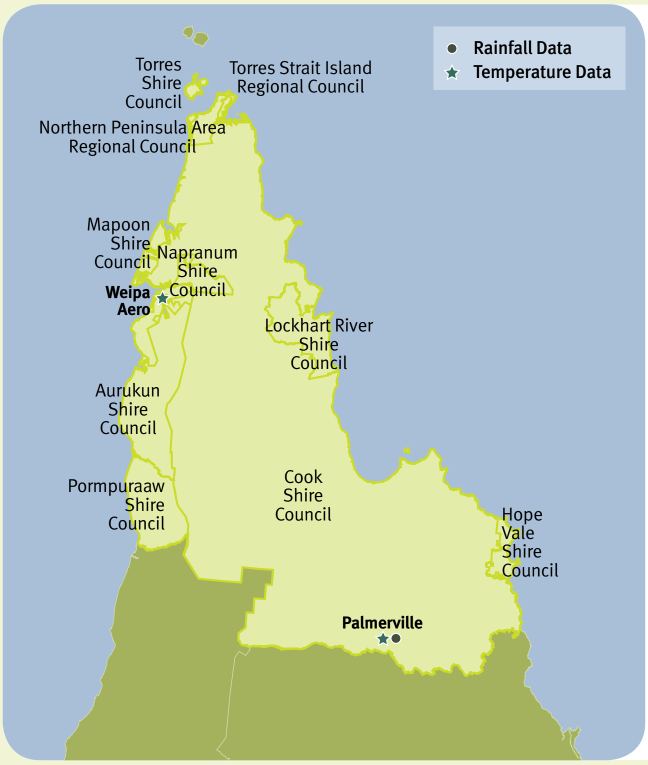
Climate change in the
Cape York Region



This regional summary describes the projected climate change for the Cape York (CY) region.

Projected average temperature, rainfall and evaporation for 2030, 2050 and 2070 under low, medium and high greenhouse gas emissions scenarios are compared with historical climate records.

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Key findings

Temperature

- There has been minimal change in the average annual temperature over the last decade (from 26.5 °C to 26.4 °C).
- Projections indicate an increase of up to 3.7 °C by 2070, leading to annual temperatures well beyond those experienced over the last 50 years.
- By 2070, Weipa may have more than three times the number of days over 35 °C (increasing from an average of 55 per year to an average of 189 per year by 2070) and Palmerville may have more than double the number of days over 35 °C (increasing from an average of 97 per year to an average of 210 per year by 2070).

Rainfall

- Average annual rainfall in the last decade remained stationary compared to the previous 30 years.
- Models have projected a range of rainfall changes from an annual increase of 24 per cent to a decrease of 21 per cent by 2070. The 'best estimate' of projected rainfall change shows a decrease under all emissions scenarios.

Evaporation

- Projections indicate potential evaporation could increase 7–14 per cent by 2070.

Extreme events

- Storm surges will be able to penetrate further inland greatly increasing the risk to natural ecosystems, infrastructure and the risk of erosion in low-lying coastal regions.

A regional profile

Climate and landscape

The Cape York region has a tropical climate with hot to very hot temperatures experienced throughout the year. Rainfall in the Cape York region is highly seasonal, with most rain falling during the 'wet' season (October–March) either as heavy thunderstorms, monsoonal lows or cyclones.

The Cape York Peninsula is surrounded by the Gulf of Carpentaria (west), Torres Strait (north) and the Coral Sea (east) and includes all estuaries, marine areas, reefs and islands within three nautical miles of the coast.

