# Climate change and infectious diseases in Australia's Torres Strait Islands

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*Our islands have been continuously inhabited by Indigenous people for tens of thousands of years, but the climate crisis is endangering all of this. Rising seas caused by man-made climate change are threatening homes, swamping burial grounds and washing away sacred cultural sites … We, as a people, are connected to these islands through our cultural practices and traditions. If our connection to these lands disappears, our Indigenous culture disappears.*[1]

This speech was made by Mr Kabay Tamu as one of eight of Torres Strait Islanders who sought action against the Australian Government through the United Nations' Human Rights Committee in 2019.[1] The complainants asserted that Australia's responses to reducing climate change-causing emissions or to developing adaptation measures had been inadequate, and thus infringed upon their human rights obligations to Torres Strait Islander peoples.[2]

Scientific assessments provide further evidence of this inadequacy. The Torres Strait Islands are located above the northernmost tip of Queensland, Australia, and are already experiencing impacts attributed to human-induced climate change. Cyclones are projected to become more intense.[3] Drought conditions in this region have affected the security of water supply, requiring the installation of mobile desalination plants.[4] Changes to temperature and rainfall have affected the range and extent of mosquito species that are vectors for dengue, and the islands are currently the only Australian location with the invasive virus-vector mosquito, *Aedes albopictus*.[5]

## Abstract

**Objective**: This research seeks to identify climate-sensitive infectious diseases of concern with a present and future likelihood of increased occurrence in the geographically vulnerable Torres Strait Islands, Australia. The objective is to contribute evidence to the need for adequate climate change responses.

**Methods**: Case data of infectious diseases with proven, potential and speculative climate sensitivity were compiled.

**Results**: Five climate-sensitive diseases in the Torres Strait and Cape York region were identified as of concern: tuberculosis, dengue, Ross River virus, melioidosis and nontuberculous mycobacterial infection. The region constitutes 0.52% of Queensland's population but has a disproportionately high proportion of the state's cases: 20.4% of melioidosis, 2.4% of tuberculosis and 2.1% of dengue.

**Conclusions**: The Indigenous Torres Strait Islander peoples intend to remain living on their traditional country long-term, yet climate change brings risks of both direct and indirect human health impacts.

**Implications for public health**: Climate-sensitive infections pose a disproportionate burden and ongoing risk to Torres Strait Islander peoples. Addressing the causes of climate change is the responsibility of various agencies in parallel with direct action to minimise or prevent infections. All efforts should privilege Torres Strait Islander peoples' voices to self-determine response actions.

**Key words**: climate change, infectious diseases, Torres Strait Islands, Indigenous health, Australia

Such climatic changes bring risks to human health, including direct impacts from injury and death during extreme weather events, and indirect impacts mediated through environmental and social changes such as increased risks of infectious diseases and changes to nutrition, and water and food access, hygiene and security.[6] These health impacts may be greater for Torres Strait Islander peoples due to their remote location with limited healthcare services, lower economic resources, and a higher burden of pre-existing health conditions.[7] However, living on 'country' (traditional estate) is of great importance to Torres Strait Islanders to maintain cultural responsibilities, identity and kinship connections – and this can also bring health benefits.[7-9]

A call for increased attention to climate change and health impacts on the Torres Strait Islander peoples was made in 2019 by 22 medical professionals working in the Queensland Government's Torres and Cape Health and Hospital Service region:

> *[In the Torres Strait,] climate change is a health emergency. We [medical officers] are concerned about the immediate effects of heat stress and extreme weather events as*

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*well as the long-term effects … Vulnerable populations are disproportionately affected by climate change and unabated climate change will only steepen this social health gradient … Proper investment … is required to ensure our population is as healthy as possible for climate change …*[10]

