

Torres Strait Climate Change and Health – First Pass Risk Assessment



Document prepared by BMT Global for the Torres Strait Regional Authority.
BMT Eastern Australia Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia

PO Box 203, Spring Hill 4004
Tel: +617 3831 6744

ABN 54 010 830 421
www.bmt.org

BMT Project Manager: David Rissik
TSRA Project Manager: John Rainbird

Photographic credits

Front cover and inside sleeve: John Rainbird
All others see individual photo credits

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Contents

1	Introduction	1
1.1	Background	1
1.2	Locale	1
1.3	Approach	2
2	Climate Change Adaptation in the Torres Strait	4
3	Climate Change in the Torres Strait Region	5
3.1	Current Climate	5
3.2	Future Climate	5
3.2.1	Temperature	5
3.2.2	Rainfall	6
3.2.3	Evaporation	7
3.2.4	Wind Speed	7
3.2.5	Cyclones	7
3.2.6	Sea-level Rise	7
3.3	Emerging Science	9
4	Hospital and Health Service Facilities in the Torres Strait	10
5	Introduction to Health and Climate Change	16
5.1	Torres Strait Health Context	16
5.2	Existing Climate Related Health Challenges in the Torres Strait	19
5.3	Impacts to Health from Future Climate Change	20
5.4	Heat Related Health and Wellbeing Risks for the Torres Strait	21
6	Climate Change Risk Screening	23
7	Discussion	32
7.1	Summary of Climate Change Risk Screening	32
7.2	The Torres Strait Regional Adaptation and Resilience Plan 2016-2021	33
7.3	Torres Strait Communities Considered Most at Risk From Climate Change Impacts on Health	33
7.4	Potential Climate Change Impacts on Key Sectors	33
7.5	Information about Climate Change and Human Health	34
7.6	Health Sector Linkages	35
7.7	Emission Reduction and Sustainability	36
8	Recommendations	37
8.1	Collaboration and Engagement to Ensure Effective Action	37

Contents

8.2	Reducing Demand on The Health System and Responding to Changes in Demand Due to Climate Change	37
8.3	Understanding and Addressing Climate Risk on Health Facilities and Operational Capacity	39
9	References	40
Appendix A	Interview Participants	A-1

List of Figures

Figure 1-1	Study Locality	3
Figure 3-1	Heat related climate change projections for the Torres Strait. The green dot shows the observed average, red dots show high emission scenario (RCP8.5) and the blue dots a low emission scenario (RCP4.5). The error bars show the variability between different climate models used for the analysis (data from www.coastadapt.com.au)	6
Figure 3-2	Changes to rainfall and dry periods in the Torres Strait. The green dot shows the observed average, red dots show high emission scenario (RCP8.5) and the blue dots a low emission scenario (RCP4.5). The error bars show the variability between different climate models used for the analysis (data from www.coastadapt.com.au)	7
Figure 3-3	Sea level rise projections for the Torres Strait. Red shows high emission scenario (RCP8.5) and blue a low emission scenario (RCP4.5). The green line shows actual sea-level data collected over the past 20 years (data from www.coastadapt.com.au).	8
Figure 4-1	Map showing locations of health care facilities operated by the Torres and Cape Hospital and Health Service in the Torres Strait. Map from https://www.health.qld.gov.au/services/torres-cape	10
Figure 5-1	Torres Strait 2014 Chronic Disease Burden (McIver and Liu 2015)	17
Figure 5-2	Direct and indirect effects of climate change on health and wellbeing (Watts et al. 2015)	21

List of Tables

Table 4-1	Description of each of the Torres and Cape Hospital and Health Service's facilities in the Torres Strait. These provide an insight into the diversity of facilities operated by the TCHHS across the region (information from https://www.health.qld.gov.au/services/torres-cape).	11
Table 5-1	Challenges faced by clinicians when managing chronic disease in Torres Strait (adapted from McIver and Liu 2015)	18
Table 6-1	Climate Change Risk Screening	24
Table A-1	Names and positions of people interviewed for the risk assessment	A-1

1 Introduction

1.1 Background

This project was undertaken for the Torres Strait Regional Authority (TSRA) as a first step in addressing concerns that communities in the Torres Strait might experience comparatively greater climate related health impacts in the face of climate change, as compared to most mainland communities. It has been hypothesised that this increased vulnerability to health risks associated with climate change could arise from a range of factors, such as:

- The region's close proximity to the impoverished villages of Papua New Guinea's Western Province, which have poor health care and high disease burdens.
- Existing high community health burdens including diabetes, obesity and cardiovascular disease.
- Remoteness of communities and consequences for available levels of health care.
- Relatively high temperature and humidity levels.
- Mental health implications related to concerns about sea level impacts on low lying communities, as well as other climate change impacts (e.g. impacts on key resources such as seafood).
- Variable levels of water security and quality.
- Limited access to air-conditioning and levels of over-crowding.
- Existing risks from vector borne diseases such as dengue fever.

This report aims to develop a broad understanding of the risks associated with a changing climate that face the health sector in the Torres Strait. It is meant as a first step in documenting common concerns (primarily from health professionals), prioritising key risks, and providing recommendations with respect to future actions for addressing risks and filling existing gaps.

1.2 Locale

The Torres Strait Islands are a group of several hundred islands spread over more than 48,000 square kilometres (see <http://www.tsra.gov.au>) of shallow sea located between the southern coastline of Papua New Guinea (PNG) and the tip of Cape York on mainland Australia (Figure 1-1).

The region includes 18 communities on 17 inhabited island communities and the communities of Bamaga and Seisia at the tip of Cape York fall within the interests of the Torres Strait Regional Authority. Islands within the Torres Strait are allocated to one of five major Island groups: central islands, eastern islands, inner islands, near western islands, and top western islands.

Torres Strait is physically, culturally, and administratively complex. The Torres Strait Treaty was signed in 1978 and ratified in 1985. While administratively part of the Commonwealth of Australia, the treaty allows traditional visitation between Torres Strait Islands and the inhabitants of specific villages on the PNG coast, as well as traditional hunting and fishing by both groups. The proximity of Torres Strait to PNG and Asia confers a strategic importance on Torres Strait as a frontline against health, quarantine, defence, and law and order risks. Quarantine risks are managed by a series of nested zones within the region.

Introduction

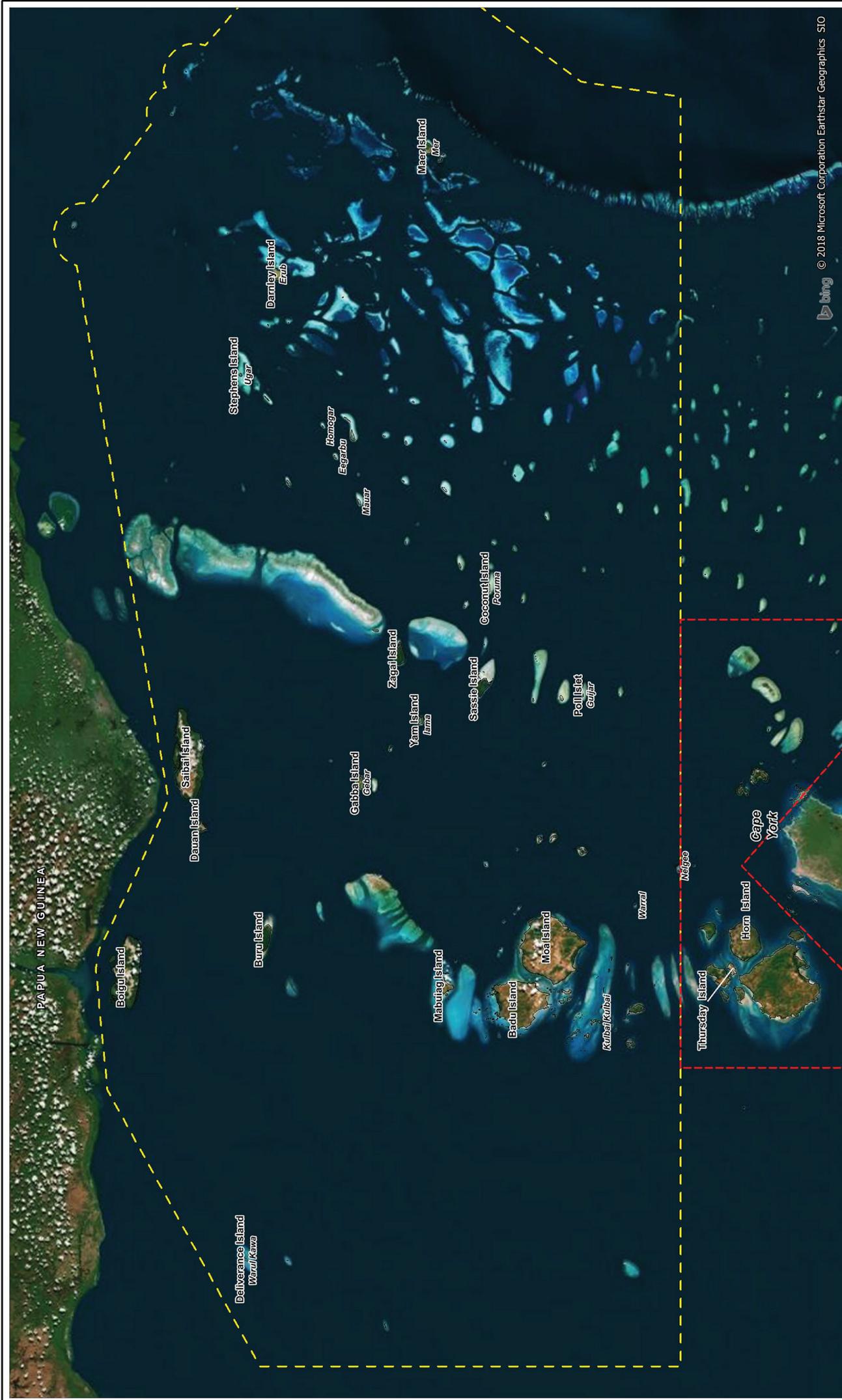
1.3 Approach

We undertook semi-structured telephone interviews with a range of key relevant stakeholder representatives involved in the health sector in the Torres Strait, or with detailed knowledge of the impacts of climate change on Torres Strait communities. Interview participants are listed in Appendix A. In undertaking the interviews, we considered the changes to the climate that will occur in 2030 and 2050. Our interviews were augmented with a desktop review of available information and reports.

We developed a series of questions which underpinned the interviews with stakeholders. The questionnaire included questions relevant to the key areas of interest in the context of this assessment, namely:

- Identification of potential direct and indirect health impacts assuming current controls with 2030 and 2050 projections of climate variables.
- Assessing current levels of awareness of climate change health implications within the TS health sector.
- Assessing current levels of controls for primary climate change health risks.
- Identification of vulnerable groups, sectors or areas.
- Identification of gaps.
- Identification of key linkages with other sectors.

In producing this report we considered health risks to the population of the Torres Strait that may be directly or indirectly related to climate change, and which may increase demands on the health system in the region. We also considered some of the implications of climate change to the infrastructure and operations of the health system in the region. The recommendations in the report are not directed at a single entity and are broad ranging. Responsible organisations for addressing recommendations have not been identified, and many cases may potentially be cross-jurisdictional.



	LEGEND Torres Strait Protection Zone Torres Strait Special Quarantine Zone	Title: Torres Strait	Figure: 1-1	Rev: A
		<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		
<p>Approx. Scale</p>				

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2 Climate Change Adaptation in the Torres Strait

While this report focuses on climate change risks to the health sector, it must be remembered that climate change impacts to communities in the Torres Strait are broader than this and, in many cases, multifaceted. As such, climate change adaptation in a health context should not be considered in isolation. Rather, much work has, and is being done by others in terms of developing other climate change adaptation and resilience building strategies more broadly. The outcomes and recommendations of this report should be viewed in conjunction with, and complementary to, these other strategies.

