

- 4. Identify and recommend a program of work to manage the implications of climate change for health in WA, which will reduce the contribution of WA health services to climate change and other detrimental impacts.
- 5. Identify and recommend a program of work to manage the implications of climate change for health in WA, which will enable WA Health services to implement change, including energy efficiency, to a more sustainable model.
- 6. Evaluate the likely benefits (health and wellbeing, social and economic) arising from climate change mitigation strategies, with a focus on WA health services.
- 7. Define the role of the Department of Health in leading public policy on climate change and health.
- 8. Recommend the Terms of Reference, scope and preferred methods for undertaking a climate change vulnerability assessment for the health sector.
- 9. Recommend the Terms of Reference, scope and preferred methods for developing a Climate Change Adaptation Plan for the health sector.

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WRITTEN SUBMISSION TO THE CLIMATE HEALTH WA INQUIRY

Introduction

Over the past half century, anthropogenic activities (caused or influenced by humans) have released gaseous constituents known as greenhouse gases (GHGs) into the atmosphere.¹ Some examples include water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O₃), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).² GHGs can be produced by the combustion of fossil fuel for the generation of electricity, in addition to agricultural, mining, transportation, and land management sectors.^{1, 3} They absorb and emit radiation at distinct wavelengths within the infrared spectrum the Earth's surface, atmosphere and clouds produce.² This has caused an increase in heat-trapping in the lower atmosphere and the temperature of the air and sea.^{1, 2} Consequently, this leads to changes in climatic systems such as precipitation patterns, rise in sea level through an increase in water volume and melting of ice caps, and rise in intensity, frequency and duration of extreme weather events.^{1, 3, 4, 5} Increasing CO₂ levels also cause ocean acidification, which affects marine ecosystems.

Climate change - a health priority (measures of disease burden)

Arguably, the largest worldwide health threat of this century is extensively considered to be climate change.^{3, 6, 7} Moreover, the recurring extreme weather events and alterations to natural environment has a strong association that has been accentuated by anthropogenic climate change research. These elements are likely to magnify harmful impacts on human health. Due to the extensive and layered health effects climate change has on humans, measuring it can only be very approximate. Between 2030 and 2050, presuming continuous economic growth and health progress and considering only a fraction of the possible health impacts, climate change is expected to cause roughly 250 000 additional deaths annually due to heat exposure in elderly people (38 000), diarrhoea (48 000 due), malaria (60 000), and childhood under-nutrition (95 000).¹ An estimation of USD two to four billion per year by 2030 will be the direct damage costs to health.¹ In addition, Professor Alan Lopez's group, the International Health Metrics and Evaluation (IHME) Global Burden of Disease (GBD), says that air pollution from coal burning is responsible for numerous health problems and the GBD estimated that around 2.5 million deaths worldwide in 2016 were due to burning solid fuels including coal.⁴

Most residents of Australia have accessibility to safe and clean potable water and food, and constructive sanitation and waste collection. However, growing demand on Australia's natural environment is placed by extreme weather events and climate change. In turn, this may unfavourably influence the population's health.⁸ From 1995

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to 2005, Australia's emissions increased from 24.2 to 25.8 tonnes of GHG per capita.⁹ In 2007, Australia became an endorser to an international agreement amongst countries to unitedly decrease GHG emissions known as the Kyoto Protocol. Since then, Australia has further reduced emissions to 22.3 tonnes of GHG per capita.⁹ Moreover, in 2015, a historic global climate agreement was agreed under the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) in Paris. Australia is committed to taking strong domestic and international action on climate change, with the Government implementing national policies to reduce emissions and adapt to the impacts of climate change in the context of coordinated global action.¹⁰

ToR 1: Establish current knowledge on the implications of climate change for health in Western Australia (WA) and recommend a framework for evaluating future implications.

Direct human health impacts

Extreme heat / heatwaves

Australia's climate has risen by 0.9°C since 1910, and there has been a change in frequency of extreme weather too. Temperatures are predicted to increase, with the expectation for WA's increase to be 0.5°C to 2°C. There will be more extremely hot and fewer extremely cool days.¹¹ Prolonged heat exposure leads to increased rates of illnesses (i.e. dehydration, heat exhaustion, heatstroke), worsening of existing health conditions (i.e. heart and kidney disease) and potentially even death.¹² Unsurprisingly, there is significant additional strain on health and emergency services.^{13, 14, 15} Since 1950, the duration, frequency and intensity of heatwaves have expanded across majority of Australia, causing an increase in the number of hospital admissions and deaths in Australia over the past century, than any other natural event.^{11, 15, 16} The hottest temperature ever recorded in WA was in the Pilbara, when the town of Mardie reached 50.5°C in February 1998. Just earlier in the year, Meekatharra in WA registered an overnight minimum of 33°C on one of the days in January. Moreover, heatwaves aggravate the occurrence of drought, increase the risk of bushfires and lead to elevated levels of urban ozone air pollution.³ The general projections for 2030 in WA are generally hotter days particularly in inland regions, dryer areas in the South West, and more frequent, intense droughts, heatwaves and fires.