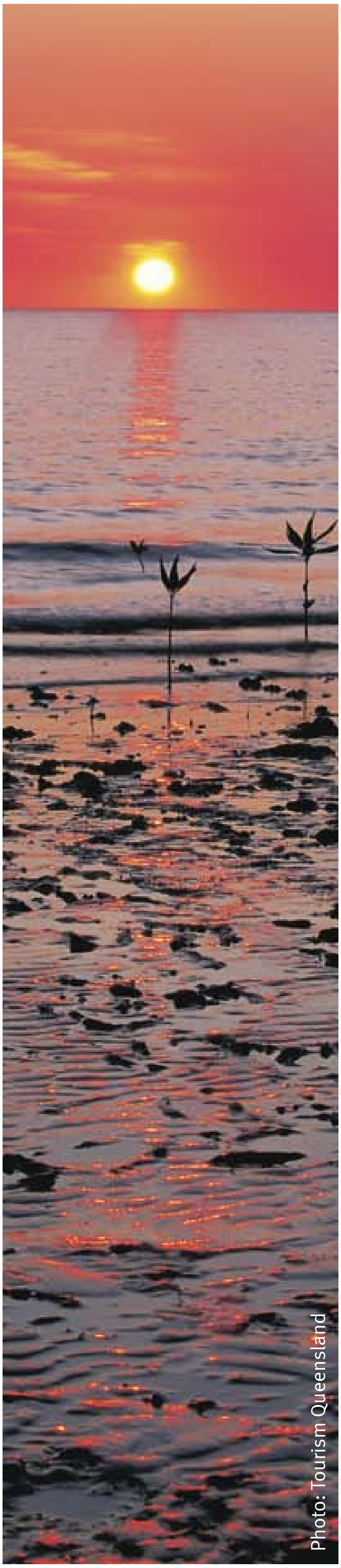
Demographics

The Cape York region is sparsely populated with an area of 124 473 square kilometres and a population of approximately 18 700 people. More than 35 per cent of the resident population is of Aboriginal or Torres Strait Islander descent.

(OESR, 2007)

Important industries of the region

The region has an established and rapidly expanding mining industry (kaolin and bauxite), an emerging tourism industry as well as significant cattle and fishing industries.



Understanding the climate and how it changes

Queensland's climate is naturally variable; however, climate change will lead to shifts beyond this natural variability. To assess the risk of human-induced climate change requires an understanding of the current climate using historical data and future climate scenarios. These future scenarios are prepared using data from Global Climate Models.

Method

Historical climate data

Historical climate data collected by the Bureau of Meteorology (BoM) were aggregated across the CY region. The fluctuations and trends in the observed data are presented including extremes in temperature and the frequency of cyclones.

Greenhouse emission scenarios

The World Meteorological Organization (WMO) and the United Nations established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC assesses the latest scientific, technological and socio-economic literature on climate change.

To estimate the potential impacts of future climate change on Queensland, climate change projections were developed using the IPCC low (B1), medium (A1B) and high (A1FI) greenhouse gas emissions scenarios. The low-range scenario (B1) assumes a rapid shift to less fossil fuel intensive industries. The mid-range (A1B) scenario assumes a balanced use of different energy sources. The high (A1FI) scenario assumes continued dependence on fossil fuels.

Greenhouse gas emissions are currently tracking above the highest IPCC emissions scenario (A1FI). The low and medium scenarios are presented to show the potential benefits of action to reduce greenhouse gas emissions.

Climate change projections

Queensland climate change projections were produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) based on the results from 23 Global Climate Models. Projections were provided for 2030, 2050 and 2070. However, as the climate can vary significantly from one year to the next, these projections show changes in average climate for three future 30-year periods centered on 2030, 2050 and 2070. Sea-level rise is also considered.

Current climate

Temperature (BoM, 2008)

Historical temperature records indicate the average temperature in the CY region has remained stable over the last decade (1998–2007).

The average annual temperature was 26.5 °C in the 30-year period from 1971–2000, which is a 0.1 °C increase on the 1961–1990 average. The annual maximum temperatures since 1950 are presented in Figure 1. The trend over time is represented by the black line in each graph.