In this respect, the potential effects of climate change in the Torres Strait are well known (as summarised in Section 3). A series of key planning documents have been developed to underpin climate change adaptation for the region. These include The Torres Strait Climate Change Strategy: Building community adaptive capacity and resilience (TSRA 2014), and the more recent Torres Strait Regional Adaptation and Resilience Plan 2016-2021 developed by the TSRA in collaboration with the Torres Shire Council, the Torres Strait Island Regional Council, Queensland government partners and local communities to set a course of action for the future (TSRA 2016).

The later plan outlines a five capitals approach to addressing climate change impacts in the region. Most notably, it focusses on improving resilience of Torres Strait communities to the effects of a changing climate and includes a pathway of actions that can be taken over time. There is significant consistency and alignment between actions in the plan and many of those recommended in this report. This includes addressing challenges that affect demand on the health system and direct and indirect impacts on the infrastructure and operations of the hospital and health system.

Other climate change related plans are under development in the region. For example, a Coastal Hazard Adaptation Strategy is under development for Torres Strait Council and Torres Strait Island Regional Council.

3 Climate Change in the Torres Strait Region

3.1 Current Climate

Projected changes to the future climate in the Torres Strait need to be considered in the context of the existing current climate. The Torres Strait Islands are a hot and humid tropical environment located at a latitude of approximately 10° south. The following information of the current climate of the region is drawn from a report by Suppiah et al. (2010).

- The annual average air temperature for the Torres Strait is 26.8°C. Average monthly air temperatures are fairly consistent with the highest temperatures occurring in December (28.1°C) and the coolest in August (25.3°C).
- Annual sea temperatures in the region are around 28°C with little annual variability.
- An important measure for the Torres Strait is apparent temperature which is based on temperature, humidity, solar radiation and wind speed. The annual apparent temperature is 38.4°C. In the wet season apparent temperature is 43.8°C and in the dry season 33.6°C.
- Rainfall varies seasonally with a wet season averaging 1750mm and a dry season averaging only 90mm.
- The northerly position of the Torres Strait means that direct impact from cyclones is small. However, the region is affected by storm surges associated with cyclones in the Gulf of Carpentaria and those heading towards the north-east coast of Australia.

A brief description of the likely climate future for the Torres Strait is provided the following sections. Data and descriptions have been obtained from resources available from the Queensland State Government, CSIRO and NCCARF. The ultimate source for all the data and figures that are presented is the climatechangeinaustralia.gov.au website maintained by CSIRO and the Bureau of Meteorology.

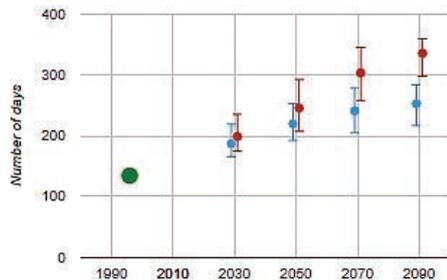
3.2 Future Climate

3.2.1 Temperature

By 2030, if the global emission trajectory remains the same as present (RCP8.5) annual average temperatures are expected to be between 0.5 and 1.1°C above the average climate of 1986-2005 (23.4°C). By 2070, average temperatures are expected to be 1.1 and 3.3°C higher than the average climate of 1986-2005 (23.4°C). Projections indicate that by 2090 the region will experience on average 337 days above 30°C. The increased temperatures will be experienced together with increased duration of warm spells (Figure 3-1).

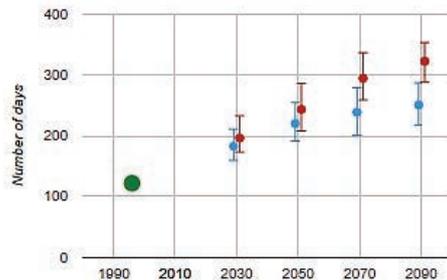
Hot days:

Mean annual number of days with maximum temperature greater than 30°C



Warm nights:

Mean annual number of nights with minimum temperature greater than 25°C



Heatwaves:

Average of longest run of days in each year with maximum temperature greater than 30°C

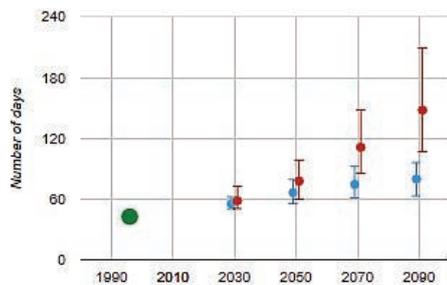


Figure 3-1 Heat related climate change projections for the Torres Strait. The green dot shows the observed average, red dots show high emission scenario (RCP8.5) and the blue dots a low emission scenario (RCP4.5). The error bars show the variability between different climate models used for the analysis (data from www.coastadapt.com.au)

3.2.2 Rainfall

Rainfall projections for a high emission scenario show that rainfall in the region will be highly variable. With the number of very wet days increasing slightly and the dry periods increasing as well. This indicates that the intensity of rainfall events will increase. There will also be an increase in the average length of the dry season.

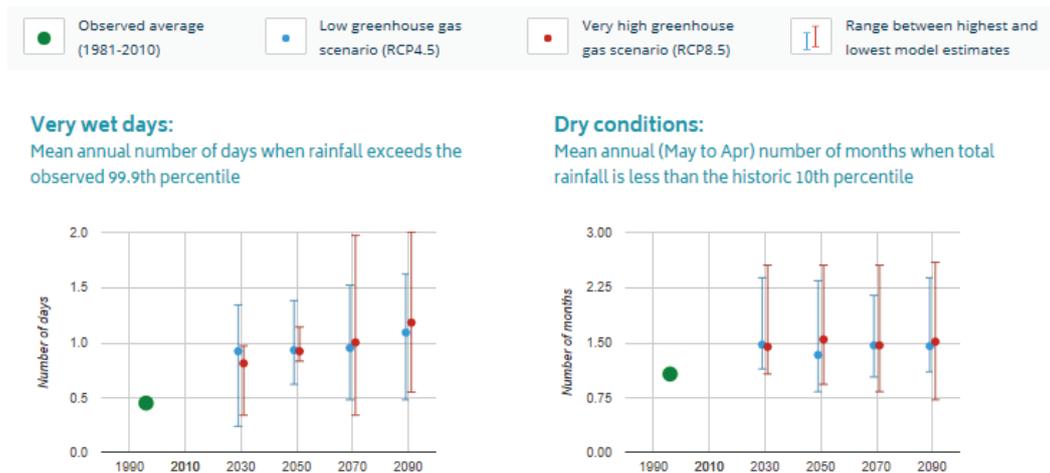


Figure 3-2 Changes to rainfall and dry periods in the Torres Strait. The green dot shows the observed average, red dots show high emission scenario (RCP8.5) and the blue dots a low emission scenario (RCP4.5). The error bars show the variability between different climate models used for the analysis (data from www.coastadapt.com.au)

3.2.3 Evaporation

Evaporation will increase in the region with between a 7-9% increase by 2070. Evaporation will not vary markedly between seasons.

3.2.4 Wind Speed

Wind speeds are projected to increase in the regions by approximately 3.4% annually. The increase will vary between seasons with increases of 5% in winter and spring. Summer wind speeds are projected to increase by 1% in 2090 under a high emission scenario.

3.2.5 Cyclones

Tropical cyclones are a major cause of severe weather in the wet tropics causing strong winds, heavy rainfall, storm surges and large wave conditions. Projections suggest that there will be a decline in the rate at which cyclones form, but an increase in the intensity of cyclones that do occur.

3.2.6 Sea-level Rise

At a high emission scenario, projections indicate that sea-levels will rise by 0.8 m above present day levels (Figure 3-3). This is an average level and does not indicate the annual or tidal variability.

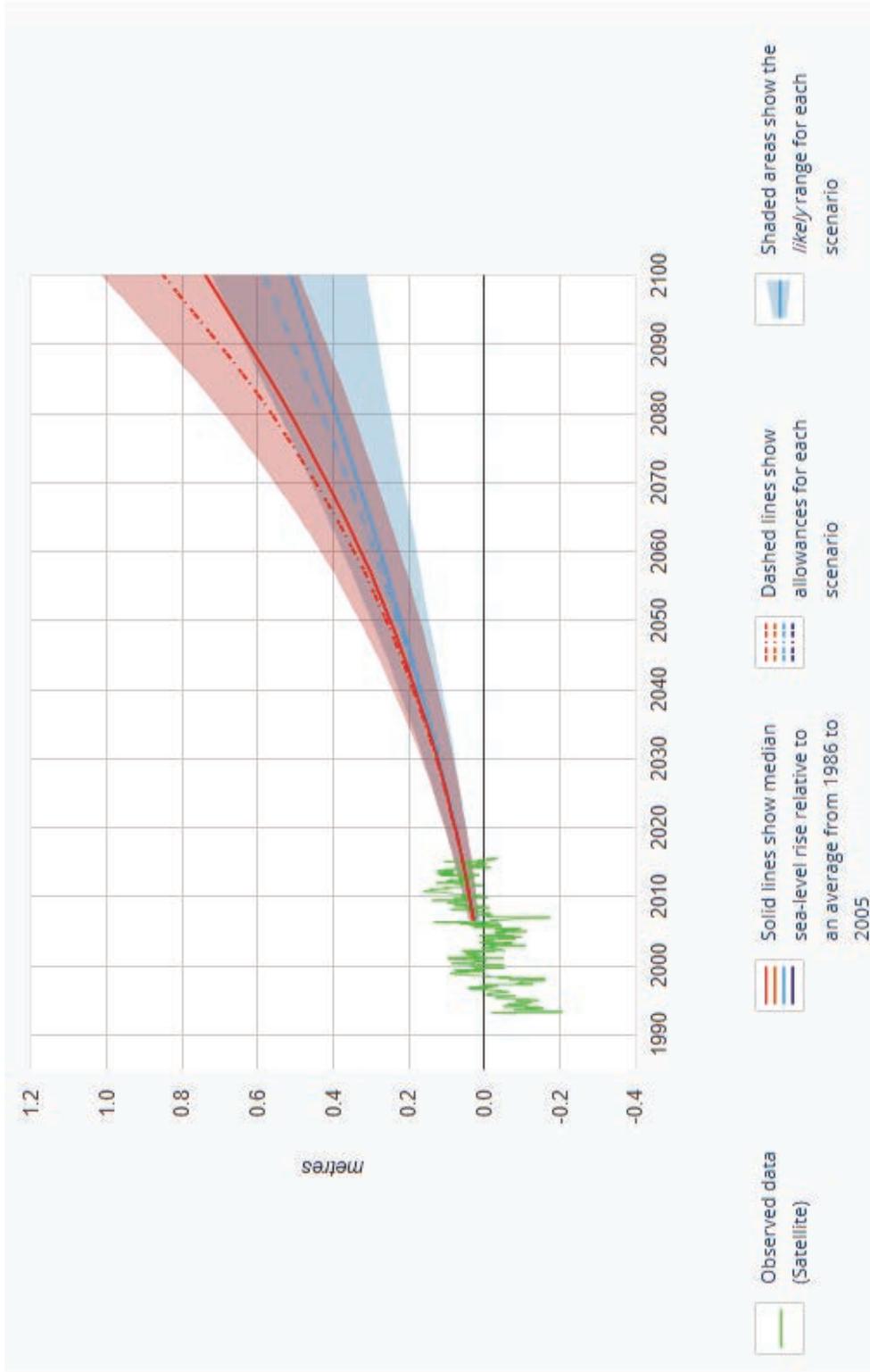


Figure 3-3 Sea level rise projections for the Torres Strait. Red shows high emission scenario (RCP8.5) and blue a low emission scenario (RCP4.5). The green line shows actual sea-level data collected over the past 20 years (data from www.coastadapt.com.au).

