DRAFT

Torres Strait Regional Heat Stress Reduction Strategy

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Introduction

Global temperatures are on the rise. Average background day and nighttime temperatures are rising as are the frequency and severity of extreme heat events. This shift in temperatures is and will increasing have, significant impacts across a spectrum of human and environmental domains.

Human evolution occurred predominantly in climates cooler than what we are experiencing today, and we are increasingly moving into climatic conditions that sit outside of our evolutionary experience.

Because heatwaves don't have the dramatic impacts of floods and storms, they tend to not get the same level of attention. Extreme heat is however amongst the most dangerous of natural hazards and has multiple and cascading impacts.

It's a threat to human physical and mental health, to species and ecosystems, social cohesion, food and water security, energy supply, infrastructure and transportation, productivity and security (Turek-Hankins et al 2021).

Extreme heat events claim more lives than other weather-related disasters (WHO) and in Australia extreme heat has claimed more lives than all other weather disasters combined (National Climate and Health Strategy 2023).

Extreme heat also has important consequences for the mental health of remote Indigenous communities. Mental and emotional wellbeing is a critical basis for community resilience and adaptive capacity, as such extreme heat poses a risk to the overall ability of these communities to respond effectively to climate change.

Whilst people living in the world's tropical regions are more acclimated to warm humid weather compared to people living elsewhere, this does not give them immunity to the challenges of a warming climate.

On the contrary, they already sit close to the threshold of physiological heat stress risk. Expected shifts in climate could push them beyond that threshold for consistently long periods, long enough to have very significant ramifications for health and wellbeing and the flow on socio-economic consequences of those impacts. Despite experiencing less warming relative to than other regions, the tropics are estimated to be more affected by climate change than high latitudes due to high background temperature and temperature's non-linear effects on metabolism (Asseng et al 2021).

The impacts of humid heat on health are less well understood compared to the impacts of dry heat. How humid heat with shift due to climate change is also harder to assess due to technical challenges related to accurately modelling moisture. We do know however that the atmosphere's capacity to hold moisture increases by around 7 % with every increase of 1^{o}C.

Torres Strait islander and Aboriginal people are no strangers to the impact of heat and are aware that excess exposure to hot weather has negative health impacts. Despite their behavioural and physiological heat response strategies developed through living in these conditions, they are generally not prepared for the new climate we face and now also have enhanced risks to heat stress due to a range of non-climate drivers.

If we continue the current climate change trajectory it is likely large sections of the world will be experiencing heat conditions outside of what we have evolved to cope this through the course of human evolution. There is a strong focus on extreme storms and sea level rise as primary climate change risks, but heat stress may present a greater challenge to humanity and planetary health given the limited capacity for vertebrates to physiologically adapt to these changes in the short timeframes available.

In short – we are unprepared for these changes.

Heat stress risk has not yet been given the consideration it requires in the Torres Strait. Work is being done at the national level to develop a National Heat Health Action Plan, and the Queensland Government has a Health Sector Adaptation Plan, but there is still a need for a great deal of work to develop effective heat related health warning and response systems, especially for remote tropical localities.

Fortunately heat stress risk can be minimised through a suite of actions across the domains of infrastructure, planning, policies, and procedures in the workplace, education and awareness and access to real time data on current and predicted heat stress conditions.

Currently most of these risk minimisation measures are not in place.

The effectiveness of these strategies may also dimmish as global temperatures rise with larger consequences which will require additional, more significant adaptive measures.

This strategy aims to raise awareness of this issue and identify critical actions that can be put in place to reduce this risk.

Key Messages:

- **Heat stress is the most dangerous extreme weather threat to human health but generally does not yet get recognition proportional to its impact.**
- **Beyond its impacts on human health, heat stress has far reaching social, environmental and economic consequences.**
- **Projected increased in temperatures due to climate change will put significant additional stress on the Torres Strait.**
- **The physiological limits of heat tolerance are finite and numerous cofactors substantially reduce these limits.**
- **There are numerous ways that heat stress risks can be reduced.**

Extreme heat and heat stress

Extreme heat is defined as conditions that are significantly hotter and or more humid than the average summer conditions for that location. The Bureau of Meteorology labels such circumstances as heatwaves when they persist for three days or more.

There are dry heatwaves as experienced over most of the Australian mainland, and moist heatwaves as experienced in areas of high humidity.

The body generates its own heat through metabolic processes. For the body to function optimally, it's important that its internal temperature remains withing a safe zone of between 36.5 and 37.5°C.

Heat stress occurs when the body is unable to shed excess heat, leading to a rise in core body temperature to levels that impact a person's normal bodily functions. Depending on the extent and duration of this condition it can lead from mild symptoms through to being fatal.   Beyond its own immediate impacts on health, heat stress can also exacerbate underlying health conditions (www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health).

Heat stress has two dimensions, strength and duration. Strength is a combination of temperature, humidity and wind which in combination determine the heat risk threshold. Duration is how long conditions stay above these thresholds as the body will accumulate heat if it is unable to shed it effectively.

Thermoregulation, the mechanisms the body uses to regulate its temperature, is achieved through a mix of physiological and behaviour responses. If either of these are impaired, thermal tolerance is reduced (Hanna et all 2015).