As cities continue to be the focus of population growth for Australia, warming temperatures compound local climatic conditions of heat island effect. As urban landscapes are characterised through their extensive buildings and infrastructure (compared to natural landscapes), they lose natural canopy and shape causing the absorption of heat during the day. This then emits back to the atmosphere at night, compounding higher day time temperatures with even higher night time temperatures. This poses a significant risk on the liveability of cities in supporting active and healthy life choices.

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Drought

Droughts are known as periods of below-average rainfall, resulting in disadvantageous outcomes for the natural environment and effects on human health. Since 1970, precipitation levels have decreased in the southwest due to reduced winter rainfall; and since 1990, autumn and early winter rain has mostly been below average in the southeast.¹¹ Average precipitation in southern Australia is forecasted to dip, with a likely increase in more frequent and severe droughts.¹¹ As recent as this year, two areas of WA were declared 'water deficient' and had supplies trucked in by the state government to keep farm animals alive. Farmers around the area of Mallee Hill in the Shire of Lake Grace and Mount Short in the Ravensthorpe Shire had run out of water for their stock and had been driving more than 40km to cart water back to their farms. Reduction in the supply and quality of water and food is not the only consequences of drought - the probability of bushfires increase and air quality is affected too (i.e. dust storms).^{8, 17} Vector-borne diseases like dengue fever and Ross River virus, tend to have an increased risk following events such as drought, the rain following after, and adaptation to it (i.e. water storage tanks).¹⁷ Moreover, from the Rural and Regional Families Survey, it is evident that, 18% of farmers who experienced drought in 2007, reported mental health issues.⁸ Hanigan et al.¹⁸ found that when the drought index rose from the first to the third quartile, there was a 15% increased relative risk of suicide for rural men aged 30–49 years.

Many of our wetland habitats are facing stress, with fauna and floristic communities making up wetland ecosystems being faced with dramatic changes in these local systems. For example, as groundwater levels reduce, previous damp land areas of the wetland are being colonised by dry land / upland species, changing the balance of fauna that can otherwise be supported in such habitats. This severe unbalance also makes the environment more susceptible to weed infestation, and the likely hood of fauna deaths as the likes of bandicoots, kangaroos and turtles are forced to migrate to other locations in order to seek out the necessary food and water sources.

Bushfires

Since the 1970s, rising temperatures, prolonged heat waves of increased frequency and intensity, and reduced rainfall are resulting in an increase in extreme fire weather and lengthening fire season across numerous parts of Australia; a further increase is expected in southern and eastern Australia.^{3, 11, 19} The latest event in WA, was the 2016 Murray Road bushfire (Waroona and Harvey), where 181 dwellings (166 only in Yarloop), historical Yarloop Workshops and thousands of hectares of Lane Poole Reserve and production forest (jarrah) were damaged. Greenhouse gas emissions from fires contribute to the total anthropogenic emissions.²⁰ Amongst the numerous health risks that bushfires pose, dehydration and heat exhaustion are some examples.³ Inhalation of smoke can be harmful to the lungs and airway, and may also travel extensive distances away from the bushfire zone, affecting communities across extensive areas.³ In Sydney between 1996 and 2007, a survey of 46 fire smoke event days was conducted, and noticeable spikes in same-day

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emergency department attendance for asthma (23%), chronic obstructive pulmonary disease (12%) and respiratory conditions (7%) were found.²¹ More direct risks would be burns, physical trauma (i.e. injury from car accidents), and death.^{3, 8} Bushfires were responsible for 433 deaths and more than 8,000 injuries between 1967 and 2013.^{22, 23} The Black Saturday bushfires in Victoria in 2009 resulted in 173 deaths; in the first 72 hours after the fires, 414 people were presented to public hospital emergency departments.²⁴ Consequently, survivors can have long-term mental health impacts, too. Bushfires increase the risk of psychological trauma such as depression, post-traumatic stress disorder (PTSD), substance abuse and domestic violence.^{25, 26, 27} In addition to these, there can be damages and destruction of homes, infrastructure and services, resulting in healthcare services being severely affected (i.e. due to damage to hospitals and medical centres).³

