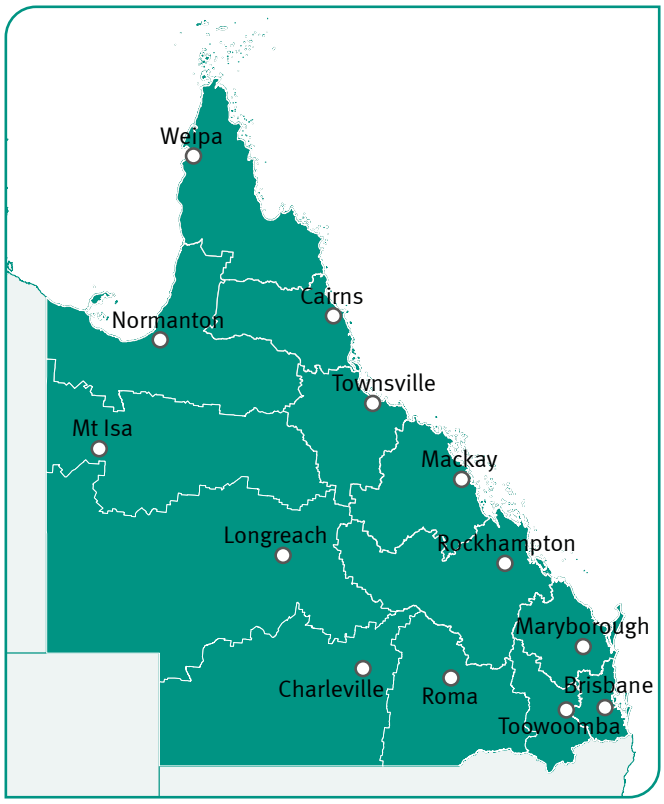
Climate change
in Queensland

VERSION 1

UNDERSTAND | ADAPT



Queensland snapshot

Queensland is Australia's second largest state by area and third largest by population. More than half of Queensland's estimated 4.8 million residents live outside the greater metropolitan area of Brisbane–a high proportion compared with the rest of highly urbanised Australia. Renowned worldwide for its diverse environment, Queensland has five of Australia's 11 World Heritage Areas and one of the Natural Wonders of the World–the Great Barrier Reef.

How will climate change affect Queensland?

In the future, the state can expect:

- higher temperatures
- hotter and more frequent hot days
- harsher fire weather
- fewer frosts
- reduced rainfall in the south-east
- more intense downpours
- less frequent but more intense tropical cyclones in the north
- rising sea level
- more frequent sea-level extremes
- warmer and more acidic seas

How can we deal with these changes?

Queensland often experiences climate extremes such as floods, droughts, heatwaves and bushfires. Climate change is likely to exacerbate the frequency and severity of these events. We will increasingly be affected by changes in temperature, rainfall, sea level and extreme weather conditions.

It makes sense to take appropriate action to better manage our climate risks. Well-considered and effective adaptation measures can limit the adverse impacts of climate change on communities, the economy and natural systems. We can achieve more if we act together to plan for and manage current and future climate impacts across different sectors and regions.

The Queensland Government is working with a range of stakeholders, using the best available science to address the risks climate change presents to our economy, environment, infrastructure and communities. This publication presents details of the expected changes to temperature, rainfall and the sea. It highlights the likely impacts on people, businesses and the environment and presents ways to respond. For more information on climate change in Queensland, visit www.qld.gov.au/environment/climate/climate-change/resources/science.

Looking to the future

Our current climate

Queensland is a vast state with great variations in climate, from the temperate south to the tropical north and the arid west.

South East Queensland, which includes Brisbane and the Gold and Sunshine Coasts, experiences warm summers with average maximum temperatures of 29°C and winter maximum temperatures averaging 20°C.

The Cape York region's climate is tropical, with high to very high temperatures throughout the year. Average maximum temperatures range from 32°C during December to February (the humid wet season) to 29°C from July to August.