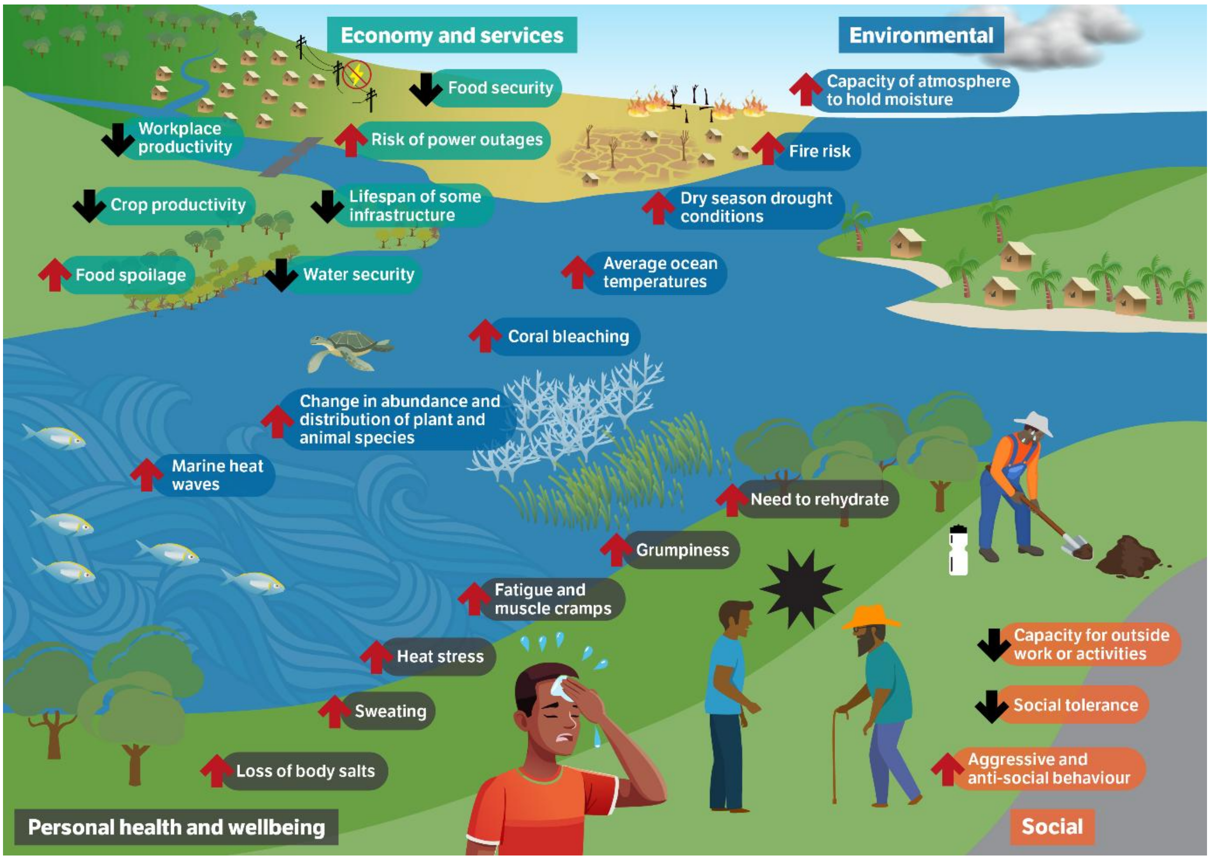


Figure 1. Extreme heat has multiple impacts across personal, social, environmental and economic domains. Source: TSRA.

The primary physiological responses are 1. increase in blood flow to the skin to help shed heat from the body's core, and 2. increase in sweating to cool the skin resulting in loss of fluid and body salts (potassium and sodium).

When moisture evaporates it cools the surface it was on. This is why we sweat more the hotter it gets; the body is working harder to keep cool. It also means we must make sure we are taking in enough fluids to replace the water we lose through sweating, and its why dehydration is one of the potential impacts of heat stress. Unless the body rehydrates fast enough to match the loss of fluids, it puts additional strain on the cardiovascular system (Heatwaves and Health: Guidance on Warning-System Development. 2015).

Dehydration significantly increases the risk of heat stress through reducing the body's capacity to keep cool through sweating plus putting internal organ function under greater pressure from fluid lose and lose of important electrolytes.

Sweating is more effective when there is a breeze, or windy conditions compared to when the air is still. If the person continues to experience heat discomfort, they seek additional measures to cool such as finding shade, removing excess clothing, drinking fluids. Their body will naturally start to feel lethargic as a response to reduce the generation of internal heat from muscular activity.

High humidity levels reduce the evaporative potential thus reducing the capacity of the body in humid climates to shed heat through sweating.

Hot weather supresses interest in undertaking physical activity which has consequences for maintenance of basic wellbeing due to reduced physical activity. (Romanello M, 2021).

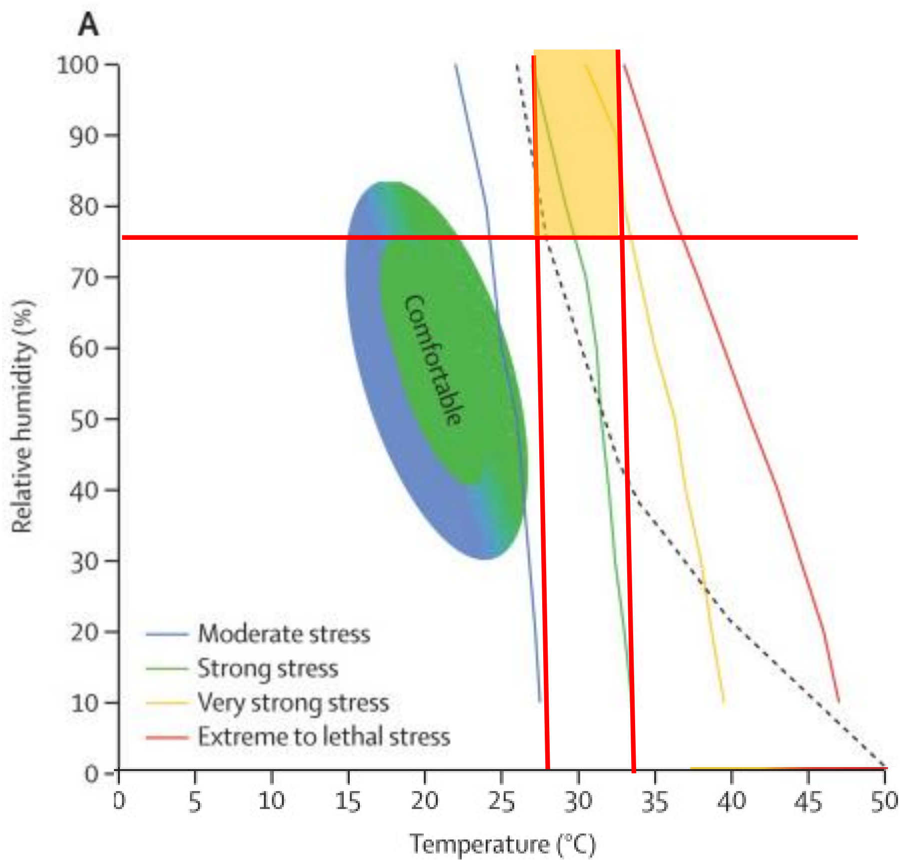


Figure 2. Relationship between temperature, relative humidity and thermal stress in humans. The red lines have been added to indicate conditions common in the Torres Strait over summer

months. Temperatures seldom exceed 35 °C, but with high humidities the region is commonly in strong stress to very strong stress conditions for extended periods. Source: Asseng et. al. 2021.

Acclimation

People who have longer-term exposure to certain climates tend to develop a physiological response that enhances their body's capacity to function under those conditions. Acclimation does not change the body's capacity to tolerate higher core temperatures, only to improve heat shedding to avoid dangerous core temperatures.

People moving to a new climatic region take generally 2-6 weeks of exposure to acclimate, but up to several years to fully acclimate. If they leave the area for longer than about a month, they lose their adaptive capacity and must reacclimate when they return.

Adaptive responses put in place by the body include decreased maximal heart rate, expansion of plasma volume, initiation of sweating at lower temperatures and reduced loss of sodium chloride (Heatwaves and Health: Guidance).

A study by Quilit et al. (2023) in the Northern Territory indicated that social-cultural adaptation strategies adopted by Indigenous communities may be as valuable as technical adaption options in reducing heat mortality. Factoring in local knowledge into heat stress reduction strategies is therefore an important consideration.