Floods, storm surges and cyclones

Consequences of more frequent and intense heavy rainfall episodes and rise in sea level are the risks of storm surges and severe flooding; it is expected to increase in various parts of Australia.¹¹ In March of this year, the powerful, slow-moving Cyclone Veronica was bearing down on the WA coast, bringing destructive wind gusts, flooding rain and dangerous tide surges over a prolonged period, and lashed the coastline of the Pilbara region between Dampier and Port Hedland. Moreover, there are more storms, floods, rainfall events and tropical cyclones projections by 2030 in WA; coastal regions are expected to experience an increase in sea level as well. Injuries, drowning, hypothermia, and longer-term mental health impacts are some of the direct health impacts.³ In 2011, an unprecedented wet season was followed by the Queensland floods, affecting more than 78% of the state, resulting in 33 deaths and three people are still missing.^{3, 28} Moreover, damp conditions nurture mould growth, and possibly aggravate asthma and other allergies.³ Due to climate change, cyclones may become more intense in certain areas.^{3, 11} They have similar direct health effects to floods and also damage essential infrastructure. In the aftermath, outbreaks of wound infections, acute respiratory infections and diarrhoeal diseases may occur and exacerbation of pre-existing health conditions can be caused by interferences to routine medical care.²⁹ Cyclone Yasi hit North Queensland in February 2011, resulting in a record number of presentations to the Townsville Hospital Emergency Department. In addition, it evoked the evacuation of 356 patients, staff and relatives at the Cairns Base Hospital, who were transferred by air to Brisbane.³⁰

Skin cancer

Australia has one of the highest skin cancer rates - 80% of all new cancers diagnosed annually.³¹ Also, solar ultraviolet (UV) radiation is high in comparison to other countries, and exposure UV radiation is the cause for 99% of non-melanoma and 95% of melanomas.^{32, 33} It was reported by the Australian Burden of Disease Study (ABDS) that in 2011, 0.8% of total burden of disease and injury due to skin cancers (melanoma and non-melanoma) was because of high sun exposure - an

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environmental risk factor.³⁴ Between 1982 and 2006, there was an increase in the rate of new diagnoses of melanoma; an approximated 13,300 new cases of melanoma was responsible for 10% of all cancers diagnosed in 2016.³⁵ Over 1,000 cases of melanoma are diagnosed in WA each year. Recently, an updated evaluation of environmental effects of ozone depletion and its associations with climate change was published by the United Nations Environment Program (UNEP), concluding that “projected changes in ozone and clouds may lead to large decreases in UV at high latitudes, where UV is already low, and to small increases at low latitudes, where it is already high”.¹¹ It is evident in data that surface UV radiation has increased in majority of Australia since the 1970s, regardless of the seasons.¹¹ In addition, until ozone recovery reduces surface UV radiation, it is anticipated that these higher levels will pursue in most Australian regions, and into the next century in the remaining parts.¹¹ Consequently, retaining existing levels of sun protective behaviours will result in increased exposure to UV radiation in upcoming decades - the outcome would be higher incidence of skin cancer in years to come.

Indirect human health impacts

Air Quality

Air quality is adversely affected by bushfires as smoke contains harmful particulate matter and carbon monoxide.²⁵ Combustion of coal to generate electricity releases harmful air pollutants, in addition to climate-changing CO₂; these include particulate matter, sulphur dioxide, nitrogen oxides, mercury, cadmium, and arsenic.³⁶ Toxic emissions are generated by coal mine fires and health risks are posed in nearby areas. In 2014 in Victoria’s Latrobe Valley, the Hazelwood mine fire burned for 45 days; smoke and ash spread over Morwell town and its surrounding areas.³ Morbidity and mortality risks from cardiovascular and respiratory diseases (particularly asthma) are increased by long-term exposure to air pollution from coal mine fires’ emissions, especially particulate matter.^{37, 38, 39, 40, 41} It was exhibited that there was a relationship between exposure to air pollutants and short-term increases in respiratory hospitalisations for children aged 0–14.⁴² In addition, it found that traffic-related air pollution was strongly correlated to and an increased risk of asthma, wheezing and worsening lung function.⁴³ The ABDS 2011 reported that 1.3% of all fatal burden, 5.9% of the fatal burden due to coronary heart disease and 4.8% of the fatal burden due to stroke was attributable to air pollution.³⁴