Western Queensland has a semi-arid to arid climate with very hot summers and warm, dry winters. The temperatures range from 37°C in summer to 24°C in winter.

Annual and seasonal average rainfall is variable, affected by local factors such as topography and vegetation, and broader scale weather patterns, such as the El Niño–Southern Oscillation.

Most of Queensland's rainfall occurs in summer. The total summer rainfall in southern Queensland often exceeds 500mm. The north is much wetter, with annual rainfall of over 1000mm. Arid areas in the west have annual rainfall below 400mm.

Pacific south-easterly trade winds produce rainfall along the eastern coast throughout the year. Tropical cyclones bring significant rainfall to the north.

However, the climate is changing across Queensland.

Average temperatures across the state are currently 1°C higher than they were 100 years ago. Recent decades have shown a clear warming trend. Our climate is already highly variable but climate change is leading to shifts beyond this natural variability.

Our future climate

Our climate is changing primarily because increasing amounts of greenhouse gases in the atmosphere are trapping heat, warming the air and oceans.

To determine what our future climate might be, scientists use global climate models to simulate the Earth's climate system. The models use a set of mathematical formulae that describe the physical processes of the atmosphere, ocean, land and ice.

Population, the economy, policy decisions and technology will all affect future emissions of greenhouse gases. We don't know exactly what these effects will be, so to cover a range of possibilities, scientists use emissions scenarios called representative concentration pathways (RCPs) to develop climate projections. These projections describe a lower emissions future, where greenhouse gas emissions are substantially reduced (using a scenario termed RCP4.5), and a high emissions future, where high levels of greenhouse gas emissions are set to continue (using a scenario termed RCP8.5).

The projections in this summary are given for 20-year periods centred on 2030 and 2070. The 2030 high and low emissions scenarios are so similar that only the high emissions scenario has been used in this publication. Projections are represented as a change relative to the average for the period 1986–2005.

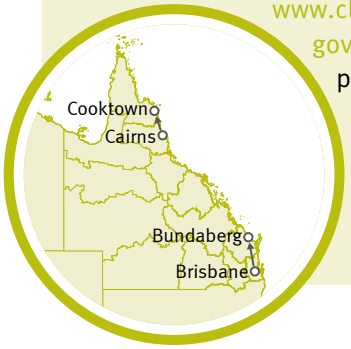
For example, in 2070 under a high emissions scenario, average temperature in Queensland is projected to rise by 2.9°C (1.9 to 3.9°C). In this case, the middle temperature rise determined by all the models is 2.9°C. The range is between 1.9°C and 3.9°C, meaning 95% of model results indicated a rise of at least 1.9°C and 95% of the model results indicated a rise of 3.9°C or less.

The Queensland Climate Transition Strategy outlines how we will transition to a zero net emissions future that supports jobs, industries, communities and the environment. Find the strategy at www.qld.gov.au/environment/climate/climate-change/response.

Queensland 2030

In 2030, under a high emissions scenario, the climate of Brisbane will be more like the current climate of Bundaberg, and the climate of Cairns more like the current climate of Cooktown.

To find out what the future climate will be like where you live, use the climate analogues tool on the Climate Change in Australia website at www.climatechangeinaustralia.gov.au. The tool matches projected rainfall and maximum temperature with the current climate experienced in another location for the years 2030, 2050 and 2090.