3.3 Emerging Science

Climate change models and associated projections are continually being resolved as new information and data become available, particularly as the scale and composition of greenhouse gas emissions become clearer. Despite the signing of international agreements to reduce emissions, there is little reduction to date and emissions continue to track at a high rate (consistent with RCP8.5). In many areas of Australia, particularly the southern regions, the present climate is already equivalent to the projected climate for 2030 (Karloly pers. comm.). Sea-level rise is reportedly occurring at higher rates and with greater magnitude than projected in IPCC 5.

These increased levels have not been incorporated into policy as yet, but it is important that they are considered when assessing risk and determining adaptation responses. The recently released IPCC report: *Global Warming of 1.5 °C* (IPCC 2018) suggests that adaptation is expected to be more challenging for ecosystems, food and health systems at 2°C of global warming than for 1.5°C (medium confidence). Some vulnerable regions, including small islands and Least Developed Countries, are projected to experience high multiple interrelated climate risks even at global warming of 1.5°C (high confidence). The USA's National Oceans and Atmosphere Administration has recently reported that sea-level rises of up to 2.5 metres may occur by 2100 as a result of rapidly melting ice in Greenland and at the poles (Sweet et al. 2017).

It is important to recognise that a lot of the climate change data are made available as averages and while averages present part of the picture, the upper extremes are more likely to present problems and should be the basis of adaptation.

4 Hospital and Health Service Facilities in the Torres Strait

The Torres and Cape Hospital and Health Service (HHS) is responsible for the health services of approximately 25,000 people widely spread across Cape York, the Northern Peninsula Area and the Torres Strait Islands. Sixty-six per cent of the population in the Torres and Cape HHS identify as Aboriginal and/or Torres Strait Islander. The HHS has facilities on 13 of the Torres Strait islands (Figure 4-1).

The Torres Strait is a complex and variable area servicing communities that are highly distributed. This requires an active network of facilities and regular movement of health professionals and patients across the region. There is a strong reliance therefore on infrastructure such as jetties, airports and roads. In addition, there is a need for good telecommunication infrastructure to enable liaison and interaction. A list of the facilities in the Torres Strait is provided below, together with information on the number of people on each island and the other islands that are serviced by staff at each facility.



Figure 4-1 Map showing locations of health care facilities operated by the Torres and Cape Hospital and Health Service in the Torres Strait. Map from <https://www.health.qld.gov.au/services/torres-cape>

Table 4-1 Description of each of the Torres and Cape Hospital and Health Service’s facilities in the Torres Strait. These provide an insight into the diversity of facilities operated by the TCHHS across the region (information from <https://www.health.qld.gov.au/services/torres-cape>).

Name and location of health centre	
<p>Badu Island Primary Health Care Centre Also services St Paul’s, Kubin and Mabuiag Islands. The centre services 810 people and also services St Paul’s, Kubin and Mabuiag Island.</p>	
<p>Boigu Island Primary Health Care Centre Boigu Island is the most northern point of Australia located 4km south of Papua New Guinea. The facility services 270 people.</p>	
<p>Dauan Island Primary Health Care Centre The facility services 191 people.</p>	
<p>Erub (Darnley Island) Primary Health Care Centre Erub (Darnley Island) is part of the Eastern Cluster of the Torres Strait Islands. The population is approximately 328 people and also provides services on Ugar and Mer islands.</p>	

Name and location of health centre	
<p>Iama (Yam Island) Primary Health Care Centre</p> <p>Iama (Yam Island) is situated in the Central Cluster of the Torres Strait Islands, approximately 100 km north-west of Thursday Island.</p> <p>Iama has a population of approximately 315 people</p>	
<p>Kubin Community Primary Health Care Centre</p> <p>Kubin is one of two communities located on Moa Island (Banks Island). The other community is St Paul's, located 22 km away by sealed road. Both communities have separate health care centres and operate independently of each other but are able to support each other if required.</p> <p>Moa Island is the second largest island in the Torres Strait and lies in the Near Western Cluster, about 40 km north of Thursday Island.</p> <p>The population of Kubin is approximately 163 people</p>	
<p>Mabuyag (Jervis Island) Island Primary Health Care Centre. Mabuiag Island is located in the Near Western Cluster of Torres Strait Islands. Other islands in the cluster are Badu and Moa Island. Mabuiag Island has a population of approximately 260 people</p>	
<p>Masig (Yorke Island) Primary Health Care Centre</p> <p>Masig (Yorke Island) forms part of the Central Cluster of islands. The population of Yorke Island is approximately 270 people.</p>	

Name and location of health centre	
<p>Mer (Murray Island) Primary Health Care Centre</p> <p>Mer (Murray Island) is part of the Eastern Cluster of the Torres Strait Islands. Mer has a total population of approximately 365 people.</p>	
<p>Ngurapai (Horn Island) Primary Health Care Centre</p> <p>Ngurapai (Horn Island) is located in the Inner Cluster of the Torres Strait Islands. It lies approximately 2 km south east of Thursday Island, 900 km north of Cairns and 40 km northwest of the tip of Cape York. Horn Island is often referred to as the 'gateway' to other islands in the region as it has the only airport in the Torres Strait with a domestic terminal.</p> <p>The population of Horn Island is approximately 531 people.</p>	
<p>Poruma (Coconut Island) Primary Health Care Centre</p> <p>Poruma (Coconut Island) is situated in the Central Island Cluster of the Torres Strait Islands. It is a narrow coral island approximately 1.4 kilometres long and 400 metres wide, bounded by shallow, fringing coral reefs. The population of Coconut Island is 167 people,</p>	
<p>Saibai Island Primary Health Care Centre</p> <p>Saibai Island forms part of the Top Western cluster of islands situated in the northern region of the Torres Strait. Saibai has a population of approximately 465 people. Boigu and Dauan Islands are close neighbours and the border villages of Papua New Guinea are only a few kilometres away.</p>	

Name and location of health centre	
<p>St Pauls Community Primary Health Care Centre</p> <p>St Paul's community is one of two communities on Moa (Banks Island). It is located on the northern end of the island, accessible by boat and helipad, and a 20 minute drive from the island's airstrip.</p> <p>The other community is Kubin, located 22 km away by sealed road.</p> <p>Moa Island is the second largest island in the Torres Strait and lies in the Near Western Cluster, about 40 km north of Thursday Island.</p> <p>St Paul's has a population of approximately 258 people,</p>	
<p>Thursday Island Community Wellness Centre</p>	
<p>Thursday Island Hospital</p> <p>The island has an area of about 3.5km². At the 2016 census, Thursday Island had a population of 2900.</p> <p>Thursday Island Hospital is the referral hospital for seventeen Primary Health Care Centres in the Torres Strait Islands.</p>	
<p>Thursday Island Primary Health Care Centre</p> <p>Thursday Island is located 35km north-west of Cape York and 800km north of Cairns and is the major administrative centre for the Torres Strait region and Northern Peninsula Area of Queensland. Thursday Island has a population of approximately 2,900. Staff provide services for the region including inner islands, outer islands and the Northern Peninsula area (about 12,000 people).</p>	

Name and location of health centre	
<p>Ugar (Stephen Island) Primary Health Care Centre</p> <p>Ugar (Stephen Island) is situated in the Eastern Cluster of the Torres Strait Islands. The other islands in the cluster are Erub and Mer. It is home to the region's smallest community of about 50 people. Staff from Mer attend one day a week.</p>	
<p>Warraber (Sue Island) Primary Health Care Centre</p> <p>Warraber (Sue Island) is located in the Central Cluster of the Torres Strait Islands. Other islands in the cluster with health care facilities are Lama (Yam Island), Masig (Yorke Island) and Poruma (Coconut Island). Warraber has a population of approximately 250 people</p>	

5 Introduction to Health and Climate Change

5.1 Torres Strait Health Context

Before examining climate and climate change interactions with health, it is worthwhile providing an introduction to the existing state of health of Torres Strait Islanders more broadly. According to the 2016 Australian census figures, the population of the Torres Strait Region was 9,555, of which 80% identified as Torres Strait Islanders (7,615) (ABS 2017). Aboriginal and Torres Strait Islander people are generally recognised as having an increased burden of chronic disease in comparison to non-Indigenous Australians, and this situation is worse in remote areas (McIver and Liu 2015).

At the National level, the 'Close the Gap' campaign initiated by the Council of Australian Government in 2008 is relevant in that it sets out the overarching National targets for health (and also education and employment) indicators, with the aim of addressing the entrenched and multigenerational disadvantage for Indigenous Australians. Within this campaign, the specific health targets include (DPMC 2018):

- (1) Close the gap in life expectancy within a generation (by 2031); and
- (2) Halve the gap in mortality rates for Indigenous children under five by 2018.

In terms of present progress against these targets (nation-wide), the following is reported in the 2018 Closing the Gap Report (DPMC 2018):

- The target to close the gap in life expectancy by 2031 is not on track. Between the periods 2005-2007 and 2010-2012 there was a small reduction in the gap of 0.8 years for males and 0.1 years for females. Over the longer term, Indigenous mortality rates have declined by 14 per cent since 1998.
- The target to halve the gap in child mortality by 2018 is on track. Over the long term (1998 to 2016) the Indigenous child mortality rate has declined by 35 per cent, and there has been a narrowing of the gap (by 32 per cent). Improvements in key drivers of child and maternal health over the past few years suggest there are further gains to be made.

In the Queensland context the health gap is the difference between the Aboriginal and Torres Strait Islander burden of disease estimates and those for the general population. In Queensland the life expectancy gap is currently estimated at 10.8 years for males and 8.6 years for females (Queensland Health 2018). In Queensland there are six leading drivers of the health gap, which together explain 74% of the health gap. These include:

- Cardiovascular disease – an estimated 20% of the health gap;
- Diabetes – an estimated 16% of the health gap;
- Mental disorders – an estimated 16% of the health gap;
- Chronic respiratory disease – an estimated 9% of the health gap;
- Intentional injuries – an estimated 7% of the health gap; and
- Cancers – an estimated 6% of the health gap.

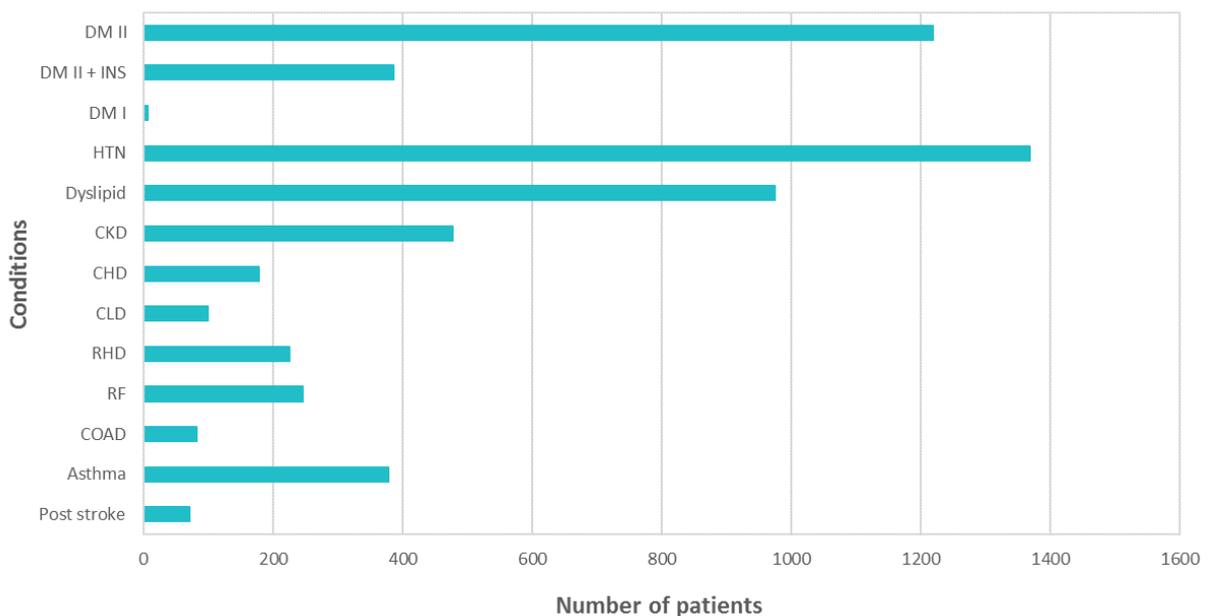
Cardiovascular disease, diabetes and mental disorders are the leading contributors to the health gap, including in remote areas such as the Torres Strait, together accounting for 52% of the health gap in Queensland (Queensland Health 2018).