Food quality

Consequential agricultural effects from climate change are without a doubt to result in decreased food production, because of stock losses and declining crop yields. Bushfires, severe weather events and changing patterns of pests and diseases may also pose as a threat and destroy food supply.⁴⁴ A drop in food production and resultant increase in prices endanger the availability of safe and healthy food for Australian communities. This means that more people will be at risk of under-nutrition - in particular, there would be an accessibility issue those in regional and remote areas and for low-income earners. Moreover, due to the negative effects of

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climate change on the global food supply, Australia will likely be under pressure to increase food exports to regions such as Asia-Pacific.⁴⁴ In addition, during heatwaves, an increase in the likelihood of power outages cause system failures to refrigeration and air-conditioning.³ Thus, food spoilage may occur because of heightened growth of pathogens, increasing the risk of gastrointestinal infections (i.e. Salmonella, Campylobacter and E. coli).³ Supplies of many medical drugs and vaccines that are required to be refrigerated may be threatened too.³

Water quality

Severe weather events related to climate change, such as flooding, can cause damage to crucial infrastructure, including sewerage and safe drinking water supply.³ This may proliferate harmful viruses and bacteria, leading to an increased risk of diarrhoeal disease.³ Moreover, the risk of infectious disease transmission in Australia is predicted to increase due to climate change; rising temperatures, varying rainfall patterns, and stagnant water after floods are expected to alter the patterns of mosquito-borne diseases (i.e. dengue fever and Ross River virus).⁴⁵

Recommended framework

A framework for evaluating future implications could possibly include:

- an extensive literature review on existing data collected in the above mentioned fields of implications to establish the current trend of each of them;
- implementing a monitoring and surveillance regime within these fields of implication to assess the ongoing occurrence, frequency, severity and effects of each of these implications;
- conduct stakeholder engagement and community consultation for input on the direct effect on them from the occurrence of any of the above implications;
 - surveys can be conducted
 - on a more community-based and personal level, case studies can be done on how local industries / businesses, as well as public services (such as police, fire brigade, health services) are affected
- alignment with the existing health impact assessment process;
- proactive green strategies for our cities and towns;
- restoration of wetland environments through weed managements, establishing of ecological linkages, pest control.

This framework could be further developed through collaboration between relevant industry stakeholders such as Local Governments, relevant government agencies, relevant industry organisations, the public, climate change NGOs etc. Such a framework should aim to establish local causes of the implications, to then monitor

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the cause with an intention to minimise or eliminate the cause.

ToR 2: Identify and recommend a program of work to manage the implications of climate change for health in WA, which will protect the public from the harmful health impacts of climate change.

Promotion and education of the community on the importance of local food production, good public transport, and resource recycling is essential. Development and promotion of land farming, community gardens, community farms, market days, sustainable organic agriculture, soil sequestration storage, worm farms, green waste to the soil, perennial pastures and community tree-planting days are crucial as well. Education and encouragement will help facilitate levels of community participation in best practice use reduction of water and energy.

Education

Education is an essential element of the global response to climate change. It helps people understand and address the impact of global warming, encourages changes in their attitudes and behaviour and helps them adapt to climate change-related trends. Promotion and incorporation of lifestyle/behavioural change in residential, rural, commercial and industrial sectors, including continuing to reduce and measure GHG emissions, is important. Some initiatives such as incentives and climate change education programs may help with promotion of behavioural change.

Planting

An increase in amount of trees and vegetation can help to cool the surrounding areas through the process of evapotranspiration. Trees, as well as fruit and vegetable production, draw down carbon dioxide from the atmosphere through photosynthesis, reducing the implications of climate change. At a Local Government (LG) level, planting more trees in the public open spaces, as well as incorporation of new 'growing biodiversity and green technologies', initiatives (such as roof, wall gardens) and design opportunities to enhance Green Infrastructure can be an adaptive response to climate change. It makes a contribution to slowing the detrimental effects of climate change. Not only do they add more plant cover, but also insulation to buildings reducing energy use in heating and cooling. Encouraging community gardens also increases the availability and accessibility of healthy food choices within the local environment, which is an added health benefit as plant-rich diets address many growing health problems by reducing dependence on meat. Composting also helps to reduce methane production and although aerobic composting as in compost heap produces some carbon dioxide, application of the finished product to soil helps soil to retain carbon as well as increasing its fertility. Trees also help to block out a significant amount of the sun's radiation. In addition, some built shade can be constructed in public open spaces to make it for accessible to community members even on hot days. Lastly, introduction of a adequately funded regional campaign to address new and emerging weed and pest species is an option as well, considering how climate change is expected to favour species that

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are highly adaptable to change.