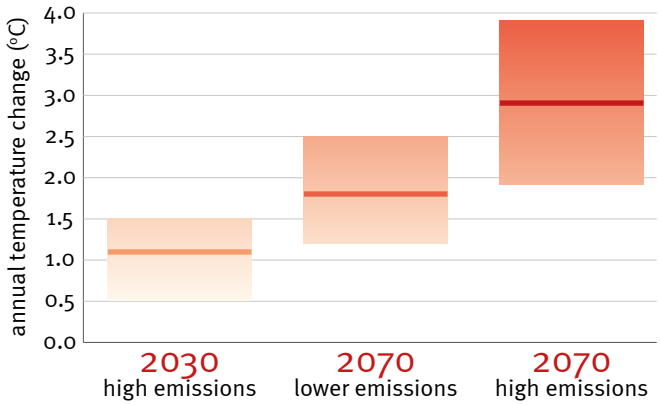


Climate projections for

Higher temperatures

Maximum, minimum and average temperatures are projected to continue to rise. For the near future (2030), the annual average warming is projected to be between 0.5 and 1.5°C above the climate experienced between 1986 and 2005. By the year 2070, the projected range of warming is between 1.2°C (low emissions) and 3.9°C (high emissions).

The state's summer average temperature is 29°C. This could rise to over 30°C by 2030 and to over 32°C by 2070.



Projected annual average temperature changes for . The horizontal line on each bar is the middle (median) projected temperature change. The extent of each bar indicates the range of projected changes.

Hotter and more frequent hot days

There is likely to be a substantial increase in the temperature reached on the hottest days, and an increase in the frequency of hot days and the duration of warm spells.

Fewer frosts

A substantial decrease in the frequency of frost risk days is projected by 2070.

Harsher fire weather

Fire weather is a measure of fuel dryness and hot, dry, windy conditions. Climate change is likely to result in harsher fire weather in the future.

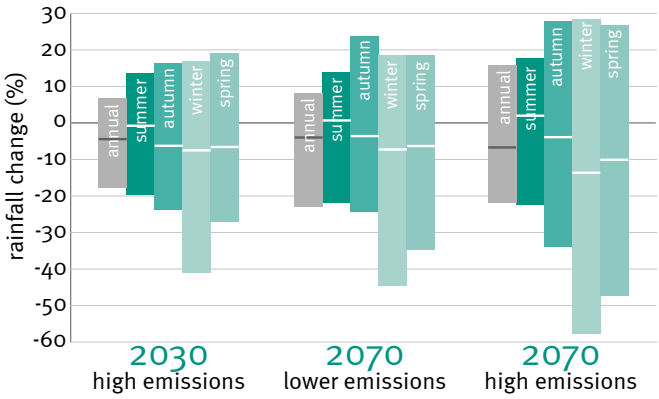
Climate change projections are based on Climate Change in Australia data from CSIRO and the Bureau of Meteorology. More detailed information on these and other climate variables is available at www.qld.gov.au/environment/climate/climate-change/resources/science.

Natural variability; reduced rainfall in the south-east

High climate variability is likely to remain the major factor influencing rainfall changes in the next few decades.

In the south-east of the state, rainfall projections for 2070 show little change or a slight decrease, particularly in winter and spring. Across the state, high variability will continue.

The intensity of heavy rainfall events is likely to increase.



Projected annual and seasonal rainfall changes for the region. The horizontal line on each bar is the middle (median) projected rainfall change. The extent of the bar indicates the range of projected changes.

Changes to drought are less clear

Projecting changes in the frequency and duration of drought is difficult. However, by late this century, under a high emissions scenario, it is likely that the south of the state will experience more time in drought.

Sea level will continue to rise

Sea level is projected to rise by 0.8m above present day levels by 2100.

More frequent sea-level extremes

Higher sea levels will increase the risks of coastal hazards such as storm tide inundation.

Warmer and more acidic ocean

Sea surface temperature has risen significantly across the globe over recent decades and warming is projected to continue.

The ocean will become more acidic due to dissolved carbon dioxide, with acidification proportional to emissions growth.

Climate risks, impacts and responses

The range of likely changes to Queensland's climate in the coming years and decades presents opportunities and risks. Extensive work is being done to identify the likely impacts, sector by sector, and how best to respond to them.