In terms of disease burden, the key risk factors include:

- Smoking, alcohol and other drugs;
- Obesity, low rates of physical activity and poor nutrition;
- High blood pressure and high cholesterol;
- Unsafe sex; and
- Child sexual abuse and intimate partner violence.

Of these, obesity and smoking were the largest individual causes of health loss, contributing 13% and 11% respectively to the total burden of disease (Queensland Health 2018).

Mclver and Liu (2015) provide a review specific to chronic disease in the Torres Strait, recording hypertension, type II diabetes mellitus and dyslipidaemia (e.g. hypercholesterolemia) as the most common chronic diseases (Figure 5-1).



RF = rheumatic fever, RHD = rheumatic heart disease COAD = chronic obstructive airways disease, HTN = hypertension, CLD = chronic liver disease (mainly hepatitis B), CHD = chronic heart disease, DM II = INS = diabetes mellitus, type II on insulin

Figure 5-1 Torres Strait 2014 Chronic Disease Burden (Mclver and Liu 2015)

Torres Strait health professionals interviewed during the course of this project reflected that the above health trends are broadly applicable to the Torres Strait. Specific existing (non-climate) health concerns mentioned in the context of Torres Strait included:

- The Torres Strait community tend to be affected by chronic diseases at earlier stages in life and have earlier progression of disease, when compared to elsewhere.

- Health issues associated with overcrowded housing (i.e. living arrangements).
- Lower socio-economic backgrounds limiting preventative and follow-up care.
- International border risks (i.e. the close proximity to Papua New Guinea means that tuberculosis, leprosy, mumps and yaws are more visible).
- The geographical spread and isolation of the islands presents unique (and perhaps complicated/expensive) logistical and operational challenges for the health system.

Given the high prevalence of chronic diseases in the Torres Strait, chronic disease management is a critical health priority (McIver and Liu 2015). McIver and Liu (2015) go on to summarise key challenges to managing chronic disease in the Torres Strait (). It is expected that climate change will add an additional pressure that compounds health issues for the local communities and health system.

Table 5-1 Challenges faced by clinicians when managing chronic disease in Torres Strait (adapted from McIver and Liu 2015)

Challenge Category	Challenge
Environmental	Limited options at supermarket
	Lack of facilities and human resources
	Remoteness, distance
	Desalination of water
	Hot climate deters patients to exercise
Patient	Getting patients motivated
	Poor patient compliance
	Cultural values, affecting eating habits
	Lifestyle, poor eating habits
	Lack of knowledge to the importance of health, poor understanding
	Lack of health education and access to technology for more health knowledge
Clinician	Lack of continuity of care
	Lack of coordination, teamwork, consistency
	Lack of time, human resources
	Multiple systems for recording data
	Lack of recall system
	Lack of effort in non-medical side, e.g. health promotion
	Lack of standardisation of management

5.2 Existing Climate Related Health Challenges in the Torres Strait

As outlined above, Torres Strait communities and the local health system face a variety of existing and inter-related health challenges. Current weather patterns and climatic extremes (i.e. existing climate in the absence of future climate projections) also contribute to the challenges. Most notably:

- The low-lying islands of Saibai, Boigu, Masig, Warraber, Lama and Poruma are regularly affected by saltwater inundation and subject to coastal erosion). Low lying villages on Mer, Erub and Mabuiag are also at risk of flooding and erosion close to their homes and key infrastructure. This causes extreme distress and worry in the community.
- Excessive heat (air temperatures) and humidity result in lower rates of physical activity in the communities (i.e. exercise), which has flow on effects to health.
- Higher temperatures contribute directly to poor health of vulnerable people in the community and cause incidence of heat rash, heat exhaustion and heat stroke, and may also contribute to heart attacks and deaths (Green et al. 2010).
- High temperatures and high rainfall at certain times of year can increase the transmission rates of infectious diseases.
- Some islands have little space for housing (i.e. little land space for additional dwellings to be built) and existing houses are often overcrowded by National standards. Housing conditions alone, but also in combination with climatic factors such as heat and storm surge events, can facilitate the spread of disease through communities and add to mental health burdens.
- Outbreaks of Dengue fever and other mosquito borne viruses can be associated with wet weather events.
- There are often shortages of safe drinking water in many places and a reliance on desalination to help fulfil the needs of communities. There is frequently a need to boil even municipal water supplies.
- Climate can affect the productivity of horticulture (both locally and elsewhere), and therefore the availability, affordability and quality of fresh produce for human sustenance and nutrition.
- Periods of warmer than usual sea temperatures have caused widespread coral bleaching, and are also (anecdotally) blamed for productivity declines in the local seafood catch, including both artisanal and commercial seafood catches. Seafood is a key protein source throughout the Torres Strait and is an important source of income and livelihoods, particularly for the eastern group of islands. Reduced seafood supply can affect health both directly (i.e. diet, mental health) and indirectly (i.e. affordability and access to health good and services).

5.3 Impacts to Health from Future Climate Change

It is anticipated that climate change will have a range of direct and indirect impacts on human health and on the services provided in the human health services area. Direct impacts are those caused by exposure to climate change related events such as the increasing frequency and intensity of weather events such as drought, flood, storms, hot days and heat waves. Indirect impacts are those where other drivers of human health are changed due to climate effects. Additionally, climate change is likely to act as a risk multiplier, exacerbating many of the pressures and risks which occur at present. The following have all been identified as direct or indirect impacts of health and wellbeing due to climate change:

- Increased risk of heat related health impacts (heat stress, dehydration, cardiovascular failure, increased conflict);
- Death or injury from extreme weather events;
- Spread of vector-borne diseases such as dengue, chikungunya and malaria;
- Increased allergens impact respiratory allergies and asthma;
- Declines in the quality and availability of food;
- Declines in the availability, safety and quality of drinking water;
- Increased impacts on mental health;
- Increased risk of antibiotics resistance; and
- Displacement of people from their homes, forced migration.

Some people are more sensitive to the impacts of climate change. These include the elderly, young children, people with medical conditions, people with a mental illness, people with a disability, pregnant women, culturally and linguistically diverse groups, and low-income households. Impacts on these communities will place more pressure on the public health system, noting that climate change could also directly affect health system assets and services (Watts et al. 2015). Figure 5-2 conceptually summarises some of the key direct and indirect interactions between climate change and human health.

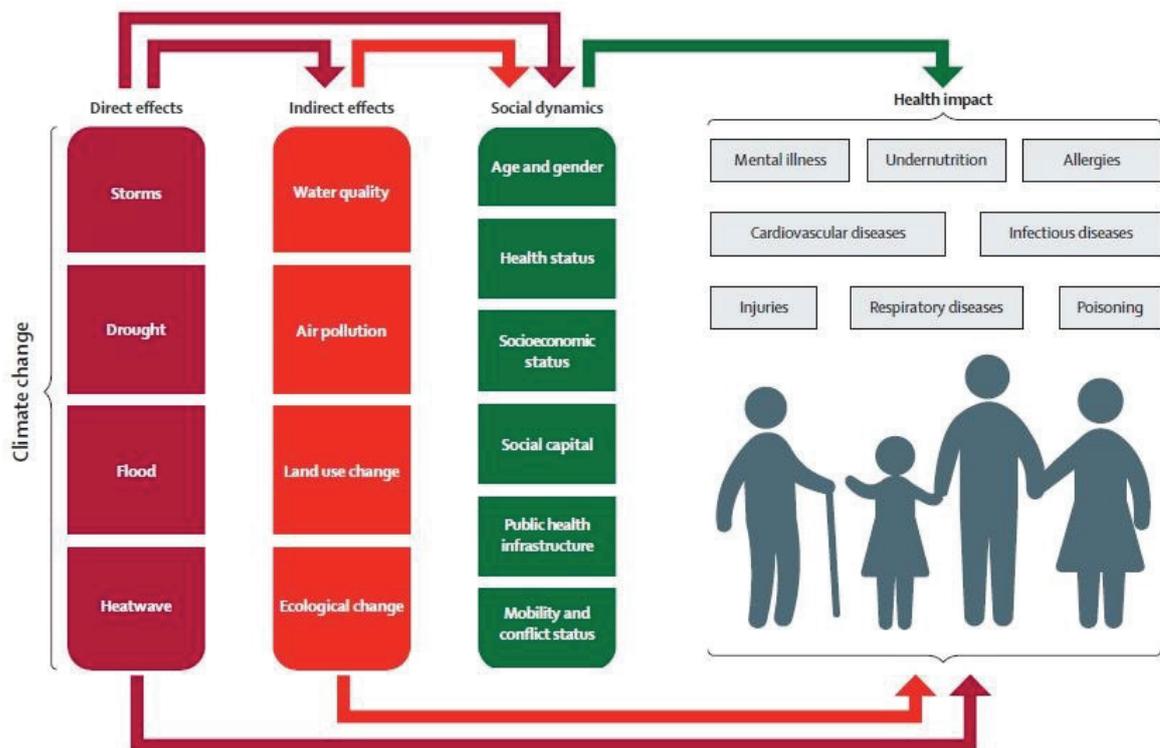


Figure 5-2 Direct and indirect effects of climate change on health and wellbeing (Watts et al. 2015)

5.4 Heat Related Health and Wellbeing Risks for the Torres Strait

Most heat stress research has focused on higher latitude communities where seasonal temperature variation is greater than in the tropics, and where heat waves tend to be more extreme and have led to significant impacts on health and wellbeing.

Whilst tropical regions tend not to be subject to such temperature extremes, they experience prolonged seasons of high temperatures accompanied by significantly higher humidity levels. The effects of exposure to heat combined with high humidity results in extreme heat stress risks lasting many months. Whereas acclimatisation offers some protection, human thermoregulatory capacity has upper physiological limits. Further exacerbation of heat and humidity extremes elevates risks for all who live in tropical regions as global warming progresses.

People living in hot regions of the world are already at or close to the upper limit of their potential to acclimatise to any further increases in temperature. Factors that increase vulnerability to heat stress include obesity, age (very young and very old), lack of physical fitness, illnesses that reduce the body's thermoregulatory capacity (illness that affect the cardiac, nervous and renal systems in particular).

It is possible that despite being acclimatised to warm weather, that many Torres Strait Islanders are already close to the limits of their capacity to cope with heat stress, a situation that will be exacerbated due to increasing temperatures due to climate change. Periods of very hot weather can also exacerbate other social issues as people's social tolerance levels decrease from heat irritation. A study reviewing heat impacts on human conflict found a very strong relationship between increase

in warmer temperatures and increased rates of interpersonal violence (Quantifying the Influence of Climate on Human Conflict, Hsiang et al 2013).