Water

Freshwater is a finite resource which is becoming more and more scarce. Pollution and waste generation as well as being causes of climate change, also have a direct and indirect effect on our water supply. On average, Australians use 130 kg of plastic per person each year. Only 12% of that gets recycled. More frightening still, up to 130,000 tonnes of plastic will find its way into our waterways and into the ocean.⁴⁷ To further exacerbate this problem, climate change is having a chaotic effect on rain fall which directly affects the waterways, dams and groundwater from which we get our potable water from. It is becoming increasingly essential that we become wiser with our water usage and to explore more efficient ways to collect and distribute potable water for our daily needs. Through education and greater societal awareness of the issue, people's daily water usage habits could be altered to reduce inefficient use of potable water. Rainwater harvesting practices could be promoted and incentivised; for example collecting rainwater from the roof of a home into a water tank, which is then plumbed for use within the home. Furthermore, water can be reused through a grey water system, where the water from sinks and showers can be directed for use of flushing the toilet. Finally, the wastewater could be used for irrigation of gardens and agricultural fields or replenishing surface and/or ground water after treatment. It is important to become wiser with our use of limited freshwater supplies but even this is not enough, a more innovative solution which WA is utilising a climate independent source of water: the Ocean. Desalination is a secure water source that does not depend on rain. Water produced by the Perth (Kwinana) and Southern (Binningup) Seawater Desalination Plants makes up 48% of Perth's water supply. A third and upcoming one in Alkimos is a work in progress.

Public transportation

Australia's second largest source of greenhouse gas pollution after electricity is transport, and the sector has seen the largest percentage growth (62.9%) since 1990. WA's annual transport emission is 14.5 million tonnes, and per capita emissions are 5.6 t CO₂/person. Improving the quality, efficiency and accessibility of public transport, cycling and walking alternatives as well as shifting to renewable powered vehicles in the form of electric bicycles, cars, trains, and buses, is most definitely crucial. Serpentine-Jarrahdale (SJ) is being known to be the fastest growing LG Area in the Western Australia. Without high-quality public transport, SJ Shire and its suburbs risk a continued reliance on car ownership and travel, meaning environmental congestion and social isolation for the communities. Planning and infrastructure investment for the Perth Region continues to promote opportunities for increased public transport use within existing suburbs. METRONET and the State Government having identified the need for increased availability of rail within Perth, specifically to connect into the hyper growth region of SJ Shire. METRONET outlined the need to develop a station in Byford, which the Shire supports and reflected in its planning for many years, and also listed the extension of the Armadale line to Byford

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as a critical need to connect SJ suburbs, and reduce road congestion. The Shire has identified the new Byford Town Centre for creating Byford Central Station Precinct as a vibrant and economically successful location. Some benefits include the increased transit ridership, reduced vehicle-kms travelled, reduced air pollution, and preservation of farmland and green space. Currently, only 4.4% of Shire residents use public transport to travel to work. Carbon emissions are 40% higher on the road than rail for each km too. By developing the Train Station in the Town Centre, it will encourage people to access it by walking and cycling, reduce traffic congestion and carbon emissions, because increased rail traffic reduces road traffic, especially in a fast developing residential area.

ToR 3: Identify and recommend a program of work to manage the implications of climate change for health in WA, which will strengthen the preparedness and resilience of communities and health services against extreme weather events, with a focus on the most vulnerable in the community.

Predictive modelling, scenario planning, identification of knowledge gaps as well as information dissemination will strengthen the preparedness and resilience of communities and health services against extreme weather events, especially for the most vulnerable in the community. Relevant up-to-date risk assessment information will be incorporated. Fire management practices that maintain levels of public safety while conserving biodiversity, through use and promotion of low flammability plants and fire plans developed for natural areas in consultation with LGs and land managers can be integrated. Education and preparedness information seminars could be provided to the community by local governments on topics such emergency evacuations (in case of bushfire or flood events), what to do with livestock and animals in the case of an extreme weather event, how to build resilience within the food production and agricultural. An evacuation centre can be set up for the most vulnerable in the community during extreme weather events, in addition to emergency management for the whole community. Volunteers can be organised and trained up to be prepared for such events, and help out with transporting the vulnerable from their homes to the evacuation centres.

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