Sector	Climate risks* ↑ = increase, ↓ = decrease	Impacts*	Potential responses*
	↑ heatwaves ↑ fire weather ↑ inundation and flooding ↑ tropical cyclone intensity ↑ sea level	• Erosion and infrastructure damage along the coastline • Increased maintenance costs • Increased disruption to services • Increased energy and water usage	• Consider future climate and sea-level rise when locating and constructing new developments and infrastructure • Increase road heights • Insure public assets • Design buildings to accommodate changing climate
	↑ temperature ↑ heatwaves ↑ fire weather ↑ tropical cyclone intensity ↑ sea level	• Increased threats to tourism infrastructure • Damage to popular environmental sites • Risks to tourists unfamiliar with conditions	• Consider climate risks in emergency planning for tourist sites • Adopt appropriate cancellation policies for extreme weather • Prepare for changing seasonal demand
	↑ heatwaves ↑ fire weather ↑ rainfall intensity ↑ inundation and flooding ↑ tropical cyclone intensity ↑ sea level ↑ sea temperature	• Disruption to supply chains • Disruption to workplaces and infrastructure • Loss of customers during emergency recovery • Increased flood damage • Increased maintenance costs • Increased disruption to water supplies	• Business continuity planning • Shift critical infrastructure out of hazard zones • Enable flexible working arrangements • Diversify customer base and products • Consider future climate and sea-level rise when locating and constructing new infrastructure • Insure critical assets • Implement water management planning
	↑ heatwaves ↑ fire weather ↑ flooding ↑ sea level	• Damage to cultural sites • Loss of significant ecosystems	• Identify cultural sites at risk and mitigate impacts • Review and document cultural practices • Increase cultural activities and ceremonies to transfer knowledge
	↑ temperature ↑ hot days ↑ heatwaves ↑ fire weather ↑ drought risk ↓ rainfall ↑ tropical cyclone intensity ↑ sea temperature	• Changed distribution of pests and diseases • Heat stress on livestock and crops • Farms affected by bushfire • Reduced water security • Crops destroyed by cyclones • Increased heat stress	• Consider diversifying outputs or business • Employ strategies to minimise heat stress on livestock • Consider different crop varieties and sowing times • Improve water efficiency
	↑ temperature ↑ hot days ↑ fire weather ↑ drought risk ↓ rainfall ↑ tropical cyclone intensity ↑ sea level ↑ sea temperature ↑ ocean acidification	• Changes to habitat • Altered disturbance regimes • Changing dynamics of invasive species • Cyclone and storm tide inundation damage to landscapes and natural systems • Coral bleaching • Existing threats to flora and fauna are exacerbated	• Develop strategies to respond to new and emerging diseases and pests • Increase green urban infrastructure and urban biodiversity • Link habitats to allow species to move • Consider moving selected populations to new areas
	↑ heatwaves ↑ fire weather ↑ flooding ↑ tropical cyclone intensity	• More stress on health and emergency services • More heat-related deaths, particularly among the elderly and disadvantaged • Mental health effects • Changes in disease occurrence	• Use existing social networks to support vulnerable community members • Implement rural mental health care programs • Consider climate risks when developing emergency planning for schools, hospitals, services • Increase green spaces and cool zones for heat stress
	↑ heatwaves ↑ fire weather ↑ rainfall intensity ↑ inundation and flooding ↑ tropical cyclone intensity	• Increased fire season duration and fire intensity will affect urban fringe communities • Increased sea level and storm intensity will affect coastal communities and increase inland flooding risk	• Improve bushfire safety standards for urban development • Increase focus on community preparedness and prevention • Update risk management standards to account for increased risk from climate change

* As applicable to specific state regions

Adapting to climate change

Queensland's environment, economy and communities are already experiencing the impacts from a changing climate. The development of a Queensland Climate Adaptation Strategy will assist government, businesses and communities to manage and respond to our changing climate.

Human settlements and infrastructure

Climate change impacts, including rising sea levels, increased risk of storm tide inundation, coastal flooding and increased coastal erosion are likely to affect property and infrastructure.