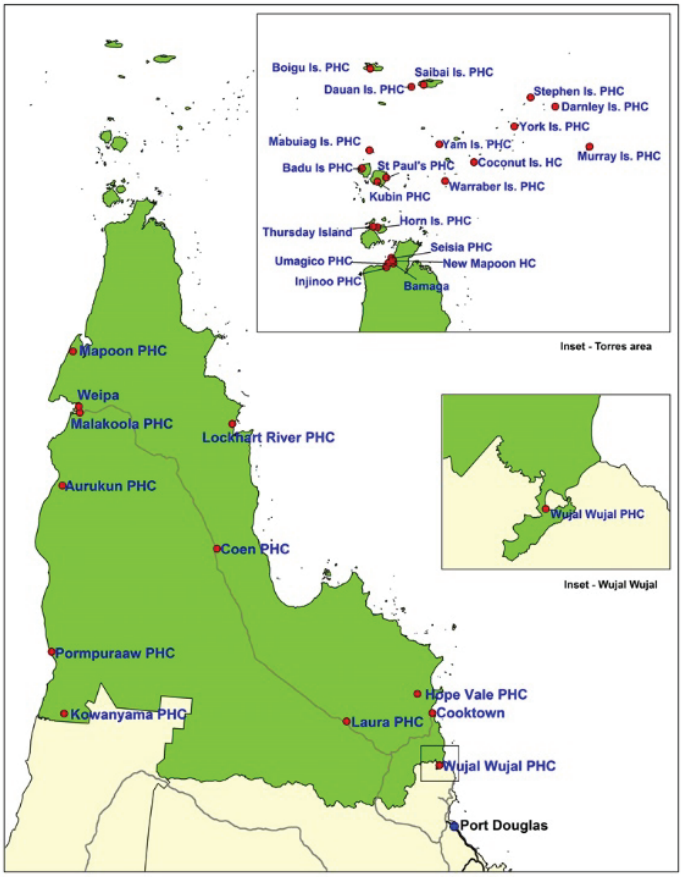
This research responds to part of this call by identifying the present and future likelihood of increased occurrence of climate-sensitive infectious diseases. It provides more detail to previous climate-focused health research that noted changes in "temperature, humidity and rainfall can influence the transmission dynamics of infectious diseases"[6(p561)] and that climate change will compound determinants of infectious diseases, notably "globalisation, population growth and social and demographic inequalities".[11(p1)] In responding to this call, this research addresses climate disruption through a localised perspective of the geographically vulnerable Torres Strait Islands. The research approach overtly recognises the importance of Torres Strait Islanders' voices to self-determine responses and contributes evidence to the need for climate change to be adequately addressed to prevent human and ecological damage.

## Background

This research was conducted by five health researchers, two of whom are Torres Strait Islanders. These two co-authors brought both their professional and cultural knowledge to the proposed need for the research, contribution of the research and specific topic focus. This approach acknowledges that research regarding Indigenous peoples and their country should proceed only with their consent, input and involvement – to reconsider collaboration, power and access that has long been Western-dominated.[12] More specifically, Torres Strait Islander researchers have called for traditional and cultural knowledge to be accessed by fellow Islanders to respond to complex environmental problems, including climate change research and associated resilience strategies.[13]

The Torres Strait Islands is an archipelago of approximately 200 islands covering 48,000 square kilometres located between the northernmost tip of Cape York in Queensland, Australia, and the south-western coast of Papua New Guinea.[3,14] Seventeen of the Torres Strait Islands are permanently inhabited and serviced with electricity, water and sewerage.[14] The largest population and commercial centre are located on Thursday Island. Figure 1 displays the islands within the wider region of the Torres and Cape Hospital and Health Service and names all inhabited islands.[15]

**Figure 1: Map of Torres Strait and Cape Hospital and Health Service, with the Torres Strait Islands featured in the upper inset.[15]**




Torres Strait Islanders are ethnically, linguistically and culturally distinct from mainland Aboriginal Australians and were legally recognised as a separate people under the *Queensland Torres Strait Islanders Act 1939*.[16] The Torres Strait Islander population is a 'sub-minority' of Australia's total Indigenous population:[17] the total population in June 2016 of 70,880 Torres Strait Islander peoples was 8.8% of the 798,400 total Aboriginal and Torres Strait Islander peoples, which in turn forms 3.3% of the total Australian population.[18]

For the 4,994 (7%) of Torres Strait Islanders living in the Torres Strait,[18] the desire to live on traditional country remains strong; additionally, the diaspora maintains close family and country contact.[19] The *Torres Strait Treaty 1978* (ratified in 1985) maintains the region administratively as part of the Commonwealth of Australia while recognising and enabling traditional hunting and fishing rights.[3]