There is likely a complex interaction between acclimation and the use of air conditioning, which would likely reduce a person's level of acclimation if they spent extended periods in an airconditioned environment. This could have perverse outcomes where people may become more exposed to heat stress when outside. Air conditioning is likely to become increasing necessary as part of the heat stress reduction response options, so establishing optimal ways to use it without reducing acclimation would need to be established.

Heat stress, heat exhaustion and heat stroke – physiological impacts.

Strictly speaking, heat stress is the initial stage of excess heat accumulation and typically includes excessive sweating and feeling uncomfortably hot. Action should be taken to help cool the body.

Heat exhaustion is the next stage and includes symptoms such as muscle cramp, dizziness, fatigue, nausea and weakness. Heat exhaustion occurs when the body loses excessive amounts of fluids and slats, usually from excessive sweating. It's essential that action is taken immediately to reduce any further exposure to heat stress conditions.

Heat stroke is a serious medical condition and can include the above symptoms as well as confusion/altered mental states (e.g. hallucinations) rapid heart rate, slurred speech, vomiting and possible loss of consciousness.   Heat stroke requires immediate medical attention.

At a basic level of human physiology people everywhere have essentially the same capacity to tolerate elevated core body temperatures. This threshold is essentially determined at a biochemical level where temperatures that exceed certain limits impact biochemical pathways.

Safe Work Australia highlight common effects of working in heat stress environments include:

• Heat rash, leading to skin irritation and discomfort.

• Heat cramps resulting from heavy sweating without replacing salt and electrolytes.

• Fainting, particularly when workers stand or rise from a sitting position.

• Dehydration from increased sweating if workers aren’t drinking enough water.

• Heat stroke occurs when the body can no longer cool itself. This can be fatal.

• Burns can occur if a worker comes into contact with hot surfaces or tools.

• Slips, as a worker will sweat more in hot conditions which can increase the risk of slips - for example, a worker might slip when using sharp tools if their hands are damp.

• Reduced concentration, as heat can make it more difficult to concentrate, leading to confusion. This means workers may be more likely to make mistakes, such as forgetting to guard machinery.

• Increased chemical uptake into the body may occur as the heat causes the body to absorb chemicals differently and can increase the side effects of some medications.

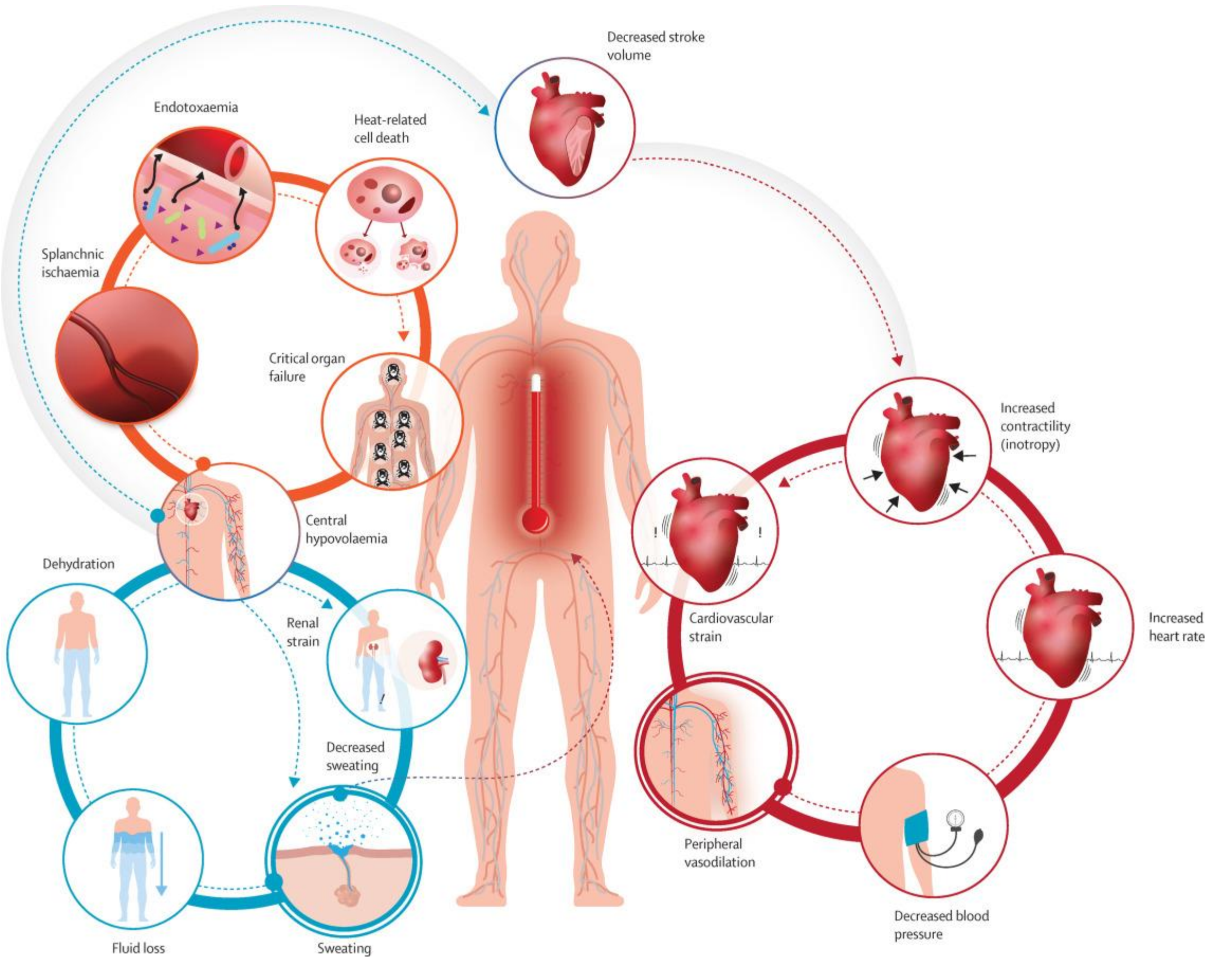


Figure 3. The physiological pathways of heat stress. Source: Lancet Series Heat and Health 1 (2021).

Psychological impacts of excess heat

Indigenous communities in the Torres Strait have a close connection to their land and sea country. There is significant documentation related to how the shifts we are experiencing in environmental conditions add to anxiety, stress, sadness and grief in Indigenous communities (Romanello M et al. 2021).

Extreme weather events such a heat waves and floods have been associated with depression, fear and anxiety, suicide, self-harm, and post-traumatic stress disorder in Indigenous communities globally (Middleton, J. et al. 2020). Changes in temperature and precipitation are cited in relation to hospitalizations, suicide, self-harm, substance use, depression, and stress.

The cumulative impact of acute and chronic climatic stressors could lead to the increased incidence of mental-health disorders, increased use of health services, and increase in maladaptive coping mechanisms such as substance use (Middelton et al 2020).