The capacity to significantly upscale acclimatization diminishes among those in hot regions, where acclimatization is already approaching thermal maxima for human tolerance. Survival will require capacity to lessen extreme heat exposures through expansion of existing technical and behavioural adaptations, where possible. These nations are at extreme heat risk. Hanna and Tait, 2015: Limits to thermoregulation and Acclimatisation Challenge Adaptation to Global Warming

Annual average apparent temperatures in the Torres Strait are currently around 38.4°C (summer average apparent temperatures are 42.3°C). Annual average temperatures are projected to increase an annual apparent temperature of 42.2°C by 2070 under current high emissions trajectories. The U.S. National Oceanic and Atmospheric Administration (NOAA) provides a Heat Index table as a ready reckoner to test when climatic conditions fall into the danger zones for human health (Fig. 1). An examination of this Heat Index table shows current temperature and humidity conditions in the Torres Strait already fall into the danger zone of extreme human health risk at intervals during summer (Fig 2.).

Cultural adaptations among Torres Strait Islanders recognise the impacts of heat and avoid participating in vigorous outdoor activities during hot weather when able. However, the imposition of a western 9-5 workday regime means that many people now undertake outdoor activities throughout the year, at direct risk of increased exposure to heat related health impacts. Whilst access to cool area is a key adaptation option, the excessive use of air-conditioning may also be contributing to a lowering of the acclimatisation levels of some members of the community. Many homes in the Torres Strait do not have air-conditioning and often lack good passive design to reduce heat uptake.

The convergence of multiple risk factors heralds significant heat risks among Torres Strait Island communities. Multiple strategies are required to alleviate the associated health risks which are escalating under a warming climate. A baseline study is needed to characterise and quantify heat exposures, current practices, and community perceptions of their risks. Strategies will need to be worked out in collaboration with the community to ensure community buy-in and appropriateness.

6 Climate Change Risk Screening

The climate change risk assessment component of this report is presented as a tabulated climate change risk screening.

This risk screening lists various climate change hazards (i.e. sea level rise, air/sea temperature, cyclones, drought etc.), noting that Section 3 indicates the projected hazard change. Multiple potential health related effects/impacts are listed for each hazard, as applicable. For each of these effects, subsequent table columns provide detail with respect to the following:

- Have these occurred in the past in the Torres Strait and what was the effect?
- Is there an existing risk management strategy in place to tackle this hazard?
- Is there any residual (remaining) risk from this hazard?
- Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?
- Recommended actions.
- Broad (high/medium) prioritisation of recommended actions.

For clarity, the potential climate change effects to health services have been allocated to one of the following categories:

- (1) Risk to Hospital and Health related infrastructure;
- (2) Risks to hospital operational activities including risks to staff and patients; and
- (3) Risk to demand on the health system.

The climate change risk screening is presented on the following pages as Table 6-1.

For the prioritisation of recommended actions, we have provided an indication of the relative high level priorities. To do this we assigned two categories: high and medium. Further information (e.g. defining urgency, funding allocations and other key decision making criteria) would be required to prioritise further. High priorities reflect actions which address issues where there is already a residual risk from the climate stressor, and where immediate benefits will be derived from those recommendations. Medium priority reflects those recommendations which address areas of risk which are not apparent at present, or where current management actions are working effectively. Note that some recommendations will be listed as high priority for one stressor and low priority for others.

Climate Change Risk Screening

Table 6-1 Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in <i>Italics</i> are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Risk to hospital and health related infrastructure						
Storms	These have occurred but have not directly impacted hospital and health related infrastructure, although they have caused flooding and erosion.	Not specifically for health service infrastructure, but sea walls have been built which prevent extensive erosion. Flooding occurs on low lying mud islands (confirmation required as to whether health infrastructure has flooded in the past).	Yes, damage does occur during storms at some locations	An increase in storm magnitude may impact health infrastructure on some islands by causing flooding or direct storm related damage. This is likely to occur by 2030 and beyond. Increased storm activity will also likely lead to more regular disruption to electricity supplies, with associated impact on the ability of the hospital system to operate effectively. In many cases air conditioners are unable to operate while backup generators are being used, which could be problematic during periods of hot weather. Loss of electricity may prevent healthcare facilities from using modern equipment and tools. Once renewable energy infrastructure such as solar and wind infrastructure is developed there may be a risk that these will be damaged during storms. This is likely to occur in 2070.	A detailed climate change risk assessment of hospital and health infrastructure should be undertaken and a program initiated to upgrade facilities to increase their resilience to climate change impacts. This should be supported with an economic analysis to determine when the most appropriate times are for implementing actions such as repairing facilities after impact, enhancing resilience of facilities to reduce impact or relocating facilities. <i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i>	High
Cyclones	Extreme winds and associated storm surge associated with cyclones can cause direct damage to health facilities (e.g. roof and windows). Storm surge related damage on low lying islands.	Sea-walls to reduce erosion Health facilities constructed in accordance with design standards for cyclone areas. Emergency management plan to be enacted when cyclones occur	Sea walls have been damaged by strong surges on some islands. Storm surge inundation is not reduced by sea-walls.	Stronger and longer lasting cyclones and higher sea-levels will result in greater impact from winds and storm surge than those faced at present and these may impact hospital infrastructure, access roads and emergency services facilities. Facilities, roads and infrastructure on low-lying islands are particularly vulnerable. This is likely to become more apparent after 2050.	A detailed climate change risk assessment of hospital and health infrastructure should be undertaken and a program initiated to upgrade facilities to increase their resilience to climate change impacts. This should include a review of all health facilities building codes. This should be supported with an economic analysis to determine when the most appropriate times are for implementing actions such as repairing facilities after impact, enhancing resilience of facilities to reduce impact or relocating facilities.	High
Sea-level rise	Impact on ground water salinity on low lying islands. Supplies can be contaminated.	Hospitals use desalination and bottled water	Not at present although plastic bottles result in a waste management issue.	Impacts on ground water resources and other water supplies likely to increase with a resultant increase in reliance on desalinated water or on bottled water. This will increase expenses and the waste management challenge will be exacerbated.	<i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i> <i>There is a need to work with communities, local and state governments to address climate risks to water security and supply.</i>	Medium
Sea-level rise	Sea-level rise has exacerbated beach erosion on some low-lying islands.	Sea-walls constructed to reduce erosion (Ti and Saibal). Some individuals and communities have	There is residual risk as erosion continues to occur in some areas.	Sea-level rise may lead to health infrastructure on low lying islands being inundated, potentially affecting infrastructure and services. The extent (height and timing) of inundation will vary as will the impact on the facility. Rates of sea-level rise will increase after 2050.	A detailed climate change risk assessment of hospital and health infrastructure should be undertaken and a program initiated to upgrade facilities to increase their resilience to climate change impacts. These may include raising electricity-based and other infrastructure well above inundation height. It may be necessary to relocate facilities on or between islands.	High

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Heat and heatwaves	Heat and heatwaves create a reliance on electricity to drive air-conditioning, ensure sufficient water supplies are available etc. Heat can also impact electricity infrastructure directly. There is a high demand on diesel to drive generators and provide electricity. Electricity failure can compromise ability of important infrastructure to operate. E.g. water treatment.	undertaken their own works to address erosion	No	Sea-level rise will increase the impact of storm surge from cyclones and storms. This may increase the likelihood and consequence of damage to health service buildings, and essential infrastructure (e.g. roads, jetties, electricity). Increased heat and longer heatwaves will increase demand on electricity supplies and may cause disruption to electricity supplies. Although facilities have generators, some of these may not be able to run air conditioners in addition to enabling other health services to be sustained at each location. Electricity failure can disrupt other essential services such as sewage treatment and water desalination plants, which can impact the health service and their staff.	There is a need to assess the cross dependencies between different services (roads, electricity, water, communications) to help to understand the most susceptible aspects of the system. <i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i> <i>Local government and the health sector should collaborate to identify where there are risks to health from water quality and water security in the Torres Strait. Management plans should be developed in high and medium risk areas.</i>	Medium
All hazards	Impacts on health infrastructure	Health services are upgraded in response to present events and needs	No	Health infrastructure planning is not taking climate change into account and resources may be being invested into short-term outcomes and not considering the future. For example, should new infrastructure be built on the northern Cape rather than the islands?	A detailed risk assessment should be undertaken for all health care facilities. This should be used to develop a long-term plan for maintenance, upgrading or relocating facilities and services. This should be supported with an economic analysis to determine when the most appropriate times are for implementing actions such as repairing facilities after impact, enhancing resilience of facilities to reduce impact or relocating facilities.	Medium
Droughts	Long dry periods reduce water availability and water supply infrastructure is more susceptible to contamination.	Desalination plants, Purchasing bottled water.	No, but does contribute to waste management issue for health services	Desalination is very power hungry and is expensive. Bottled water is also expensive and contributes extensively to waste issues. Waste management facilities are an important aspect of health service infrastructure. On some islands extended drought will increase fire and bushfire risk, which may pose risks to health services and infrastructure	<i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i> <i>Local government, and the health sector should collaborate to identify where there are risks to water security in the Torres Strait. Management plans should be developed in high and medium risk areas.</i> <i>Islands should have the capacity to manage and control fires in or near their community areas</i>	Medium

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Risks to hospital operational activities including risks to staff and patients						
Storms	Heavy rains and strong winds during storms have been noted to impact infrastructure on some low-lying islands. The impact has either been a result of flooding (on mud islands) or erosion (on sandy islands). The ability to transport people by road or air is compromised. Patients become isolated and must wait longer for care.	Health services have an emergency management plan which is implemented as required, and which is working effectively under current conditions.	No	An increase in storm magnitude is likely to impact health infrastructure and access routes to health facilities. Increased storm activity will also likely lead to more regular disruption to electricity supplies, with associated impact on the ability of the hospital system to operate effectively. In many cases air conditioners are unable to operate while backup generators are being used. Storms also damage infrastructure (including electricity). This can affect equipment and software and impacts the ability for healthcare facilities to use modern equipment and tools.	Weather warnings should be used to underpin contingency planning and the potential for patient isolation should be a key consideration when determining and prioritising management actions. The access routes to and from health facilities should be assessed to determine their susceptibility resilience to climate change effects. This should also include assessments of boat ramps, jetties and airstrips. A long-term plan should be developed to upgrade priority infrastructure.	Medium
Storms	Floods can contaminate water supplies. <i>Cryptosporidium</i> already an issue	Desalination plants, Purchasing bottled water. Good guidance available and staff awareness is high. Boiling water	No, good guidance is available, and the community has a good awareness of the issue. Waste management is an issue.	Desalination is very power hungry and is expensive. Bottled water is also expensive and contributes extensively to waste issues. Waste management facilities are an important aspect of health service infrastructure.	<i>Renewable energy sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i> Hospital and health services should develop a waste management plan to support facilities to manage their waste appropriately. Water quality monitoring should be continued and used to inform hospital managers to ensure that staff and patients are not affected by poor water quality.	Medium
Cyclones	During cyclones and associated bad weather, patient transport is disrupted. There is a reliance on helicopters, planes and boats. When these are compromised, patients become isolated and cannot get to health clinics or the large health care facilities on Thursday Island or in Cairns. Cyclones affect access to and from hospitals and health services. This makes it difficult to move sick people, erodes roads, damages destroy infrastructure.	Health services have an emergency management plan which is implemented as required, and which is working effectively under current conditions.	Yes, although works well most times it can be strained during extreme events	An increase in the magnitude and strength of cyclones as a result of climate change, combined with higher sea levels will increase the current challenges on these communities. This could include the need for mass evacuations from low lying islands to reduce potential for loss of life. Major cyclones in the Cairns region can also impact the Torres Strait through impacts on supply lines to the region and the greater need for health and emergency services resources to be deployed on the mainland	<i>The HHS should develop a Business Continuity Plan for each facility outlining how to function effectively during and following extreme events. This should include close liaison with the Emergency Services sector.</i> Weather warnings should be used to underpin contingency planning and the potential for patient isolation should be a key consideration when determining and prioritising management actions. <i>The access routes to and from health facilities should be assessed to determine their susceptibility resilience to climate change effects. This should also include assessments of boat ramps, jetties and airstrips. A long-term plan should be developed to upgrade priority infrastructure.</i>	High