Torres Strait Islanders describe their notion of health and wellbeing as being supported through a close relationship between living on country and being immersed in community, and individual health.[7] Yet climate change has been documented as having current and future impacts on these aspects in the Torres Strait Islands and its peoples from increases in temperature and prolonged warm periods, the intensity of rainfall events, the length of the dry season and evaporation, tropical storm activity and sea-level rise.[3]

## Methods

This research employed a desktop-based study to identify climate-sensitive diseases of concern in the Torres Strait; these are defined as infections that may be affected by changing climatic conditions including local weather, air temperature, precipitation and

humidity, water availability and food sources. Such conditions can change the distribution and breeding conditions of vector-borne diseases, the population density or location of the animal species reservoir, and the disease transmission pathways.[11,20]

The compilation of relevant infectious diseases with proven, potential and speculative climate sensitivity occurred under the guidance of one of the co-authors who is a senior practising infectious diseases physician. An initial and non-exhaustive list of infectious diseases was compiled from the World Health Organization's list of Neglected Tropical Diseases,[21] the diseases described in the Intergovernmental Panel on Climate Change's Fifth Assessment Report,[22] and the Queensland State Department of Health's list of notifiable conditions.[23]

Following this compilation, a narrative review was conducted to provide a comprehensive background for topical understanding and identify inconsistencies or gaps with the current body of literature.[24,25] A database search of journal databases was conducted using key terms with Boolean operators of "climate change" AND "infectious disease" AND "Australia" within three databases (PubMed, Scopus, Web of Science). Articles were excluded if they were published before 2009 to ensure recent publications within the decade and the search was limited to articles of research published in English with full-text available. The search yielded 139 articles, of which 35 articles met the inclusion criteria. Grey literature augmented the limited peer-reviewed literature.[26]

To identify climate-sensitive infectious diseases present or emerging in the Torres Strait and surrounding areas in Cape York, the articles were further searched individually, with only two[27,28] describing the Northern Australian region (that includes the Torres Strait) and nine noting diseases with climate sensitivity in tropical environments.[27,29-36] The Queensland Government's public notifiable conditions database was consulted for case data of reported diseases for the Torres [Strait] and Cape [York] Hospital and Health Service (HHS) region over the past six years.[23] It is noted that the Torres and Cape HHS region includes communities and towns on mainland Australia and a total population of 27,000, of which 64% identify as 'Aboriginal and/or Torres Strait Islander', and is therefore not specific to Torres Strait Islander peoples.[37]

The list of infectious diseases was further refined to select diseases of concern if they met four criteria: a vaccine not being available, causing significant morbidity (defined as a major condition with a risk of disability or death), being difficult to control (defined as challenging to prevent the spread of infections even with standard and transmission-based precautions), and regularly occurring in the Torres and Cape HHS region. The diseases were assessed against these criteria consulting the Principles and Practice of Infectious Diseases[38] and from the case data of the Queensland Government's notifiable conditions database.[23]

## Results

The compilation of 33 climate-sensitive infectious diseases is displayed in Table 1 and clustered by transmission through air-, food-, soil-, water- and vector-borne sources. The word 'occurrence' is applied as a term to describe the range of implications from these changes on transmission, distribution or prevalence of the identified infectious disease. The climatic changes described included temperature, humidity, rainfall, extreme weather events, ultraviolet radiation, sun exposure, and density of the reservoir population found to be likely to alter the occurrence. The majority of infectious diseases (29 of 33) were anticipated to increase in occurrence from climate-related aspects, although the level of change was unable to be quantified from the literature available.

The infectious diseases listed in Table 1 were cross-referenced with those listed in Queensland Health's notifiable conditions database for the Torres and Cape region[23] and with literature identifying the likelihood of such diseases in the Torres Strait, northern or tropical Australia. This process identified 24 climate-sensitive infectious diseases (from the original total of 33 diseases) and these are displayed in Table 2. Four diseases are air-borne (measles, meningococcal disease, tuberculosis and varicella), five are food-borne (campylobacteriosis, giardiasis, salmonellosis, shigellosis and typhoid), two are soil-borne (melioidosis and nontuberculous mycobacteria), eight are vector-borne (Barmah Forest virus, chikungunya, dengue, Hendra virus, Japanese encephalitis, Kunjin virus, malaria and Ross River virus), and five are water-borne (cholera, cryptosporidiosis, hepatitis A, legionellosis and leptospirosis). All but one disease (giardiasis) were listed as notifiable diseases in Queensland, and there were cases recorded of 16 of these 24 diseases in the Torres and Cape HHS between 2014 and 2019.