Periods of excess heat can also reduce people's general tolerance, leading to increased grumpiness, anti-social behaviour, and incidents of domestic violence (Van Lange 2016). There is a strong evidence base linking increased temperatures to increases in violent behaviour, at both individual and societal scales (Van Lange 2016). This risk would be increased where people are living in overcrowded homes without climate control as is common in the Torres Strait.

The impacts of heat on peoples general physical and mental wellbeing as we move into a warmer climate will potentially have multiple and cascading ramifications for the region if not adequately understood and addressed.

Factors that exacerbate risk of heat stress

Not everyone reacts the same way to heat stress and not everyone has the same level of vulnerability.

Factors that increase risk of heat stress include:

- Poor general health
- Excess body weight
- Older age or very young (4 years of age or younger)
- Being pregnant
- Low levels of fitness
- Some medications can increase the risk of heat stress
- Certain health conditions/diseases will increase the risk of heat stress (heart disease, high blood pressure, respiratory diseases, diabetes.)

Heat Stress can be exacerbated by:

- Wearing clothing that restricts the body's ability to cool
- Working in proximity to machines or processes that generate heat

- Working in areas where heat and light are reflected off the water or sand or reflective surfaces such as roofs.

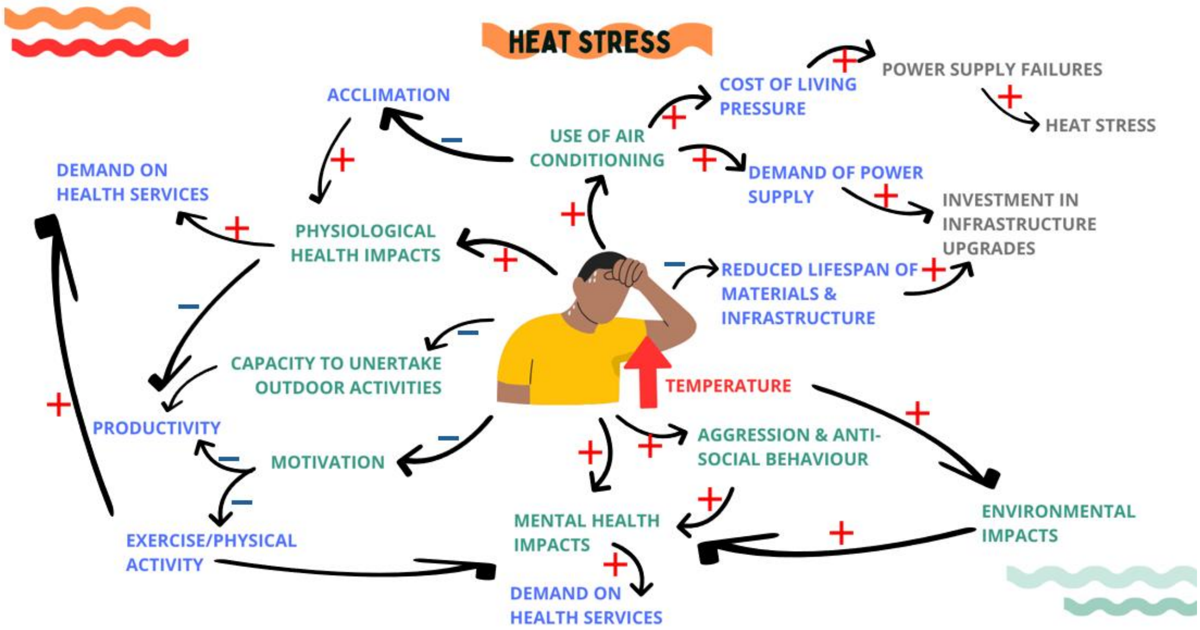


Figure 4. Consequences and feedback from heat stress. Source: TSRA.

Why is the Torres Strait at risk?

Whilst general heatwave conditions as experienced in dryer part of Australia are not very common in the Torres Strait, due to the regions very high humidity levels during summer heat stress is a very real risk for the region's inhabitants.

Torres Strait Islander and Aboriginal people who live in the region are acclimate to the region's historic conditions. Many people, in particular elders, carry a laplap, a small towel used to wipe away sweat. The body however has physiological limits to its capacity to shed excess heat regardless of acclimation. Further to this, climate change is driving average conditions towards higher levels of average heat and more frequent and extreme heat events.

Data collected from homes on Masig indicate that heat stress is already a considerable risk for households in the region. Since 1950 the mean maximum daytime temperature in the region has already increased by 1°C since 1950 (http://www. Bom.gov.au/climate/change) from 29.7°C to 30.7°C. Over the same period the mean minimum temperature has increased by two degrees from 23°C to 25°C. Cool night-time temperatures are essential for good health and to allow people to recover from hot days. 25°C is considered a threshold for hot nights (HeatWatch Queensland Discussion Paper 2019).

If we add to some of the additional factors recognised to increase heat stress vulnerability, listed here, it is clear that the region's population have high exposure to heat stress impacts.

Other factors increasing heat stress risk include:

- Living in remote communities
- People living on low incomes
- People living without access to air conditioning or heat refuges
- People living in overcrowded housing
- People with limited access to transport
- People with pre-existing health conditions

Professor Linda Selvey, UQ School of Public Health has concluded from a review of academic literature of the direct connection between increases in death and illness and heat extremes and that such increases have likely already occurred in the Torres Strait.

Minimising the Impacts of Extreme Heat - A guide for local government.pdf (nsw.gov.au)

Elevated temperatures have multiple potential consequences beyond the health impacts of heat stress including (Fig 1):

- Increased risk of water security challenges
- Impacts on local gardening and food production
- Impacts on food quality
- Increased risk of food spoilage or possible food safety risks
- Increased risk of anti-social behaviour
- Increased risk of disruption to key services including increased risk of power outages

Temperature Projections for the region.

How well the global community manages to reduce greenhouse gas emissions will have a bearing on the severity of heat impacts over the coming decades. There is however already a certain amount of climate change now locked in and temperatures will continue to rise for the foreseeable future regardless of emissions reduction strategies.

Analysis of high-quality temperature observations for Horn Island from the ACORN-SAT dataset of the Bureau of Meteorology to demonstrate an upward trend in temperatures in the Torres Strait region. According to the dataset, the average maximum temperature in the Torres Strait increased by 0.80°C from 1951-60 to the most recent decade 2011-2020. Average minimum temperatures have risen by twice that amount in the same period from 23 °C to 25 °C (Fig. 5)

Further, the number of days with a maximum temperature greater than 30°C at Horn Island increased statistically significantly from 154 days per year in 1951-60 to 231 days per year in 2011-2020. The number of days with a maximum temperature greater than 34°C also increased significantly from 0.7 days per year in 1951-1960 to 2.5 days per year in 2011-2020.