Average maximum temperature has remained stable in the Cape York region

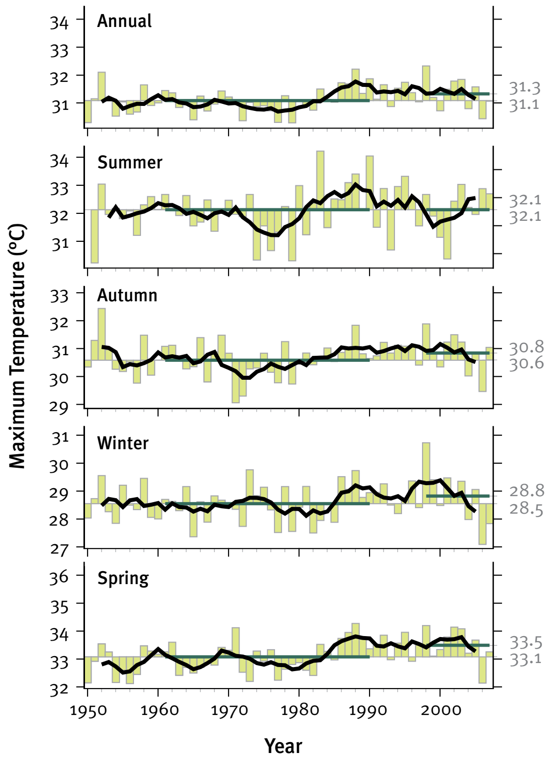


Figure 1: Historical annual and seasonal maximum temperatures for the Cape York region for the period 1950–2007, compared to the base period 1961–1990

The black line is a five-year running average.
The mean for both the baseline of 1961–1990 and the last decade 1998–2007 are shown by the green lines and indicated numerically at the right of the graph.
Note: vertical scales may differ between graphs.

Data source: BoM, 2008

Temperature extremes (BoM, 2008)

Extremes in temperature (such as a number of days exceeding 35 °C) are single events that usually do not extend past a couple of days. Due to the influence of regional topography, proximity to the ocean and prevailing winds, location-specific data are required when considering changes in these extreme events over time.

Historical temperature records for Weipa (Figure 2) show that, in recent decades, the number of days each year where the maximum temperature exceeds 35 °C has tended to increase. However, there is no observable trend for Palmerville (Figure 3). Due to its inland location, Palmerville currently experiences more extreme temperature days than coastal Weipa.

The number of days over 35 °C has risen in Weipa

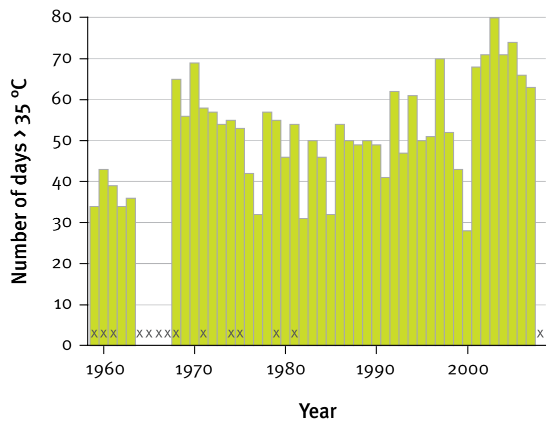


Figure 2: Number of days where the temperature exceeded 35 °C for Weipa

Blank spaces are those years where the maximum temperature did not exceed 35 °C.
'X' denotes the year for which the full data set is not available (i.e. the actual values may be greater than what is shown).

Data source: BoM, 2008

Photo: Tourism Queensland

No observable change in the number of days over 35 ˚C in Palmerville

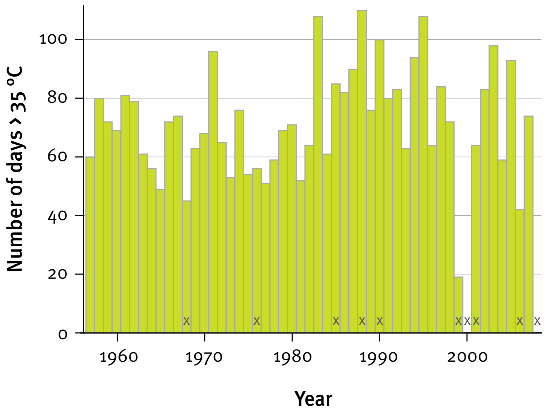


Figure 3: Number of days where the temperature exceeded 35 ˚C for Palmerville

Blank spaces are those years where the maximum temperature did not exceed 35 °C.
X' denotes the year for which the full data set is not available (i.e. the actual values may be greater than what is shown).
Data source: BoM, 2008

Rainfall (BoM, 2008)

Annual and seasonal average rainfall is strongly influenced by natural variability, local factors such as topography and vegetation, and broader scale weather patterns, for example El Niño-Southern Oscillation (ENSO) events. To understand how this natural temporal variation changes rainfall patterns, long-term rainfall records are required. The BoM has been collecting rainfall data for the Cape York region since 1897.