The 24 infectious diseases identified in Table 2 were further reviewed to identify climate-sensitive diseases in the Torres Strait of particular concern against the criteria of not being vaccine-preventable in Australia, causing significant morbidity, difficult to control, and regularly occurring in the Torres and Cape HHS region.[23,38] This process resulted in five climate-sensitive diseases of concern: one air-borne infection (tuberculosis), two mosquito-borne infections (dengue; Ross River virus) and two soil-borne infections (melioidosis; nontuberculous mycobacteria).

These diseases are presented in Table 3, where the Torres and Cape HHS case data for 2014–2019 are compared with the statewide data for the same period in Queensland. Given that the population of 27,000 living in the Torres and Cape HHS[37] is 0.53% of the total Queensland population of approximately five million, the anticipated number of cases are presented in this table against the actual cases. Table 3 identifies that the Torres and Cape HHS region has a disproportionately high number of disease cases: in the six-year period reported here (2014–2019), this region had 20.4% of the Queensland's melioidosis cases, 2.4% of tuberculosis cases, and 2.1% of dengue cases.

## Discussion

This section profiles the five identified infectious diseases of concern under a changing climate in the Torres Strait. These diseases are presented within the context that Torres Strait Islander peoples intend to remain living on country and this population experiences a higher burden of co-morbidities than the general Australian population.[62] These two aspects, therefore, increase the potential morbidity from climate-sensitive infections.

Tuberculosis can increase occurrence through increases humidity, rainfall and temperature – factors that are exacerbated by climate change.[39,63] Although Australia has one of the lowest rates of tuberculosis incidence globally,[64] there is a discrepancy. In 2015, the Australian-born non-Indigenous population notification rate was 0.8 per 100,000, but for Indigenous Australians, the rate was 4.8 per 100,000.[64,65] There were 27 cases

**Table 1: Infectious diseases with reported relationship with climate change.**

| Transmission | Disease | Climate sensitivity | | |
|---|---|---|---|---|
| | | Factor projected to increase occurrence | Factor of change with inconclusive impact on occurrence | Factor projected to decrease occurrence |
| Air-borne | Measles | Temperature[6]<br>Relative Humidity[6]<br>Rainfall[6] | | |
| | Meningococcal disease | UV Radiation[6] | | Temperature[6]<br>Rainfall[6] |
| | Tuberculosis | Temperature[39]<br>Humidity[39]<br>Rainfall[39] | | |
| | Varicella | Sun exposure[6] | Temperature[6] | |
| Food-borne | Campylobacterosis | Temperature[40,41]<br>Relative Humidity[40]<br>Rainfall[40,41] | Temperature[42] | |
| | Giardiasis | Temperature[29]<br>Rainfall[29] | | |
| | Salmonellosis | Increased temperature[11,20,29,40,43-45]<br>Relative Humidity[40])<br>Rainfall[40] | | |
| | Shigellosis | Temperature[41]<br>Rainfall[41] | | |
| Food-borne (also water-borne) | Typhoid | | Undetermined factor[46] | |
| Soil-borne | Melioidosis | Temperature[47]<br>Rainfall[27,29,40,45] | | |
| | Nontuberculous mycobacteria | Extreme weather events[41] | | |
| Vector-borne | Barmah Forest virus | Temperature[48] | | |
| | Chikungunya | | Undetermined factor[29] | |
| | Dengue | Temperature[32,49,50]<br>Rainfall[49,50]<br>Relative Humidity[49,50] | | |
| | Hantavirus | Temperature[51]<br>Rainfall[51] | | |
| | Hendravirus | Temperature[52]<br>Reservoir population density[53]<br>Reduced Rainfall[53] | | |
| | Japanese encephalitis | Temperature[6]<br>Rainfall[6] | | |
| | Kunjin virus | Rainfall[28,40]<br>Temperature[28] | | |
| | Lyme disease | Temperature[20] | | |
| | Malaria | Temperature[20,40,54]<br>Rainfall[54] | | |
| | Murray Valley encephalitis | Rainfall[40] | | Temperature[40] |
| | Nipah virus | Reservoir population density[20] | | |
| | Rift Valley fever | Reservoir population density[20] | | |
| | Ross River virus | Temperature[33] | | |
| | Schistosomiasis | | Undetermined factor[20] | |
| | Tick-borne encephalitis | Reservoir population density[20] | | |
| | West Nile fever | Reservoir population density[20] | | |
| | Zika virus | | Undetermined factor[29,55] | |
| Water-borne | Cholera | Temperature[43]<br>Extreme weather events[56] | | |
| | Cryptosporidiosis | Rainfall[29,31]<br>Temperature in metropolitan areas[57] | Rainfall[57] | Temperature[29,57] |
| | Legionellosis (L. longbeachae, L. pneumophila, other Legionella sp.) | Temperature[41]<br>Rainfall[41] | | |
| | Leptospirosis | Rainfall[45] | | |
| Water-borne (also food-borne) | Hepatitis A virus | Temperature[41]<br>Rainfall[41] | | |