Humidity is harder to model but projections from the Queensland Future Climate dashboard indicate changes in relative humidity are likely to be in the range of 1.0-1.5%. Bear in mind this is relative humidity, so absolute humidity levels will increase with rising temperatures as RH is humidity in relation to the temperature.

It is likely that by 2100 most days in the region will exceed 30 °C based on current emissions trajectory. This would place inhabitants in a constant state of potential heat stress if significant adaptation measures to keep people cool are not deployed.

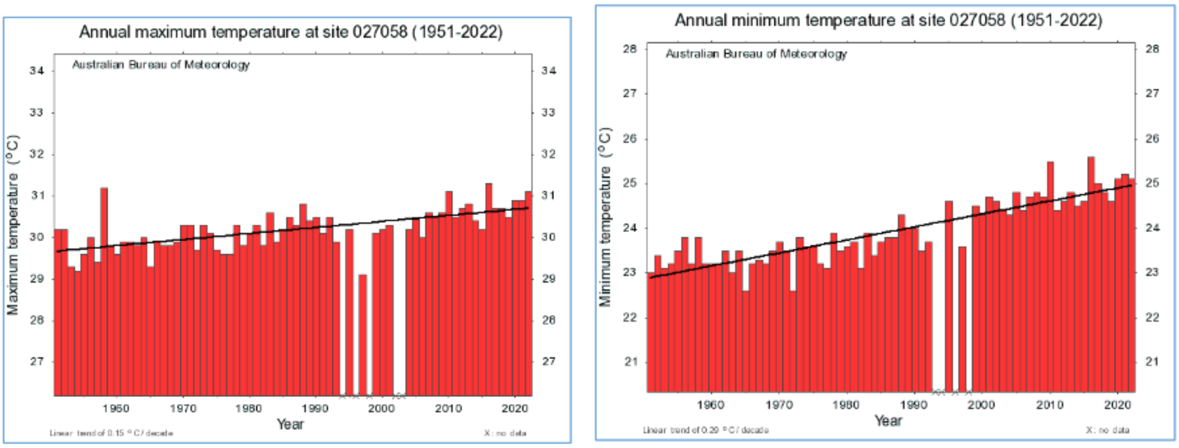
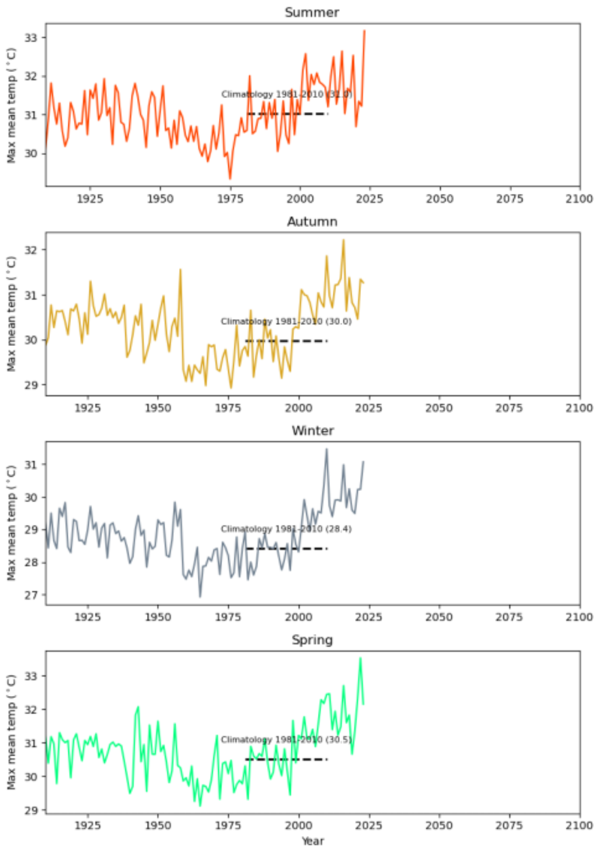


Figure 5. Temperature trends from Horn Island since 1950 showing a steady increase in both average day and night time temperatures, with night time temperatures increasing at approximately twice the rate of day time temperatures.Source: Bureau of Meteorology.



Maximum temperaures in the Torres Striat by season. The dashed black line represents the average temperature value for 1981-2010. Source: https://adapt-log.csiro.au/

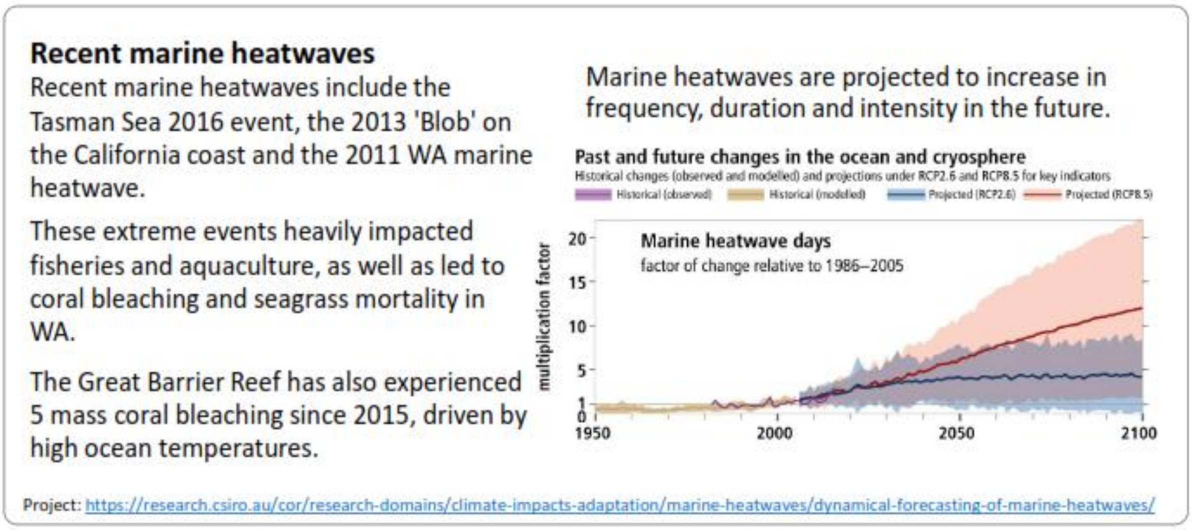


Figure 6. Projected increase in frequency, duration and intensity of marine heat waves against two emissions pathway scenario’s RCP 2.6 and RCP 8.5 compared to historical trends. Source: CSIRO.