Coastal inundation and erosion events could become more frequent and severe with rising sea levels, resulting in increased clean-up and asset maintenance costs.

Flooding, due to more intense extreme storms, could affect infrastructure such as water, sewerage, storm water, transport and communications. The areas of most risk are those closest to the coast, where there can be flash flooding and wind damage, affecting industry, infrastructure and roads. This may increase the cost of insurance to business and the community. Inland areas are likely to face increased bushfire risk.

Adaptation measures

- Consider how to adapt existing homes and communities to deal with projected inundation.
- Plan for new developments and infrastructure to take into account climate impacts and extreme events such as flooding, tropical cyclones and sea-level rise.
- Develop a Coastal Hazard Adaptation Plan.

The **Queensland State Planning Policy** recognises climate change as a key consideration for State and local governments to incorporate through their planning and development frameworks. The policy ensures the impacts of climate change, such as storm tide inundation and coastal erosion, are accounted for when making or amending local government planning schemes or regional plans, and during development assessment. For more information visit www.dilgp.qld.gov.au.

Tourism

Increases in temperature will potentially expand the tourist season in some regions, where greater warmth provides greater comfort during the colder months. However, they may reduce the tourist season in other areas where uncomfortably hot conditions occur for longer periods. Increased bushfire and flooding risk may threaten tourism infrastructure and damage popular environmental sites. The increased risks to tourists unfamiliar with these conditions will need to be managed.

Adaptation measures

- Consider climate risks in emergency planning for tourist sites.
- Adopt appropriate cancellation policies for extreme weather.
- Prepare for changing seasonal demand.

'Ready Set Go' is a smartphone app designed to assist tourism operators prepare for the impacts of extreme weather events, such as floods and cyclones. The app has been developed by the Queensland Tourism Industry Council, EC3 Global and National Centre for Studies in Travel and Tourism. For more information visit www.apple.com/au/itunes and http://play.google.com.

Business and industry

Climate change could cause increased disruption to businesses and industry. Increased frequency of flooding and inundation, bushfires and heatwaves may disrupt supply chains, make it difficult for staff to get to work and prevent customers from accessing services and products. Extreme events may also damage workplaces, equipment and facilities, especially if the businesses are unprepared.

Businesses that are prepared will be able to ensure continuity of supply to their clients during/following a disruptive event. Investment in infrastructure, insurance and risk planning will increase as businesses prepare for the impacts.

Adaptation measures

- Undertake business continuity planning accounting for likely increases in extreme weather and events.
- Shift critical infrastructure out of hazard zones.
- Enable flexible working arrangements.
- Diversify customer base and products.

Indigenous communities and culture

Significant Indigenous cultural values are attached to the natural environment. Strong links have been maintained by Indigenous communities to country and wildlife, with access to land and its resources crucial for cultural value maintenance. A loss of biodiversity, and degradation of islands is a threat to cultural practices.

Sea-level rise will pose a particular challenge for coastal communities. During inundation incidents, when a disruption of the water supply may occur, the short-term risk of communicable disease transmission increases. Some communities in the Torres Strait are already being regularly inundated, and sea-level rise may lead to relocation from traditional lands.

Adaptation measures

- Identify cultural sites at risk and mitigate impacts.
- Review and document cultural practices.
- Increase cultural activities and ceremonies to transfer knowledge.

The **Torres Strait Regional Authority** commissioned a comprehensive assessment of the risks of climate change driven coastal erosion and inundation of Torres Strait island communities. It identified and assessed specific adaptation options, and documents those options preferred by the communities. The assessment is available at www.tsra.gov.au.

Agriculture

More extremes of climate and changes in rainfall variability could decrease crop production, forage production, surface cover, livestock carrying capacity and animal production, and cause major changes in plant and animal species composition.