The variability in annual and seasonal rainfall is outlined in Figure 4. The average annual rainfall in Cape York varies greatly from year to year. Over the last decade the average has increased by six per cent compared to the 1961–1990 average; however, this is well within the variability measured over the last 100 years.

Figure 4 shows the dominant summer rainfall pattern with a 1961–1990 average rainfall around 820 mm, compared to an autumn average (the next most dominant rainfall period) of around 420 mm.

Historical rainfall shows high variability

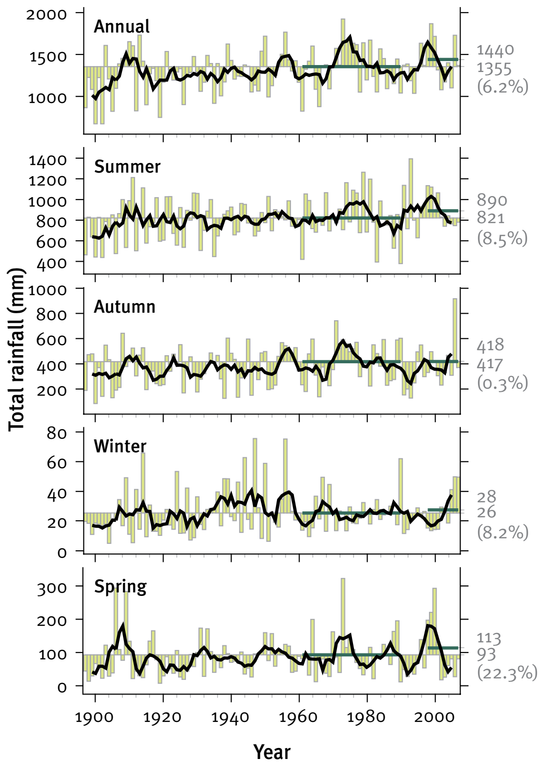


Figure 4: Historical annual and seasonal total rainfall for the Cape York region for the period 1897–2007

The black line is a five year running average.
The mean for both the baseline 1961–1990 and the last decade 1998–2007 are shown by the green lines and indicated numerically at the right of the graph.
The difference in rainfall between the baseline and last decade is shown in per cent.
Note: vertical scales may differ between graphs.
Data source: BoM, 2008

Evaporation

Potential evaporation is a measure of the evaporative (or drying) power of the atmosphere. The potential evaporation rate assumes that there is an unlimited supply of water to evaporate (either from the soil or from water bodies). Although potential evaporation can differ from actual evaporation, a change in potential evaporation gives a good indication of the change in the evaporative power of the atmosphere. Networks to measure potential evaporation are not as well developed as those that measure temperature and rainfall and there are insufficient data available to indicate the changes over time.

Averaged over the Cape York region, the annual mean potential evaporation over the period 1971–2000 (2216 mm) is significantly greater than the annual mean rainfall over the same period (1431 mm), which is a contributing factor to the depletion of soil moisture.

Cyclones

Strong winds, intense rainfall and ocean effects such as extreme waves combine to create the total cyclone hazard. This hazard is greatest in Queensland between January and March, but tropical cyclones in Queensland can occur anytime over the period from November to April.

On average, 4.7 tropical cyclones per year affect the Queensland Tropical Cyclone Warning Centre Area of Responsibility. This area includes all of Queensland, a large portion of the Gulf of Carpentaria, Northern NSW and extends out to 600 km off the Queensland coast.

In some areas of Queensland there is a relationship between the impact of cyclones and the El Niño-Southern Oscillation (ENSO) phenomenon. However, for northern Queensland regions, such as Cape York, this trend is not evident (Figure 5).