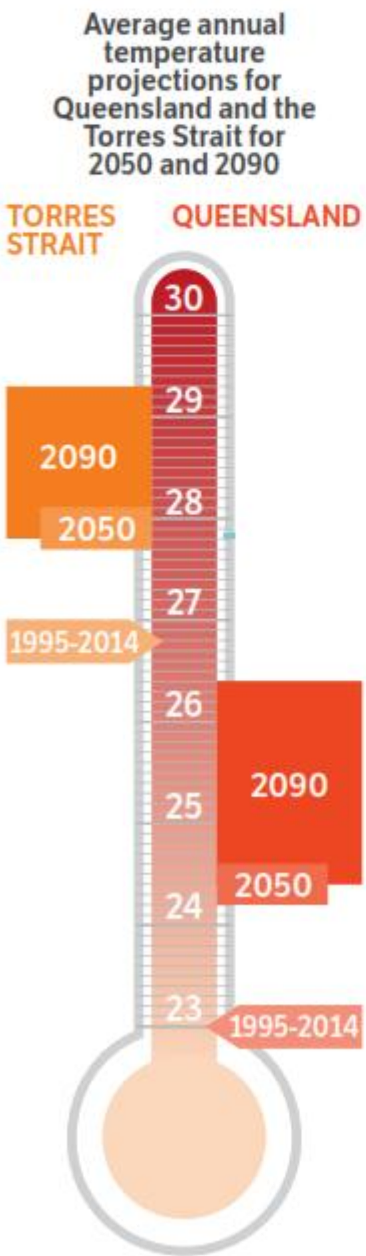


Figure 7. Projected changes in Torres Strait annual average temperatures compared to those of mainland Queensland. Source: Queensland Future Climate – Torres Strait Regional Summary

Recommended actions

This modified diagram from the Australian National Climate and Health Strategy identified the key aspects of a comprehensive Heat Risk Response Plan.

"The comprehensive plan involved an early warning system, preparedness strategies including training of medical and community workers to better identify and treat heat-related illnesses, building public awareness of health risks, and coordination of inter-agency emergency response effort when heat waves occurred"

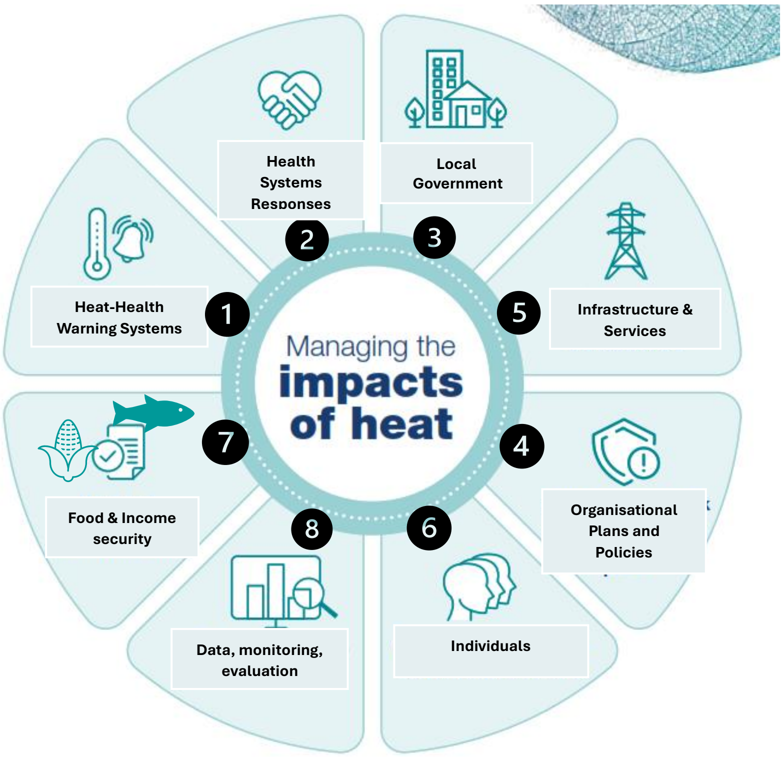


Figure 8. Elements of a comprehensive heat risk response plan. Source: Australian National Climate and Health Strategy (2023).

1. Heat Health Warning System

Being able to warn communities of impending heat stress conditions in going to become increasingly important. This is still an area of ongoing research to determine what temperature and humidity values constitute a real threat to human health for the Torres Strait. There is still a challenge in developing accurate forecast methodologies of humid heat risk conditions.

The factors that determine a HHW vary from region to region. A determination has to be made as to what values need to be exceeded for there to be a likely risk to health. This can include a blend of variables such as temperature and humidity as well as length of time values exceed defined thresholds.

To have an effective system requires quality local data as well as forecasting capabilities coupled with effective strategies to get information out to communities.

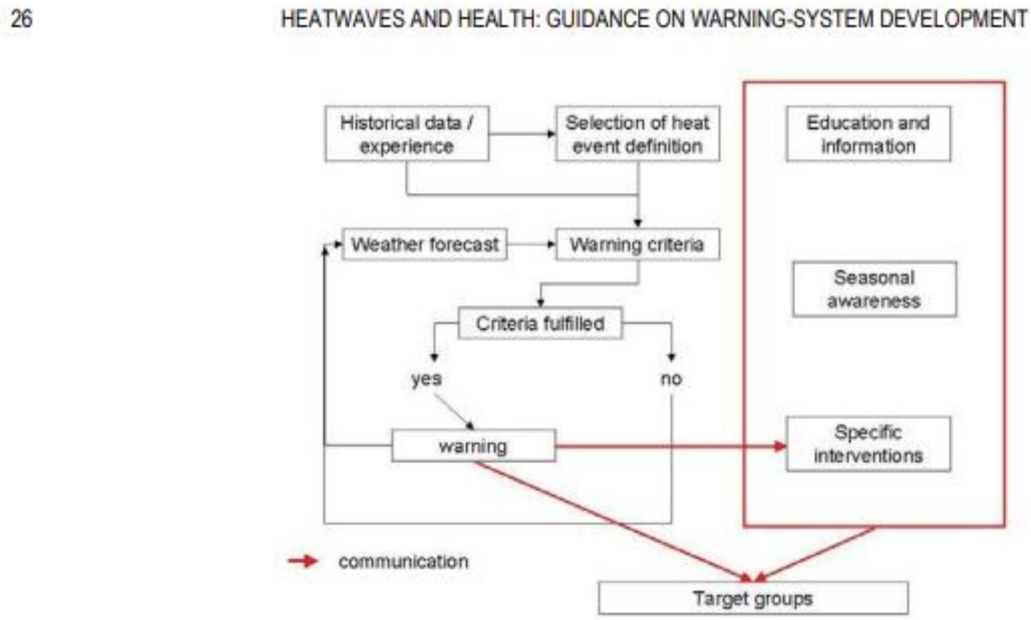


Figure 9. Flow diagram showing the operation of a heat health warming system within a wider heat-health action plan (elements in the red box). Source: McGregor et. al. (2015).

Biometeorological indictors

Many biometeorlogical indices have been developed to quantify atmospheric conditions that relate to human comfort and heat stress. Common examples are included below, and more complex variations exist that factor in additional variables.