Livestock may be exposed to a greater risk of heat stress in some regions. Lower rainfall and increasing evaporation will cause more frequent depletion of soil moisture, reduced ground cover and lower livestock carrying capacity. Conditions may increase plant diseases, weeds and pests.

Warmer conditions would allow some pest species to move southwards into areas where they are currently excluded.

Adaptation measures

- Manage climate variability and change by using forecasts of rainfall (and temperature) in decision-making about crops and planting times.
- Consider future climates in designing monitoring and control programs for pests, weeds and disease.
- Employ strategies to minimise heat stress on livestock.
- Select plant varieties and production systems that are more adaptable to a changing and variable climate.
- Increase water efficiency.

The Managing Climate Variability program has developed **CliMate**, designed for producers who seek to understand recent weather and probabilities of future weather events. The tool uses weather data, statistics and forecasts with farming system information, such as soil water and heat sum. It is available at https://climateapp.net.au/.

The Queensland Government's **LongPaddock** website provides climate information, seasonal forecasts and a range of decision support tools to assist producers to improve their climate risk management. Visit www.longpaddock.qld.gov.au.

Biodiversity and iconic ecosystems

Even a small (1–2°C) rise in temperature can have a significant impact on biodiversity and natural systems. This may place additional stresses on ecosystems as competition between plant species changes.

Increased sea surface temperatures are likely to cause more regular coral bleaching in the Great Barrier Reef. These bleaching events are likely to become more severe as temperatures increase and such events could occur annually by 2050. Maintaining the health of reef water quality is paramount for coral recovery after a bleaching event.

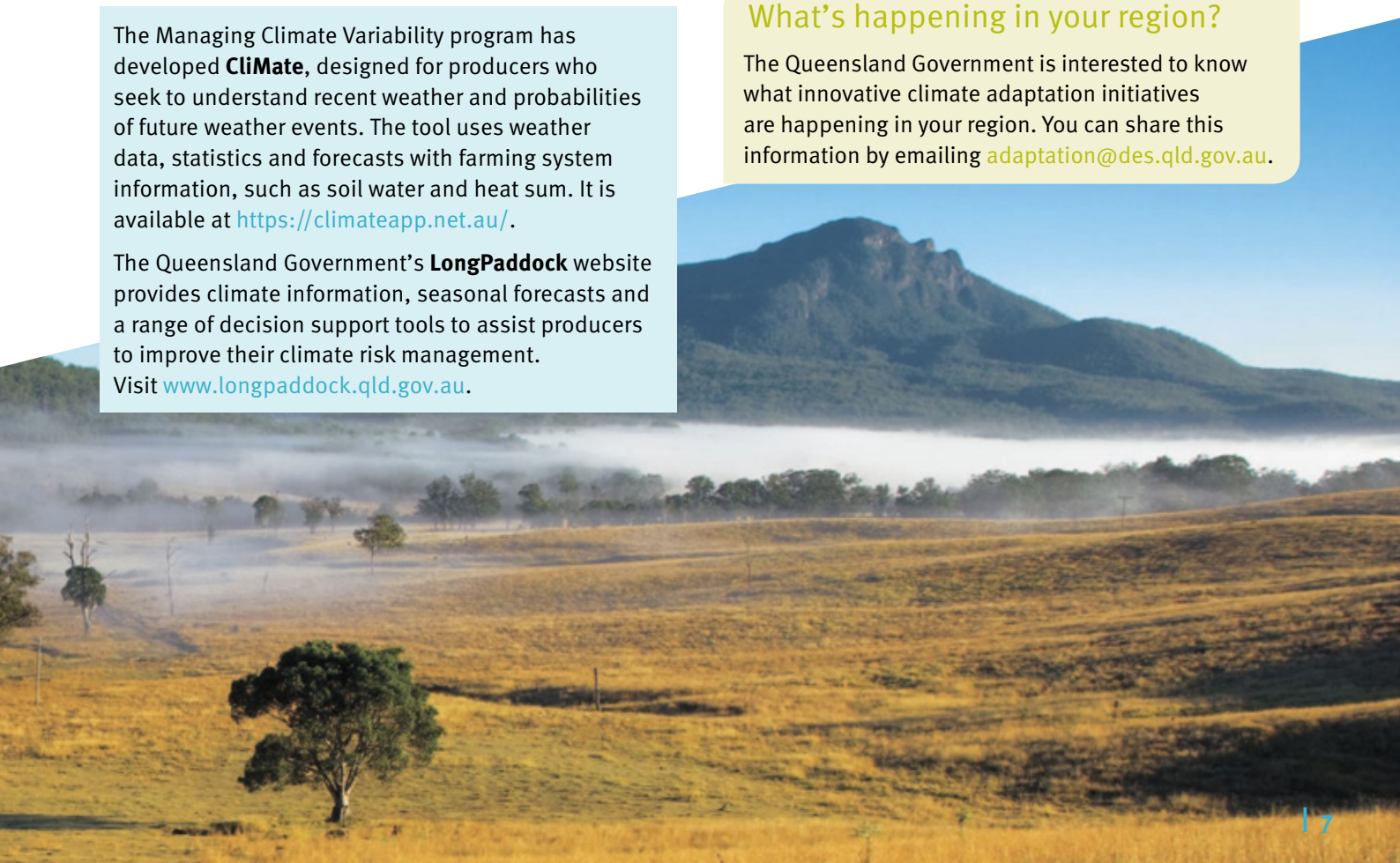
Warming seas and increased storm tide inundation may harm coastal ecosystems, which have important recreation and biodiversity values.