of tuberculosis recorded in the Torres and Cape between 2014 and 2019,[23] although these rates may include Papua New Guinea nationals seeking treatment on the Torres Strait Islands.[65]

Mosquitoes are disease vectors that thrive in tropical regions such as the Torres Straits. Climate-related increases in the frequency and severity of extreme weather events are anticipated to affect mosquito populations.[56] This includes changes in the distribution of the *Aedes aegypti* and *Aedes albopictus* mosquitoes,[30] both of which transmit dengue and Ross River viruses (RRV)[66] – the two vector-borne diseases of concern under climate change in the Torres Strait. Dengue has been identified as a climate-sensitive disease, noting that increases in temperature, rainfall, humidity and solar radiation positively affect mosquito growth and therefore the occurrence of cases.[43,49,50] There have been 40 cases of dengue in the Torres and Cape HHS in the past six years.[23] Climatic changes that increase temperatures are anticipated in Northern Australia; while this may raise temperatures above the 'thermal limits' of other mosquito species, there is a risk that warmer-adapted mosquitoes, namely *Aedes aegypti*, will survive and therefore sustain RRV transmission.[33] There have been 136 cases of RRV diagnosed in the Torres and Cape HHS in the past six years.[23]

Projections of changing weather patterns and extreme weather events in the Torres Straits indicate increased risks of cyclones, intense rainfall and flooding.[3] This is pertinent to the occurrence of two infections contained in moist soil conditions that have been identified as of concern in the Torres Strait: melioidosis and nontuberculous mycobacteria. Projected increases in rainfall under a changing climate in Northern Australia, including the Torres Strait, are likely to increase the occurrence of melioidosis.[27] Melioidosis is caused by *Burkholderia pseudomallei*, an endemic environmental bacterium in water and soil.[40] It is considered a concerning bacterial pathogen in Australia's Northern Territory as it is the most common cause of fatal community-acquired bacteraemic pneumonia.[67] It can also have severe morbidity outcomes for people with existing illnesses, such as diabetes.[67] In the Torres and Cape HHS in Queensland, there have been 56 cases in the past six years.[23]

Nontuberculous mycobacteria (NTM) are naturally occurring bacteria found in water and soil as well as animals, birds and plants.[41]

**Table 2: Climate-sensitive infectious diseases and recent cases in the Torres and Cape Hospital and Health Service region (case data from Queensland Health notifiable conditions database[23]).**