Occurrence of cyclones across the Cape York region

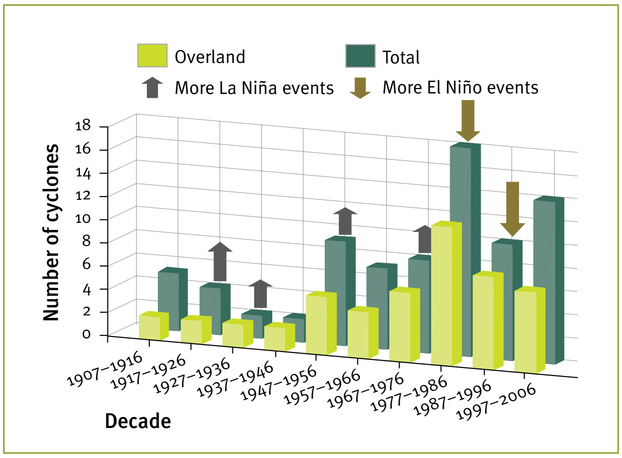


Figure 5: Total and overland number of tropical cyclones for Cape York Region for the period 1907–2006

Adapted from BoM, 2008

Projected climate change in Cape York

Global Climate Models simulate the earth's climate system using a complex set of mathematical rules that describe the physical processes of the atmosphere, ocean, land and ice. They are currently considered to be the best tools for projecting climate change. CSIRO has recently released climate change projections for Australia (CSIRO & BoM, 2007) based on the results from 23 Global Climate Models. Projections for the Cape York region have been extracted from this dataset for the Queensland Climate Change Centre of Excellence (QCCCE). The projections presented here are relative to the base period of 1980–1999.

The Global Climate Models show little difference under the low, medium and high emissions scenarios to 2030. Therefore, the 2030 climate change projections for Cape York have been presented on a mid-range emissions scenario.

However, the projections diverge at 2050 under different emissions scenarios. Therefore, the 2050 and 2070 projections are based on low and high emissions scenarios.

The full range of projected changes for temperature, rainfall and potential evaporation for Cape York in 2030, 2050 and 2070 are described in Table 2. The numbers shown in brackets in Table 2 indicate the range of the results from the Global Climate Models.

Overview of climate projections

In summary, the 'best estimate' changes to temperature and rainfall under the three emissions scenarios are:

2030 (medium emissions scenario)

- **Annual and seasonal temperature**: annual mean temperature (the average of all daily temperatures within a given year) is projected to increase by 0.8 °C. There is little variation in projections across the seasons.
- **Annual and seasonal rainfall**: no change in the annual rainfall (the total rainfall received within a given year) is projected. The largest seasonal decrease of three per cent (-3 mm) is projected for spring.
- **Annual and seasonal potential evaporation**: across all seasons the annual 'best estimate' increase is projected to be around three per cent (66 mm), with some models projecting up to a five per cent increase in autumn (23 mm), summer (26 mm) and winter (25 mm).

2050 (low and high emissions scenarios)

- **Annual and seasonal temperature**: annual temperature will increase by 1.0 °C and 1.7 °C under the low and high emissions scenarios respectively. There is little variation in projections across the seasons.
- **Annual and seasonal rainfall**: annual rainfall is projected to remain unchanged under the low emissions scenario or decrease by one per cent (-14 mm) under the high emissions scenario. The largest seasonal decrease of six per cent (-6 mm) under the high emissions scenario is projected for spring.
- **Annual and seasonal potential evaporation**: under a high emissions scenario an increase in annual potential evaporation of up to nine per cent (199 mm) is projected with the best estimate being six per cent (133 mm). Autumn, summer and winter are projected to have the greatest increases up to 10 per cent (46mm, 53mm and 49 mm respectively).

2070 (low and high emissions scenarios)

- **Annual and seasonal temperature**: annual temperature is projected to increase by 1.4 °C and 2.7 °C under the low and high emissions scenarios respectively. There is little variation in projections across the seasons.
- **Annual and seasonal rainfall**: annual rainfall is projected to decrease by one per cent (-14 mm) for each emissions scenario. The largest seasonal decrease under a high emissions scenario of 10 per cent (-10 mm) is projected for spring.
- **Annual and seasonal potential evaporation**: under a high emissions scenario, annual potential evaporation is projected to increase by as much as 14 per cent (310 mm). Autumn, summer and winter are projected to be the seasons most impacted with increases up to 17 per cent (79 mm, 90 mm and 84 mm respectively) in some models.