- The Heat Index (HI) combines temperature and RH to determine the apparent temperature, or what the temperature actually feels like when humidity is factored in.
- The Net Effective temperature (NET) factors in wind speed as well.
- Wet-bulb temperature (WBGT) combines temperature and humidity into a single number and is affected by wind and radiation. It is measured by a specific device that measure three variations to account for these factors.
  - BoM don't measure WBGT but make an estimation of it. BoM has developed a refined wet bulb temperature (NEWT) that is more accurate that previous versions and is a useful index of thermal comfort.
- Apparent temperature - (AT) is defined as the temperature at the reference humidity level, which produces the same amount of discomfort as that experienced under the current ambient temperature and humidity. It is therefore an adjustment of ambient temperature based on humidity levels.
- Excess Heat Index (EHI) - developed by BoM considers the relationship of maximum and minimum temperatures averaged over a three-day period to a climate reference value (95th percentile) of observed daily temperature. Appropriate for dry climates.

The Queensland Future Climate initiative is developing a heat hazard metrics that factor in RH and solar radiation.

The University of Sydney has developed a Health Health Indicator

Actions:

- Identify a suitable biometeorological indicator for the Torres Strait
- Develop a forecasting capability to predict heat stress conditions.
- Establish a warning system to notify target groups, broader community and stakeholders of impending heat stress conditions.

2. Health system responses

Establishment of heat stress thresholds to hot humid climates

- Determine what are the actual conditions that when exceeded cause heat-health impacts in the Torres Strait.
- Issue heat health warnings based upon the heat health warning systems outlined above.

Data and monitoring

- Ensure targeted heat and humidity data is being collected when people attend clinics to assess links between heat stress and presentations to local clinics as well as issues such as incidents of domestic violence.
- Random selection of housing types for data collection points, to find which housing types are better suited to heat health in the region.
- Ensure that in event of heatwaves there is adequate testing for electrolyte imbalances (esp. sodium and potassium) and checks for other indicators of prolonged heat stress such as cortisol. This could provide a better picture of the degree of heat stress being experienced, as well as accumulation of exposure, especially for the elderly and vulnerable sections of the community.
- Survey the community as to their experience of heat and what coping strategies they already know of and use.
- Develop and distribute appropriate education and awareness materials on heat stress risk to communities and organisations.
- Determine optimal use of air conditioning in the Torres Strait that doesn’t undermine acclimation but provides critical relief during periods to high heat stress risk.

Training and capacity

- Ensure clinic staff are trained in responding to heat stress, heat exhaustion and heat stroke.

Multi-agency coordination

- Ensure there is multi-agency coordination during extreme heat events. There is a risk of multiple impact events occurring simultaneously such as wildfires coupled with extreme heat and power failures for example.

3. Local Government Actions to reduce heat stress

- Understanding where heat stress risks lie for local government assets and services and staff and put in place contingency measure as appropriate. For example, power failures are common during heat wave with implications for basic environmental health services and communications technologies.
- Community planning for green and cool spaces. Expand the amount of area under shade within the footprint of the community area.
- Ensure construction of buildings factor in passive cooling and or other options to help keep staff/residents cool.
- Understand their duty of care to staff working outdoors or in heat risk situations and have suitable policies and measure in place.
- Plan for extreme heat conditions in relation to water security. Ensure community have access to free good quality drinking water.
- Educate community on heat risks to pets and livestock

4. Organisational Plans and Policies - Employer actions to reduce heat stress

Safe Work Australia has a guide on managing the risks of working in heat [Guide for managing the risks of working in heat.pdf (safeworkaustralia.gov.au)](). Organisations and employers have legal obligations under the Work Health and Safety Act in relation to worker health and safety, including risks of heat stress.

- Develop an organisational heat stress workplace policy and procedures based on assessment of hazards, risks and control measures.
- Ensure employees are aware of the risks, mitigation measures and the heat risk policy.
- Monitor conditions (temperature, humidity, wind) to evaluate heat stress risk during periods elevated heat risk.
- Ensure that supervisors and workers are trained to respond effectively to heat-related emergencies, including recognition of symptoms of heat stress, mitigation options, basic first aid and reporting as required.
- Ensure indoor work areas are kept at suitable temperature and humidity levels to avoid exposing staff to heat stress risks.
- Have a heat stress incident response forms and keep a record of any heat stress incidents.
- Ensure staff have suitable clothing and equipment (e.g. access to drinking water) to minimise heat stress risk.
- Consider shifting operational hours to avoid heat stress exposure for outdoor workers.

5. Infrastructure and services responses

Housing considerations

Social housing in the Torres Strait does not include installation of air conditioning units. Some residents install their own air conditioning systems by most homes do not have air conditioning.

Tropical homes are designed to maximise air flow which runs contrary to conditions to optimally run air conditioning. It is also likely that people who spend more time inside air conditioner environments that in ambient conditions will lose some or all of their humid climate acclimation. However, the projected changes in temperatures mean that air conditioning is increasingly going to need to be part of the adaption strategy. A suitable solution will probably involve a combination of installation of air conditioning in sealed areas of the home such as the bedrooms and encouragement to only use these options as necessary to avoid reducing the body's natural capacity to shed heat when leaving the home.

- Review current housing being built in the Torres Strait in relation to ambient indoor heat and humidity conditions.
- Review of current heat mitigation options for housing (e.g. air conditioning, ventilation, shading) to assess if all new homes should include (bedroom) air-conditioning and if existing homes should be retrofitted in this regard.
- Review of design processes currently applied for social housing provision to ensure climate (current and future) and culturally appropriate house design and construction.
- Implement additional passive cooling options where appropriate such as planting of trees and plants and orientation of the house during construction to improve shading of housing.

General Infrastructure considerations

Heat can impact infrastructure and various ways, including reduction of the lifespan of certain materials, increased risk of power supply failure, distortion or buckling of materials and pushing certain technologies and process past their thermal thresholds. This also leads to higher maintenance costs. During extreme events, power infrastructure is itself operating under increased thermal stress whilst also trying to meet increased demand, acerbating the thermal stress and possibility of powerplant failure.(https://www.bsr.org/en/emerging-issues/infrastructure-breaks-under-extreme-heat)

Solar panels also make less electricity when they become too hot. Furthermore, extreme heat could lower the ability of transmission lines to carry power by some 6 percent by mid-century. Transformers are more likely to fail too; MIT found that for every 1-degree rise in temperature, the lifetime of a transformer decreases by four years. .(https://www.bsr.org/en/emerging-issues/infrastructure-breaks-under-extreme-heat)

- Assess capability for power infrastructure to meet growing energy demands under a warming climate to ensure system and its components are fit for purpose.
- Review infrastructure procurement processes to ensure climate resilience is factored into the design, construction, maintenance and location of all new assets.

6. Individual actions to reduce heat stress.

Developing and implementing community scale heat stress responses should consider and include local traditional knowledge and strategies to managing heat.