| Disease cluster | Infectious disease name (additional reference) | Disease in Torres and Cape HHS? | Number of reported cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Total (6 years) |
| Air-borne | Measles | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Meningococcal disease | Yes | 0 | 1 | 0 | 0 | 0 | 2 | 3 |
| | Tuberculosis | Yes | 9 | 6 | 2 | 4 | 4 | 2 | 27 |
| | Varicella | Yes | 40 | 26 | 31 | 37 | 41 | 48 | 223 |
| Food-borne | Campylobacterosis | Yes | 16 | 15 | 13 | 24 | 19 | 35 | 123 |
| | Giardiasis[29] | No Data | - | - | - | - | - | - | - |
| | Salmonellosis | Yes | 38 | 64 | 49 | 26 | 30 | 28 | 235 |
| | Shigellosis | Yes | 21 | 25 | 8 | 8 | 18 | 26 | 106 |
| Food-borne (and water-borne) | Typhoid | Yes | 0 | 3 | 4 | 0 | 0 | 0 | 7 |
| Soil-borne | Melioidosis[58,59] | Yes | 6 | 11 | 7 | 12 | 10 | 10 | 56 |
| | Nontuberculous mycobacteria | Yes | 10 | 10 | 18 | 10 | 7 | 8 | 63 |
| Vector-borne | Barmah Forest virus[14] | Yes | 6 | 5 | 18 | 4 | 7 | 4 | 44 |
| | Chikungunya[60] | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Dengue[59,61] | Yes | 2 | 2 | 28 | 5 | 2 | 1 | 40 |
| | Hendra virus | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Japanese encephalitis[14,40] | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kunjin virus[28] | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Malaria | Yes | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| | Ross River virus | Yes | 27 | 30 | 16 | 18 | 18 | 27 | 136 |
| Water-borne | Cholera | No Cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cryptosporidiosis | Yes | 2 | 1 | 25 | 3 | 12 | 7 | 50 |
| | Legionellosis | No cases | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Leptospirosis | Yes | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| Water-borne (and food-borne) | Hepatitis A | Yes | 1 | 0 | 1 | 0 | 0 | 0 | 2 |

*Note:*

*Case data are retrieved from the Queensland Department of Health Notifiable Diseases Report for the Torres and Cape Hospital and Health Service region; therefore this includes diagnoses from both Indigenous and non-Indigenous peoples, and both Torres Strait Islands and mainland populations.[23]*

When inhaled, NTM can cause the slow development of a progressive and destructive lung disease and exposure related to skin trauma can cause localised disease.[41] NTM has been identified as a climate-sensitive disease due to its emergence after extreme events that increase exposure to high concentrations of aerosolised bacteria from the movement of water and soil.[41,68] This may also affect the safety of drinking water supplies.[69] There have been 63 cases of NTM infection diagnosed in the Torres and Cape HHS in the past six years.[23]

## Conclusions

This research identified 33 climate-sensitive infectious diseases of which 16 have recorded cases in the Torres Strait Islands and/or the wider Torres and Cape region. Of this subset, the five infectious diseases of tuberculosis, dengue, Ross River virus, melioidosis and nontuberculous mycobacterial infection were identified as diseases of concern under a changing climate in the Torres Strait. Case data of these five diseases have been recorded at a greater proportion than anticipated for the population size. This includes the region having more than 20% of Queensland's melioidosis cases but only 0.52% of the state's population.

These findings augment existing assessments and statements regarding the impact of climate change on the Torres Strait Islands and its Indigenous peoples. Torres Strait Islander peoples intend to remain living on their traditional country long-term, yet climate change brings risks of both direct and indirect human health impacts. The impacts of climate-sensitive infectious diseases exist in the context of a high burden of existing acute and chronic diseases. Therefore, these results provide further evidence for the need to address climate change through mitigation and adaptation actions. The perceived insufficiency of government actions to date is reflected in the current United Nations' claim lodged by a group of Torres Strait Islanders on the grounds that climate change has already resulted in impacts to their country and are thus a human rights violation.

## Implications for public health

The call to action in 2019 by medical officers in the Torres Strait to recognise a 'climate emergency' in the region is supported

**Table 3: Climate-sensitive infectious diseases of concern in the Torres Strait compared with Queensland state-wide data.[23]**

| Infectious disease | Qld total cases (2014-19) | Anticipated cases by proportion in T&CHHS (0.53% of the Qld population) | Actual cases in T&CHHS cases (2014-19) | Actual proportion of cases in Qld (%) |
|---|---|---|---|---|
| Dengue | 1,935 | 10 | 40 | 2.1 |
| Melioidosis | 274 | 1 | 56 | 20.4 |
| Nontuberculous mycobacteria (other and unspecified) | 7,983 | 42 | 63 | 0.8 |
| Ross River virus | 15,357 | 81 | 136 | 0.9 |
| Tuberculosis | 1,111 | 6 | 27 | 2.4 |

by the evidence provided in this research – that climate-sensitive infections pose a disproportionate burden and ongoing risk to Torres Strait Islander peoples. There is, therefore, a need for coordinated action among relevant agencies to minimise or prevent specific infections in the Torres Strait Islands while ensuring that Torres Strait Islander peoples co-design and approve the actions. Such actions would occur in parallel with systemically addressing and reducing the causes of climate change nationally and globally.

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