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Cyclones	Cyclones can increase demand for services and cause stress for staff	The health work force is not sufficient (in numbers and skills) and not well organised. Challenged with addressing current needs.	No, there is strong support from Queensland Health and the emergency services sector	Increased magnitude of cyclones will exacerbate the challenge. Staff and patients need to be confident that the system is able to cope during these events. In large events support from Queensland health and the Emergency Services may take longer than expected.	The HHS should develop a Business Continuity Plan for each facility outlining how to function effectively during and following extreme events. This should include close liaison with the Emergency Services sector. Staff should be trained in how best to maintain patient services during extreme events.	Medium
Cyclones	Impacts on desalination plants and wells, can affect water security on affected islands. Floods can contaminate water supplies. <i>Cryptosporidium</i> already an issue.	Bottled water is used and water is boiled. Guidelines are available from the Department of health.	No	Impacts on water supply and water treatment services following cyclones, may lead to a spread of illness or bacteria. Bottled water is also expensive and contributes extensively to waste issues. Waste management facilities are an important aspect of health service infrastructure.	Hospital and health services should develop a waste management plan to support facilities to manage their waste appropriately. Water quality monitoring should be continued and used to inform hospital managers to ensure that staff and patients are not affected by poor water quality.	Medium
Cyclones	Cyclones destroy houses creating problems for staff and patients.	Houses are built to design standards	Yes, in some areas houses are low lying and at risk from wind and associated storm tide damage.	Staff housing may be impacted, preventing staff from attending work.	Staff housing should be assessed and upgraded to increase resilience to winds and storm surge. <i>This can be done in collaboration with actions planned by the TSRA.</i>	High
Sea-level rise	Salt water ingress into ground water on some islands affecting groundwater Saltwater ingress into sewerage infrastructure can impact the ability of the sewage treatment plant to function.	Drinking bottled water	Yes	Impacts on water supply and water treatment services following cyclones, may lead to a spread of illness or bacteria. Bottled water is also expensive and contributes extensively to waste issues. Waste management facilities are an important aspect of health service infrastructure. Non-functioning sewage treatment facilities can impact health service staff and operations	Hospital and health services should develop a waste management plan to support facilities to manage their waste appropriately. Water quality monitoring should be continued and used to inform hospital managers to ensure that staff and patients are not affected by poor water quality. <i>Engage with TSRA to understand the implications of sea-level rise to ground water and accordingly to the operational activities of the health service.</i>	High
Sea-level rise	Sea-level rise to date has exacerbated beach erosion in some areas.	Sea-walls constructed by government or by private individuals	No, erosion still occurs in some areas and sea-walls have failed at times. This has not affected the health service.	Sea-level rise will continue to increase erosion rates at unprotected areas. This may cause issues for access routes to health services.	<i>The access routes to and from health facilities should be assessed to determine their susceptibility resilience to climate change effects. This should also include assessments of boat ramps, jetties and airstrips. A long-term plan should be developed to upgrade priority infrastructure.</i>	Medium
Sea-level rise	Infrequent inundation of access roads to hospital	No management plan in place.	Yes, but very low residual risk	Regular inundation of access roads to hospital potentially impacting supply chains, access by patients and staff. The extent of impact will vary between islands.	<i>The access routes to and from health facilities should be assessed to determine their susceptibility resilience to climate change effects. This should also include assessments of boat ramps, jetties and airstrips. A long-term plan should be developed to upgrade priority infrastructure.</i>	Medium

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Heat and Heatwaves	Staff not affected to date	Heat management guidance available from Queensland health. Bottled water available for staff and patients. Air conditioners present in health service buildings.	No	Increased demand for electricity during excessively hot days or heatwaves can lead to electricity failure. This has implications for the ability of hospitals to provide service. Backup generators may not be able to support air conditioners. Disruption of electricity as a result of cyclones and extreme storms, can prevent hospitals from providing service.	<i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i>	Medium
All hazards	Difficult to attract staff to work in isolated areas		No	Conditions associated with a changing climate will reduce the attraction for potential staff in the islands which can impact the ability for the health services to operate effectively.	Housing and accommodation for health and hospital staff must be made climate friendly and comfortable, and resilient to climate related impacts. This will help to ensure that staff can be attracted to work in these locations. Effort should be made to build capacity and train local Torres Strait Islanders in health sector skills. This will increase the likelihood of maintaining staff numbers into the future. The connection with the Torres Strait in terms of culture and spirituality has additional potential benefits.	Medium
Risk to demand on the health system						
Heat, heatwaves and associated humidity	During periods of very hot weather, elderly people have been more prone than usual to heart attacks and other cardiovascular and respiratory issues. Other vulnerable groups such as young children and those suffering from other illnesses are also affected.	Increased hospital admissions are managed through regular approaches. There is a good existing knowledge in the community about the need to drink lots of fluids and avoid physical exertion. <i>(Do all hospitals and health facilities have air conditioning?)</i> <i>(What are implications for staff housing?)</i>	Yes, the health work force is not sufficient (in numbers and skills) and not well organised. Challenged with addressing current needs.	With expectations of increased heat and longer heat waves, impacts of heat and heatwaves are likely to increase, resulting in increased hospital admissions and potentially increased mortality. Discouraging physical exertion can reduce physical activity and lead to other health risks. The effect of heat and heatwaves is likely to impact the potential of recruiting quality health staff to the area. This will also be compounded by other climate change related pressures.	<i>Monitor impacts on health during heat events.</i> <i>Housing design should be improved to help alleviate heat and humidity stressors. Better design can help to make the most of sea breezes for example.</i> More shading should be provided on all inhabited areas. Potable water should also be easily accessible. The health services should develop and circulate guidance for indoor and outdoor workers to support them to work safely during heat and heatwaves. This may include frequent drink breaks, opportunities to seek respite from heat in air-conditioned areas, and access to better quality and more suitable clothing. <i>This can be done in collaboration with project work planned by the TSRA.</i> <i>The implications of reduced physical activity should be made clear to community leaders and approaches to increase activity safely should be considered and implemented. E.g. shaded exercise equipment and easy access to drinking water.</i>	High

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Heat and heatwaves	Higher temperatures and other extreme conditions discourage people from exercising	Programs in place to encourage exercise	Yes, most people still preferring to take taxis (even for short distances)	Hotter weather and longer heatwaves will continue to discourage people from exercising. This can have an impact on the general health of the Torres Strait community and increase admissions.	<i>It is important that adaptation options do not contribute to green-house gas emission. For example, cooling options should use renewable energy. An example of a key action is to reduce the reliance on diesel in the Torres Strait.</i>	High
Heat and heatwaves	High electricity demand		No, demand is under control at present	Potential disruption to electrical supplies due to disruption of electricity during heatwaves will prevent people from being able to boil water or freeze foods. This could impact health and increase demand on the health services.	<i>Renewable energy and battery sources should be used to power facilities. In the longer term, battery technology should be considered as an alternative to backup generators.</i>	Medium
Sea-level rise	High tides already impact some areas of the Torres Strait. These include land loss in some areas and the ability to develop new homes on low-lying lands. This is leading to overcrowding. Overcrowding (more than 2 people per bedroom) links directly to poor health – generally through infections and chronic diseases. People living on very low relief islands already have no option but to develop in erosion prone areas.	There are attempts to build more houses, most is government housing but there is limited land available.	Yes, overcrowding continues	Climate effects on housing and housing availability is the biggest issue over the timeframes of this project. Higher seas will continue to reduce the amount of land available (either through inundation or from loss of land to erosion). This will add further stress to the housing system and exacerbate all health implications.	<i>Overcrowding should be addressed through the provision of safe and resilient houses. Where land is limited stakeholder engagement must be undertaken to underpin the development of a sustainable long-term plan, including the potential for relocating some of the community.</i>	High
Sea-level rise	Northern sand and mud islands (not rocky islands) are experiencing a greater frequency of inundation. Low lying areas in Saibai, Boigu and Yam islands already result in houses and infrastructure being flooded. Impacts include: Increased risk of vector borne diseases Damp and mould in houses – increased skin infections and respiratory illness Increased anxiety, stress and associated mental health issues because of damage to	\$25 million has been spent constructing a seawall, but this was not aimed at reducing flooding but at reducing energy and foreshore erosion.	Yes	Sea-level rise will continue to affect low lying islands. As the impact becomes clearer, the likelihood of stress and associated mental illness will increase.	<i>An education and awareness program should be undertaken in affected or at-risk communities. The Adaptation and Resilience Plan for the Torres Strait should be implemented and monitored and adjusted accordingly. Need better engagement with local political leaders to get them to help drive change. Community leaders need to engage more effectively and more regularly with the broader Torres Strait Islander community. Health practitioners must be well trained in assessing, diagnosing and addressing mental health issues. As the incidence of these issues increases, the health system should be prepared to provide effective support. This includes appropriate resourcing.</i>	High

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
	<p>home and property and not having any alternatives. Also people worrying about family members.</p> <p>Impacts on people's mental health as they see their assets being affected. Losing homes and lifestyle. The notion of leaving their homeland.</p>				<p><i>Establish monitoring programs that can assess impacts of climate related impacts on health</i></p> <p><i>Ensure long-term post event monitoring programs are developed to monitor community recovery (mental and physical health and well-being).</i></p>	
Sea-level rise	<p>Impact on ground water salinity and quality. Supplies can be contaminated</p>	<p>Guidance on boiling water before drinking.</p> <p>Desalination plants.</p> <p>Purchasing bottled water.</p>	yes	<p>Sea-level rise can affect quality of ground water and impact wells and can also directly affect desalination plants. This can affect drinking water supplies.</p> <p>Increasing population size (not great, but enough to be material) will increase demand which can present challenges in maintaining sustainable water supplies.</p> <p>Purchasing bottled water reduces available income of the community and can reduce their ability to afford other essential items.</p>	<p>Drinking water should be monitored and appropriate management actions should be taken and resourced. There should be a focus on ensuring access to healthy water for all communities.</p> <p>In maintaining water supplies, there is a need to ensure that community gardens and shade trees are able to get adequate water to ensure that the climate change adaptation benefits they provide are maintained.</p>	High
Sea-level rise	<p>Saline ground water and tidal inundation can prevent growth of fresh fruit and vegetables.</p>	<p>Older generation grow food, fish and hunt.</p> <p>Younger generation relies on shops</p>	<p>Is an issue – older generation still able/happy to grow fruit and veg and source food from the land and sea, but younger generation more focussed on purchasing food.</p> <p>Disruptions through climate prevent supplies and increase costs.</p>	<p>Ability to grow fresh fruits and vegetables in some areas may be compromised. This can have direct implications for health and well-being of affected communities.</p> <p>Climate change likely to increase risk as may affect transport and supply of food (also affecting food quality and prices in the process).</p> <p>Influence the ability to grow fresh produce locally</p>	<p>The ability of communities to grow fresh fruit and vegetables is important. Community gardens on high ground or on constructed garden beds above inundation levels can help. This will increase access to nutrients for the community and have a positive influence on health.</p> <p>Develop and implement education program on growing fresh fruit and vegetables targeting younger community members.</p>	High
Heat (ocean)	<p>Warming seas and associated coral bleaching have recently caused a collapse of the crayfish fishery, a major industry. A \$10 million loss affects the local economy and livelihoods (and therefore spend on health).</p>		<p>Yes, there are no replacement fishery opportunities</p>	<p>Yes, ocean temperatures continue to increase. Without global climate mitigation, coral reef will continue to be stressed and bleaching will continue to occur. When this occurs on a regular basis, recovery potential is reduced. The crayfish fishery will continue to be affected with flow throughs to community resilience and impact on economy and livelihoods.</p> <p>Lack of a viable income can lead to mental health issues of affected communities.</p> <p>Financial hardship resulting from climate change related impacts is likely to reduce the ability of people to present at clinics and hospitals when they are sick. This can impact recovery rates and general population health.</p>	<p>Undertake investigations into alternative fisheries for local businesses. Failing this, alternative business/income sources should be identified.</p> <p>Health practitioners must be well trained in assessing, diagnosing and addressing mental health issues. As the incidence of these issues increases, the health system should be prepared to provide effective support. This includes appropriate resourcing.</p>	High