- Build an awareness of heat stress and options to reduce your risks.
- Keep well hydrated during warm weather by drinking at least 2 litres of fresh water daily.
- Avoid spending more time than you need out in direct sunlight.
- Avoid strenuous activities during hot weather. If you have to work in the heat, make sure you take rest breaks in the shade, wear suitable loose clothing and sun protection, keep well hydrated.
- Wear clothing that will help to keep air flowing around your body.
- Keep an eye on older or unwell members of the community who might not be very mobile or able to respond as well to heat.
- Be aware that very young children don't have the same capacity to regulate their body temperate.
- Don't use a fan in very hot weather unless it is blowing cooler air onto you.
- Take cool showers or use a damp towel to cool yourself.
- Avoid hot drinks and alcohol.
- Be aware that pregnant women, very young children, elders, people with other health conditions such as heart conditions and diabetes are more susceptible to heat stress.
- Some medications can increase risk of heat stress so check with the health clinic if you are on any of these medications.
- Be aware temperatures inside vehicles can quickly reach dangerous levels on hot days. Ensure children and pets are not left unattended in vehicles during warm or hot weather.
- Pets– dogs and cats can't sweat and have to maintain their core temperature by panting. During hot weather dogs can quickly overheat if they undertake excessive activity. Ensure pets have access to plenty of drinking water and cooler refuge areas out of the heat.

7. School and Sporting Clubs actions to avoid heat stress

Intense physical activity during sporting events if undertaken during periods of heats stress risk can put people at risk of mild through to very serious health impacts. There may be a need to shift the timing and location of sporting events to ensure they can be conducted safely during summer months.

- Undertake an assessment of where heat stress risks lie for students/ staff/ participants, programs, activities and assets.
- Monitor conditions (temperature, humidity, wind) to evaluate heat stress risk during periods elevated temperatures.
- Develop heat risk plans and procedures to ensure risks of heat stress are mitigated.
- Ensure staff, student and members are aware of heat stress risks and the school/clubs response measures.
- Consider options to cool venues when sports occur.

8. Food and income security responses

Local gardens, commercial and subsistence fishing are important parts of Torres Strait communities' food and income security. Changes in background temperatures and extreme heat events pose substantive risks to the productivity of marine and terrestrial food resources.

Warmer temperatures impact crops through increased risk of loss of soil moisture, increased risk of pests and diseases that thrive in warmer conditions, as well physiological heat stress. The projected temperature increases will most likely reach the maximum heat tolerance thresholds of crops and induce heat stress, wilting, and crop failure, especially in traditional crops like taro, yam, and arrowroot. (Food Security and Climate Change in the Pacific: Rethinking Options, 2011).

Strategies to combat heat impacts on crop productivity include:

- Selection of crop varieties with greater heat tolerance
- Install water efficient irrigation to counter low soil moisture conditions
- Explore food production in climate-controlled conditions such as greenhouses
- Develop a regional food security action plan to expand reliable production of fresh produce factoring in future climatic challenges

Impact of heat on marine resources

The marine environment is very susceptible to temperature shifts. Many marine species inhabit specific thermal tolerance zones and will shift their distribution to stay in their comfort zones where possible. Marine heat waves can lead to severe impacts on coral reefs as well as led to fish kills due to low oxygen levels in warner water. Captured crayfish can easily die when brought up to holding cages in the warmer surface waters during marine heatwave conditions. Turtle populations are expected to undergo a steep decline due in part to the impact of heat on the gender of hatchlings.

Adaptation actions will be developed through the respective adaptation pathways for fisheries and for land and sea management but will need to include increased temporal and spatial flexibility in management arrangements, development of novel resources, options to reduce the impact of weather and fuel costs on fishing effort and building greater resilience into supply chains.

Next steps.

The TSRA will convene a working group of relevant stakeholders to progress development and implementation of the action plan.

References

1. Asseng, S., Spänkuch, D., Hernandez-Ochoa, I., & Laporta, J. (2021). The upper temperature thresholds of life. *The Lancet Planetary Health, 5*(6), e378-e385.

2. Asian Development Bank. (2011). *Food Security and Climate Change in the Pacific, Rethinking the Options*. Pacific Studies Series.

3. Heat Stress. (n.d.). Retrieved from WorkSafe Queensland.

4. Heat Stroke Vs. Heat Exhaustion: Know the Warning Signs. (2024). Retrieved from WMGK.

5. HeatWatch Queensland. (2019). *Extreme heat in the Sunshine State*. The Australia Institute Discussion Paper.

6. McGregor, G. R., Bessemoulin, P., Ebi, K., & Menne, B. (Eds.). (2015). *Heatwaves and Health: Guidance on Warning-System Development*. WMO-No 1142. World Meteorological Organization and World Health Organization.

7. McMichael, A. J., Woodruff, R. E., & Hales, S. (2003). *Climate change and human health: risks and responses*. World Health Organization. Retrieved from WHO.

8. Middleton, J., Cunsolo, A., Jones-Bitton, A., Wright, C. J., & Harper, S. L. (2020). Indigenous mental health in a changing climate: a systematic scoping review of the global literature. *Environmental Research Letters, 15*(5), 053001. doi: 10.1088/1748-9326/ab68a9

9. Australian Government Department of Health and Aged Care. (2023). *National Climate and Health Strategy 2023*.

10. Romanello, M., McGushin, A., di Napoli, C., Drummond, P., Hughes, N., Jamart, L., et al. (2021). The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *The Lancet, 398*(10311), 1619-1662. doi: 10.1016/S0140-6736(21)01787-6

11. Turek-Hankins, L. L., Coughlan de Perez, E., Scarpa, G., Ruiz-Diaz, R., Schwerdtle, P. N., Joe, E. T., Galappaththi, E. K., French, E. M., Austin, S. E., & Singh, C. (2021). Climate change adaptation to extreme heat: a global systematic review of implemented action. *Oxford Open Climate Change, 1*(1), kgab005. doi: 10.1093/oxfclm/kgab005

12. Van Lange, P. A. M., Rinderu, M. I., & Bushman, B. J. (2016). Aggression and violence around the world: A model of climate, aggression, and self-control in humans (CLASH).

13. Quilty, S., Jupurrurla, N. F., Lal, A., Matthews, V., Gasparrini, A., Hope, P., Brearley, M., & Ebi, K. L. (2023). The relative value of sociocultural and infrastructural adaptations to heat in a very hot climate in northern Australia: A case time series of heat-associated mortality. *The Lancet Planetary Health, V7-8*.

14. Ebi, K. L., Capon, A., Berry, P., Broderick, C., de Dear, R., Havenith, G., Honda, Y., Kovats, R. S., Ma, W., Malik, A., Morris, N. B., Nybo, L., Seneviratne, S. I., Vanos, J., & Jay, O. (2021). Hot weather and heat extremes: health risks. *The Lancet*.

Stakeholders

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TSIRC	Environmental Health	Ewan Gunn	
TSC			
TSCHHS			
Qld Health			
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