Temperature extremes

Global Climate Models indicate that increasing greenhouse gas concentrations in the atmosphere will increase the likelihood of a record high temperature in a given region. The Global Climate Models project a rise in extreme temperatures (CSIRO & BoM, 2007). Table 1 shows the projected number of days above 35 °C for two observing stations in the Cape York region with good historical records.

Under a high emissions scenario in 2070 for Weipa the number of hot days above 35 °C is projected to increase from 55 days to 189 days. Under the same scenario for Palmerville, the number of hot days would more than double, increasing from 97 days to 210 days.

Station Name	Current	2030 Mid	2050 Low	2050 High	2070 Low	2070 High
Palmerville	97	113 (112–136)	136 (113–142)	155 (136–191)	142 (126–175)	210 (175–266)
Weipa	55	82 (74–92)	86 (76–105)	118 (91–162)	102 (85–136)	189 (125–263)

Table 1: Number of hot days per year above 35 °C projected for 2030 (mid emissions scenario) and 2050 and 2070 (low and high emissions scenarios)

Current number of days calculated using a base period of 1971–2000.

Cyclones and sea-level rise

Extreme weather events, such as cyclones, have a complex link to ocean surface temperatures, characteristics of a region and global climate patterns such as the ENSO, making it difficult to predict their frequency of occurrence. This results in discrepancies in cyclone frequencies between different climate models.

Variable	Season	(1971–2000)	2030†	2050†		2070†	
			Emissions Scenarios				
		Current historical mean*	medium	low	high	low	high
			Projected Changes#				
Temperature °C	Annual	26.5 °C	**+0.8** [+0.6 to +1.1]	**+1.0** [+0.7 to +1.4]	**+1.7** [+1.2 to +2.3]	**+1.4** [+1.0 to +1.9]	**+2.7** [+1.9 to +3.7]
	Summer	28.0 °C	**+0.9** [+0.6 to +1.2]	**+1.1** [+0.7 to +1.5]	**+1.7** [+1.2 to +2.4]	**+1.4** [+1.0 to +2.0]	**+2.8** [+1.9 to +3.9]
	Autumn	26.5 °C	**+0.9** [+0.6 to +1.2]	**+1.0** [+0.7 to +1.4]	**+1.7** [+1.2 to +2.4]	**+1.4** [+1.0 to +2.0]	**+2.8** [+1.9 to +3.8]
	Winter	23.8 °C	**+0.8** [+0.6 to +1.1]	**+1.0** [+0.7 to +1.4]	**+1.6** [+1.1 to +2.3]	**+1.4** [+0.9 to +1.9]	**+2.6** [+1.8 to +3.7]
	Spring	27.5 °C	**+0.8** [+0.6 to +1.1]	**+1.0** [+0.7 to +1.4]	**+1.6** [+1.1 to +2.3]	**+1.3** [+0.9 to +1.9]	**+2.6** [+1.8 to +3.6]
Rainfall %	Annual	1431 mm	**0** [-7 to +7]	**0** [-9 to +9]	**-1** [-14 to +15]	**-1** [-12 to +12]	**-1** [-21 to +24]
	Summer	888 mm	**0** [-8 to +9]	**0** [-9 to +11]	**0** [-14 to +19]	**0** [-12 to +15]	**0** [-22 to +30]
	Autumn	421 mm	**-1** [-12 to +10]	**-1** [-14 to +12]	**-2** [-22 to +20]	**-1** [-18 to +17]	**-3** [-33 to +32]
	Winter	24 mm	**-1** [-18 to +14]	**-1** [-21 to +17]	**-2** [-33 to +28]	**-2** [-28 to +23]	**-4** [-46 to +45]
	Spring	104 mm	**-3** [-26 to +19]	**-4** [-28 to +22]	**-6** [-43 to +36]	**-5** [-38 to +30]	**-10** [-59 to +59]
Potential evaporation %	Annual	2216 mm	**+3** [+2 to +4]	**+3** [+2 to +5]	**+6** [+4 to +9]	**+5** [+3 to +7]	**+10** [+7 to +14]
	Summer	531 mm	**+3** [+1 to +5]	**+3** [+2 to +4]	**+6** [+3 to +10]	**+5** [+2 to +9]	**+10** [+5 to +17]
	Autumn	463 mm	**+3** [+2 to +5]	**+4** [+2 to +6]	**+7** [+4 to +10]	**+6** [+3 to +9]	**+11** [+6 to +17]
	Winter	494 mm	**+3** [+2 to +5]	**+4** [+2 to +6]	**+7** [+4 to +10]	**+6** [+4 to +9]	**+11** [+7 to +17]
	Spring	726 mm	**+3** [+2 to +4]	**+3** [+2 to +5]	**+5** [+4 to +8]	**+4** [+3 to +6]	**+9** [+6 to +12]