Climate Change Risk Screening

Potential hazards	Have these occurred in the past in the Torres Strait and what was the effect?	Is there an existing risk management strategy in place to tackle this hazard?	Is there any residual (remaining) risk from this hazard?	Does this hazard have the potential to become problematic in future? If so how and under what level of climate change?	Recommended actions (actions listed in italics are identified in the Torres Strait Regional Adaptation and Resilience Plan)	Priority
Drought	Droughts have occurred in the region and have put pressure on drinking water supplies in some areas.	Yes, bans on drinking tap water are often implemented. Residents must boil water before drinking or purchase more expensive bottled water. This reduces available income and reduces capacity to spend on health Water is brought to Home Island from Thursday island.	Presently able to cope with the management plans that are in place and community adhere to bans and boiling water requirements. Bottled water use affects waste management in the Torres Strait and increases litter.	Droughts affect growth of fresh fruits and also compromise water security in some areas. This increases demand for desalination, water delivery and use of bottled water. Purchasing bottled water reduces available income of the community and can reduce their ability to afford other essential items. Droughts in PNG may lead to an increase in PNG nationals moving to the Torres Strait for resources. This may increase likelihood of diseases such as malaria and tuberculosis being brought into the area	Drinking water should be monitored and appropriate management actions that focus on ensuring access to healthy water for all communities should be taken and resourced. In maintaining water supplies, there is a need to ensure that community gardens and shade trees are also able to get adequate water to ensure that the climate change adaptation benefits they provide are maintained. A Torres Strait waste management plan should be developed to help reduce the impact of plastic bottles.	Medium
Floods	Floods result in pools of water throughout the islands enabling mosquito breeding and increasing the risk of vector borne illnesses.	Yes, the health service monitors for incidence of vector borne diseases and takes action accordingly	Yes, there are occasional outbreaks	Climate change may affect the range and extension of mosquito species. This may result in different mosquito borne diseases becoming established on Torres Strait Islands	<i>Monitoring programs should be increased to enable early identification of vector borne illnesses.</i>	High

7 Discussion

Here we build on the climate change risk screening results, by also considering the:

- (1) The Torres Strait Regional Adaptation and Resilience Plan 2016-2021;
- (2) Areas of the Torres Strait that are considered most at risk from climate change impacts to the health system;
- (3) Torres Strait communities considered most at risk from climate change impacts;
- (4) Torres Strait Sectors considered to be most at risk from climate change impacts;
- (5) Information gaps with respect to climate change and human health;
- (6) Key health sector linkages; and
- (7) Emissions reduction and sustainability.

7.1 Summary of Climate Change Risk Screening

The climate variables that were of primary concern were:

- Sea-level rise;
- Heat and heatwaves (on land and in the ocean);
- Storms;
- Cyclones;
- Drought; and
- Floods.

Our assessment showed that previous assessments of climate change risks to the region had identified many of the issues that are likely to influence the health system, although many of these have focussed on risks to the Torres Strait community and the regional infrastructure (e.g. roads, jetties, airstrips), rather than the hospital infrastructure specifically. Climate change is a risk multiplier and many of the existing issues faced by Torres Strait Islanders are likely to be amplified into the future which will increase demand on the health system. The strong relationship between all aspects of Torres Strait Islander livelihoods, lifestyles and the health system were made very clear through the assessment.

Several areas where the health system in the Torres Strait is most at risk from the effects from climate change were identified and are discussed in further detail below. Further, more detailed risk assessments of the health infrastructure and operational activities of the TCHHS are required. These will help to detect where adaptation action is required (e.g. specific locations) and when various options should be implemented. Some may benefit from small incremental changes, while others might need significant structural or institutional changes, and some facilities may need to be relocated.

Discussion

7.2 The Torres Strait Regional Adaptation and Resilience Plan 2016-2021

The Torres Strait Regional Adaptation and Resilience Plan 2016-2021 (TSRARP) outlines an integrated strategic approach to addressing a variety of priority climate change impacts in the Torres Strait. Health related actions in the Plan are focused primarily on health impacts on communities rather than impacts on health services and infrastructure. Several actions are identified which are consistent with or aligned to recommendations in this report. At this stage it is not clear which actions in the TSRARP have been fully implemented and thus all relevant actions to the health sector are restated in this report.

7.3 Torres Strait Communities Considered Most at Risk From Climate Change Impacts on Health

The following groups within the Torres Strait population will likely be more susceptible to health-related climate change risks:

- Community members with chronic diseases. The Torres Strait community tends to be affected by chronic diseases at earlier stages in life than people from other parts of Australia. They also have earlier progression of disease when compared to elsewhere. This means that a greater proportion of the community is at risk to heat and heatwaves but are also more dependent on the health system generally.
- Those that are sick and frail – have high care needs and are highly dependent on a health system that is fully functional at all times. This is challenged during extreme events such as cyclones and will in-all-likelihood be more challenged as the climate changes. As mentioned above, sick and frail people can also be at greater risk from the effects of heat and heatwaves.
- Those from low socio-economic backgrounds who do not have the resources to alleviate/reduce the effects of climate change to their health. (.e.g. lack of access to air-conditioning, or pay for fresh produce or other healthcare related needs).
- Communities living on different islands have different levels of risk. Those on low lying sand and mud islands or in low-lying villages are likely to be substantially affected by sea-level rise and associated impacts.
- Outdoor workers will be more exposed to high temperatures and high humidity which can cause heat stress.

7.4 Potential Climate Change Impacts on Key Sectors

Both the health system and Torres Strait community are fundamentally reliant of other sectors operating in the Torres Strait. The following key climate change risks for each sector must be considered concurrently. Without a fully functioning electricity sector, the health system and water security are compromised.

- **Health Sector:** As described above in this report, the health sector in the Torres Strait is challenged by a variety of direct and indirect climate pressures. These risks are compounded by

Discussion

impacts to other sectors which influences demand on the health system, and also impacts the ability of the system to function effectively.

- **Electricity sector:** Increased risk of blackouts with a flow on impact to health infrastructure and services. Generators are known to fail on a regular basis when in use with implications for food quality and availability of vaccines (loss of vaccines is a common occurrence). Loss of lighting in health facilities impacts night work and results in a loss of communication, particularly individuals (i.e. no ability to charge phones and contact health system when in need). It is essential that the electricity sector transitions to using renewable sources. This will ultimately make it more reliable and safer.
- **Water sector:** Water is a limited resource on most communities. Aging water infrastructure and challenges with infrastructure maintenance often results in the need to boil water prior to use and daily water restrictions on outer islands is common. Water contamination results in increased cases of gastroenteritis, despite a boiled water alert. This will likely increase in scale and frequency in the future. Note that the risk varies from island to island, e.g. Coconut Island has a very limited water supply while Thursday Island has lots of water. Many islanders and health centres use bottled water which creates a challenge for waste disposal. There is work being done at the moment to increase the sustainability and reliability of the water supply systems.
- **Fisheries sector:** The fisheries sector faces risks from the influence of hotter sea-temperatures and coral bleaching. This has potential direct and indirect effects on the local economy, including reducing access to fresh fish, and reducing available funds to spend on personal health care.
- **Transport sector:** The transport sector is at risk from a variety of different climate pressures. Extreme weather can disrupt transport, preventing movement of patients, nurses and doctors between locations. Storm surge, heavy flooding and a range of other climate related pressures can have a direct effect on roads, rail and air strips, impacting supply chains of medicine and food.

7.5 Information about Climate Change and Human Health

There was consensus amongst participants that the information available about climate change and human health is insufficient both within the sector and for the Torres Strait community. The lack of information includes the effects of climate change and the ways to address the challenge that it presents to human health.

Examples of information needs include:

- More locally relevant and reliable data on changes in weather patterns and climate change and better projections of future sea level rise in the area. There was a concern for example, that the lack of detailed information creates a risk that new health infrastructure will be constructed in the wrong places. This creates a risk that the assets could be lost without realising any medium or long-term benefits for the community.
- More information about the effects of climate change on local communities. Improve engagement with communities about the issue and responses. This can help to develop a better understanding

Discussion

of the community's needs for dealing with (and minimising) health risks associated with extreme events and climate change.

- Better leveraging of traditional knowledge on identifying and responding to changes in weather, seasons etc. This can assist with making climate change discussions and awareness raising more relatable. Changes can include local evidence such as bird migrations occurring earlier than historically normal etc. People understand that the whole ecosystem is integrated.
- More information on the human health carrying capacity of each island (over time, and in different climate change scenarios). This will help the health service to plan for changes in demand and ensure they are able to support communities.
- There is a need for a more strategic focus on the long-term when planning and building all infrastructure, including health related infrastructure. Ensuring that infrastructure is adapted, will help to reduce demand, will help the health service to provide comfortable and safe environments for patients and staff, and to function effectively in a changing climate.
- Better information on distribution and control of the mosquitos *Aedes albopictus* and *Aedes aegypti* which can carry and transmit a variety of viruses.
- Information on climate effects on fauna and flora that are important for the well-being and culture of Torres Strait communities e.g. turtles, fisheries. People are dependent on these for food and income. This should also include gaining a better knowledge of the impacts of other pressures such as overfishing, physical damage to ecosystems etc to underpin an integrated management approach.
- There is a need for more information in the health service and the community about reducing greenhouse gas emissions and about waste reduction in general, including from hospital and health service activities and from the use of plastic water bottles used to augment supplies.

7.6 Health Sector Linkages

Participants identified a number of important linkages that they believe should be established or strengthened to help the sector to adapt to climate change effectively. These include:

- Administrative and managerial staff in the health sector should liaise/engage better with TSRA and council to improve collaboration, communication and improve use of time and resources. Collaboration includes better sharing of data and information to support decision making.
- Need to link to organisations that can help to provide climate change projections and interpretations and integrate these with health and population projections to underpin health planning. This is essential when planning for addressing long-term sustainability of areas such as rehabilitation, aged care, renal dialysis and dementia services.
- The health sector should engage with the housing sector and local government. Overcrowding and health and wellbeing impacts of less than optimal house design are important contributors to health vulnerabilities.
- Links with the Public Health Unit in Cairns can ensure better access to support and information.
- Infrastructure and transport agencies to ensure that the health system can function effectively.

Discussion

- Health managers or climate change workers should be made aware of the Traditional Ecological Knowledge Project and should consider how they can make use of the information that is becoming available.

7.7 Emission Reduction and Sustainability

A recent study published in The Lancet Planetary Health indicated that the health sector contributes 7% of Australia's greenhouse gas emissions and makes a substantial contribution to climate change (Malik, Lenzen, McAlister and McGain 2018). While the focus of this risk assessment and associated recommendations is on climate change adaptation, The Torres and Cape Hospital and Health Service (TCHHS) should make an effort to reduce its emissions, helping to ensure that climate change remains below dangerous levels. In addition, adaptation actions should not contribute to additional emissions. For example, air conditioning to reduce heat stress of workers and patients should be powered by renewable energy as much as possible.

Examples of actions that TCHHS can take include:

- Implementing energy efficiency measures within all facilities;
- Installing renewable energy sources to reduce demand on the electricity network;
- Ensuring that suppliers are implementing energy efficient measures; and
- Minimising waste generation.

In addressing climate change impacts, it is essential that the TCHHS assesses its contribution to green-house gas emissions and implements actions to reduce emissions. These include:

- (1) Reduce potential for maladaptation (i.e. whereby adaptation action increase greenhouse gas emissions). An example is increased use of non-renewable electricity to drive air conditioners.
- (2) Consider joining the Global Green and Healthy Hospitals Network (www.greenhsopitals.net) to enable sharing of leading practices and solutions with other organisations.

