environment & Natural Resources (DENR))	Large Emitters Policy	New and extended projects with significant potential to raise emissions	Sets minimum standards and obligations for projects¹⁸⁰ Threshold of “large” arbitrary and applies only if triggers new Environment Protection Act. No requirement to offset emissions, no clear enforcement mechanism. Excludes Scope 3 emissions Opportunity: strengthen policy to give all stakeholders certainty and ensure it supports net zero 2050 goal
Department of Environment, Parks & Water Security (previously Department of Environment & Natural Resources)	Draft Greenhouse Gas Emissions Offsets Policy and Technical Guidelines (DEPWS 2021)	Unclear, but appears likely to apply to new land and fossil fuel developments (Button & Kalsi 2020)	Target-based rather than ‘no net loss’. Signals to developers to cut emissions first and then offset remainder
Department of Environment, Parks & Water Security (previously Department of Environment & Natural Resources)			Opportunity: link to NT Govt goal of establishing a strong carbon industry; ensuring benefits for Indigenous community health and resilience
Department of Infrastructure, Planning and Logistics	Electric Vehicle Strategy and Implementation Plan 2021–2026 (DIPL 2021)	Encourages fully electric & hybrid EV, focusing on passenger & light commercial	Strategy completed with targets and timelines in plan. Incentivizes EV uptake and manufacturing Linked to federal EV plan Opportunity: clearly articulate immediate and long-term health co-benefits; NT Health could create a linked plan for hospitals and health services



RACP
Specialists. Together

www.rACP.edu.au