Table 2. Summary of projections for Cape York*

* To enable the projections for each of the regions to be referenced against historical climate, observational means have been calculated using a 30-year base period of 1971–2000.

Projections represent the change in temperature, relative change in rainfall and potential evaporation relative to the model base period of 1980–1999. The numbers in brackets are the 10th and 90th percentiles and depict the range of uncertainty; the number outside the brackets is the 50th percentile (i.e. the best estimate). The changes are the average change over the region.

† These projections show changes in average climate for three future 30-year periods centred on 2030, 2050 and 2070.

Data source: CSIRO & BoM 2007. Regional summaries prepared by QCCCE.

Recent studies have projected a slight decrease (nine per cent) in tropical cyclone frequency off the East Coast of Australia by 2070 (Abbs et al, 2006), however they also simulate an increase in the number of long-lived and severe (Category 3–5) eastern Australian tropical cyclones. Under three different studies the number of severe tropical cyclones is projected to increase by 56 per cent by 2050 (Walsh et al, 2004), 22 per cent by 2050 (Leslie et al, 2007) and 140 per cent by 2070 respectively (Abbs et al, 2006).

With projected increases in the intensity of future cyclones and projected rise in mean sea levels (CSIRO & BoM, 2007), storm surges will be able to penetrate further inland greatly increasing the risk to natural ecosystems, infrastructure and the risk of erosion in low-lying coastal regions.

According to the IPCC, global sea-level is projected to rise by 18 to 59 cm by 2100, with a possible additional contribution from melting ice sheets of 10 to 20 cm (IPCC, 2007).

Impacts of climate change on the Cape York region

Projections for the Cape York region include a slight decline in rainfall with increasing temperature and evaporation, in conjunction with more extreme climate events and sea-level rise. The temperature projections for inaction on climate change suggest a temperature increase well outside the range of temperatures ever experienced over the last 50 years. The projections for temperature and number of hot days are all in the same direction—increasing.

Extreme storm events such as cyclones pose a significant risk to the communities of Cape York. A high proportion of Cape York's population reside in close proximity to the coast, greatly increasing the likely consequence of cyclones. The riskiest areas are those closest to the coast, which can incur flash flooding, wind damage and considerable structural damage from falling trees, affecting industry, infrastructure and roads.

For extensive agriculture, the combination of high rainfall (exceeding 1400 mm per year) and soils that contain very low concentrations of most nutrients essential for plant growth gives rise to low beef productivity in the Cape York region. Climate change will bring further challenges for this industry, for example:

- Higher temperatures are likely to exacerbate existing problems of poor pasture quality.
- Increased thermal stress of animals is very likely, particularly away from the coastline. This can reduce animal production, reproductive performance and increase mortality.
- Tropical weeds may increase in abundance and distribution.
- Overall it is likely that pastures may decline in quality, with potential for more woody and weed species causing lower animal production.

Sea-level rise will pose a particular challenge for the coastlines and communities of Cape York. During inundation incidents, when a disruption of the water supply may occur, the short-term risk of communicable disease transmission increases (McMichael et al, 2003). Coastal erosion and storm surges also threaten infrastructure vital to emergency rescues. For example, some communities in the Torres Strait have airstrips that are currently being threatened by beach erosion.

Malaria and other mosquito-borne diseases are likely to be affected by changing temperatures, humidity and rainfall. A key concern for those inhabiting the Torres Strait and far north Queensland is the contamination of the local mosquito population by infected people entering the region or wind-born mosquitoes bringing the disease from Papua New Guinea (Green, 2008).


Photo: Tourism Queensland

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