As identified through the risk assessment, in addition to the need for energy efficiency and the use of renewable energy, several other sustainability initiatives should be implemented on the islands by the TCHHS, local government and other management agencies. These include:

- Assessing water management approach (supply, quality and efficiency) through understanding risk to the water supply and sewerage system on each island, and for each health facility and establishing a detailed plan to upgrade and adapt the existing system. The reliance of the water supply and treatment system on the energy system, makes it essential that these are considered in tandem.
- The health and hospital systems create substantial waste through their activities. This is compounded by the waste resulting from the use of bottled water in many facilities. The TCHHS should develop a waste strategy focussing on waste reduction and management.

8 Recommendations

Several recommendations are made from this assessment. These reflect findings from the risk assessment screening, together with feedback from interview participants.

8.1 Collaboration and Engagement to Ensure Effective Action

- The Torres Strait Adaptation and Resilience Plan 2016-2021 identifies several actions that are specific to the health system. It is essential that strong links are developed between the TSRA and the Torres Cape Hospital and Health Service to ensure close collaboration in delivering projects and in monitoring the outcomes of projects that are implemented.
- Break down barriers and stop operating in silos. This is needed within and outside of organisations. Without an effective and integrated system, the health sector will not be positioned to cope with the increased demands associated with a changing climate.

8.2 Reducing Demand on The Health System and Responding to Changes in Demand Due to Climate Change

- There is a good general awareness of the ways in which climate change affects human health and associated demands on the health system. This should be augmented with a detailed assessment specific to the effects of climate change on human health in the Torres Strait.
- Gather more data and information about links between health and climate in the Torres Strait, and ensure it is available to the TCHHS together with guidance on how to utilise the information.
- Significant effort should be made in preventative measures to reduce the demand on the health system. This requires increasing the awareness and knowledge of health service professionals to ensure that the right programs are in place and that engagement with communities is conducted appropriately and sensitively. Discussions should be solutions oriented.
- The effects of climate change on the health system in the Torres Strait is a socio-ecological issue. There are many externalities which affect the ability of the health system to function now and under a changing climate. These include access to fresh food, ability of the community to generate an income, and cultural links to the land and sea. Housing and associated overcrowding is also an important consideration. The implications climate change on all of these variables must be understood and managed.
- Improving food security and sustainability of the region by supporting locally grown foods. Easier and cheaper access to fresh produce directly supports the health of the population and increases the amount of available funds that are available to help invest in other health care related products.
- The general sustainability of each island should be assessed to better understand its population carrying capacity. This includes understanding needs for water, electricity and other resources, and a realistic assessment of the likely availability of these into the future. This understanding

Recommendations

should project forward under a climate affected future. These resources are critical for the health system to be able to function effectively.

- Improve education and awareness of climate change for health professionals and the community. This will help them to understand what the future looks like, how and why certain plans are being made, and support decisions about future infrastructure and workforce needs.
- Long term planning for communities must be undertaken together with the community. This should be done with a focus on the health system. What infrastructure needs to be developed and where? Does any infrastructure need to be relocated? What can be learned from previous relocation events? For example, there was relocation of community from Saibai to Cape York in the 1960's but there is no discussion about lessons learned from this at present.
- There is a need to develop a better understanding of disease movements in the Torres Strait, including through mosquito borne movement.
- Increased understanding of climate change impacts on marine and terrestrial ecosystems.
- Climate change must be considered as being central to everything in the Torres Strait going forward.
- Need to consider the various ways in which Traditional Communities may be affected culturally by climate change and these might in turn affect the demand on the health system. For example, the loss of the ability to undertake customary activities such as hunting may have stress and identity issues leading to mental health challenges.
- Understand climate risk to housing on the islands and build a strategy for adapting existing houses to be resilient to future pressures. Ensure that there is a very good understanding of areas of future risk and prevent the development of new houses in high risk areas. This can help to reduce stress and mental health issues that are likely to be a demand on the health sector in the future.
- Need a better understanding of PNG health issues and the potential flow of any health-related issues into the Torres Strait. This also requires a broad understanding of the implications of climate change for PNG locations near the Torres Strait.
- The Public Health Unit in Cairns needs to prepare for a bigger role in understanding vector borne disease movement and information sharing. The system is working now but this may become a bigger issue and it should be prepared.

8.3 Understanding and Addressing Climate Risk on Health Facilities and Operational Capacity

- A second-pass risk assessment should be conducted on hospital and health facilities in the Torres Strait. The assessment should also include critical infrastructure relating to access for Emergency Services, patients and staff. This should be supported with an economic analysis to determine when the most appropriate times are for implementing actions such as repairing facilities after impact, enhancing resilience of facilities to reduce impact or relocating facilities.
- The ability to attract health service staff to the Torres Strait is an important consideration and a long-term plan should be made to ensure that the staffing needs of a continually expanding system can be accommodated.
- Climate change strategies of health services should be aligned with sustainability plans. These will ensure consideration of energy, water and associated critical infrastructure. Waste management is also an important element for consideration.

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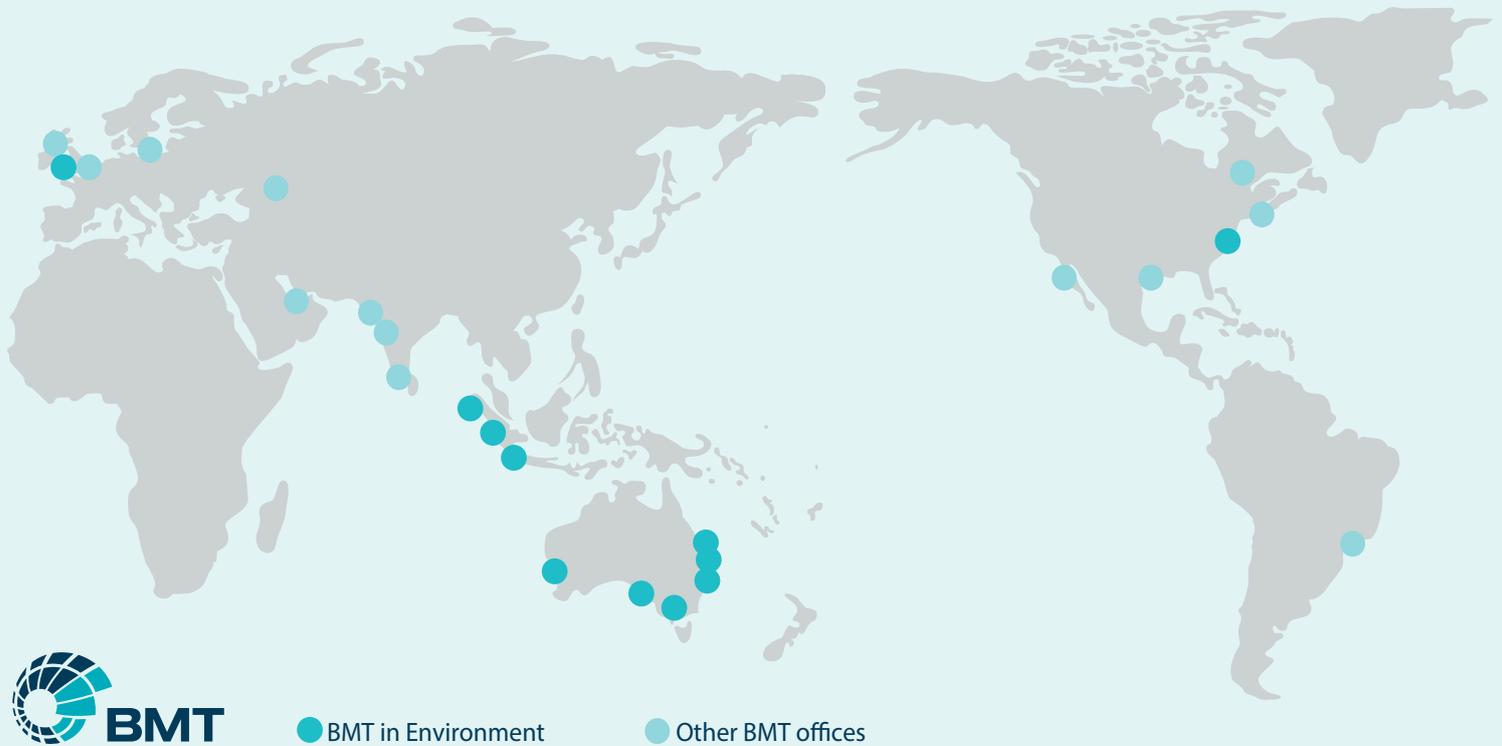
Appendix A Interview Participants

Table A-1 Names and positions of people interviewed for the risk assessment

Name	Position
Dr Anthony Brown	Executive Director, Torres and Cape Hospital and Health Service
Dr Allison Hempenstall	Medical Doctor, Torres and Cape Hospital and Health Service
Mr David Murray	Clinical Nurse Consultant, Torres and Cape Hospital and Health Service
Dr Ineke Wever	GP, Senior Health Officer, Torres and Cape Hospital and Health Service
Dr Marlon Coates	A/Northern Director of Medical Services, Torres and Cape Hospital and Health Service
Mr Vic McGrath	Senior Community Liaison Officer, Torres Strait Regional Authority
Mr John Rainbird	Torres Strait Regional Authority
Dr Sophie Dwyer	Executive Director, Queensland Health
Dr Peter Schneider	Senior Policy Officer, Queensland Health

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Brisbane

Level 8, 200 Creek Street
Brisbane Queensland 4000
PO Box 203 Spring Hill Queensland 4004
Australia
Tel +61 7 3831 6744
Fax +61 7 3832 3627
Email brisbane@bmtglobal.com

Melbourne

Level 5, 99 King Street
Melbourne Victoria 3000
Australia
Tel +61 3 8620 6100
Fax +61 3 8620 6105
Email melbourne@bmtglobal.com

Newcastle

126 Belford Street
Broadmeadow New South Wales 2292
PO Box 266 Broadmeadow
New South Wales 2292
Australia
Tel +61 2 4940 8882
Fax +61 2 4940 8887
Email newcastle@bmtglobal.com

Adelaide

5 Hackney Road
Hackney Adelaide South Australia 5069
Australia
Tel +61 8 8614 3400
Email info@bmtglobal.com

Northern Rivers

Suite 5
20 Byron Street
Bangalow New South Wales 2479
Australia
Tel +61 2 6687 0466
Fax +61 2 6687 0422
Email northernrivers@bmtglobal.com

Sydney

Suite G2, 13-15 Smail Street
Ultimo Sydney New South Wales 2007
Australia
Tel +61 2 8960 7755
Fax +61 2 8960 7745
Email sydney@bmtglobal.com

Perth

Level 4
20 Parkland Road
Osborne Park Western Australia 6017
PO Box 2305 Churchlands Western Australia 6918
Australia
Tel +61 8 6163 4900
Email wa@bmtglobal.com

London

1st Floor, International House
St Katharine's Way
London
E1W 1UN
Tel +44 (0) 20 8090 1566
Email london@bmtglobal.com

Aberdeen

Broadfold House
Broadfold Road, Bridge of Don
Aberdeen
AB23 8EE
UK
Tel: +44 (0) 1224 414 200
Fax: +44 (0) 1224 414 250
Email aberdeen@bmtglobal.com

Asia Pacific

Indonesia Office
Perkantoran Hijau Arkadia
Tower C, P Floor
Jl: T.B. Simatupang Kav.88
Jakarta, 12520
Indonesia
Tel: +62 21 782 7639
Fax: +62 21 782 7636
Email asiapacific@bmtglobal.com

Alexandria

4401 Ford Avenue, Suite 1000
Alexandria
VA 22302
USA
Tel: +1 703 920 7070
Fax: +1 703 920 7177
Email inquiries@dandp.com