Adaptation measures

- Continue to manage the impact of agriculture on nutrient runoff into the reef catchments.
- Increase conservation of forests on fertile soil for koalas, sugar gliders and other foliage-feeding fauna.
- Undertake weed management and rehabilitation of native plant species, including community education.
- Maintain links between habitat patches to enable species to move.

What's happening in your region?

The Queensland Government is interested to know what innovative climate adaptation initiatives are happening in your region. You can share this information by emailing adaptation@des.qld.gov.au.



Human health

Higher temperatures and more hot days could result in heat exhaustion and increased mortality among vulnerable people, including the very young and old. People in locations that have not regularly experienced such high temperatures may struggle to adapt to these conditions. Malaria and other mosquito-borne diseases are likely to be affected by changing temperatures, humidity and rainfall.

Rural, regional and remote communities are particularly sensitive to a changing climate, compounding existing difficulties and inequities. A changing climate will also increase the demand for social support, health and mental health services.

Adaptation measures

- Develop agreements with workers on how to manage extreme hot days.
- Clearly identify public cool zones or shaded areas for the community.
- Develop social support networks.

The **Queensland Government** addresses the impact of hotter days on school children by providing guidelines on managing excessive heat in schools. There are clear indicators of when children need to be protected from excessive heat, and strategies to ensure their safety, such as limiting physical activity and sporting events during the hottest part of the day. There is more information at www.education.qld.gov.au.

Emergency services

Higher temperatures and longer dry seasons will increase bushfire risk in some regions, particularly for urban fringe communities where natural ecosystems abut houses and businesses.

Projected increases in tropical cyclone and storm intensity and sea-level rise will see a higher risk of flooding and inundation, particularly for coastal communities.

Adaptation measures

- Improve bushfire safety standards for urban development.
- Increased focus on community preparedness.
- Update risk management standards to account for increased risk from climate change.

MetEYE, a map of weather observations and official forecasts produced by the Bureau of Meteorology, can increase community preparedness by providing forewarning of extreme weather events such as heatwaves, cyclones and flooding rain. This service provides seven-day forecasting of many climate variables including temperature, wind, rain, humidity, frost and snow. See www.bom.gov.au/australia/meteye/.

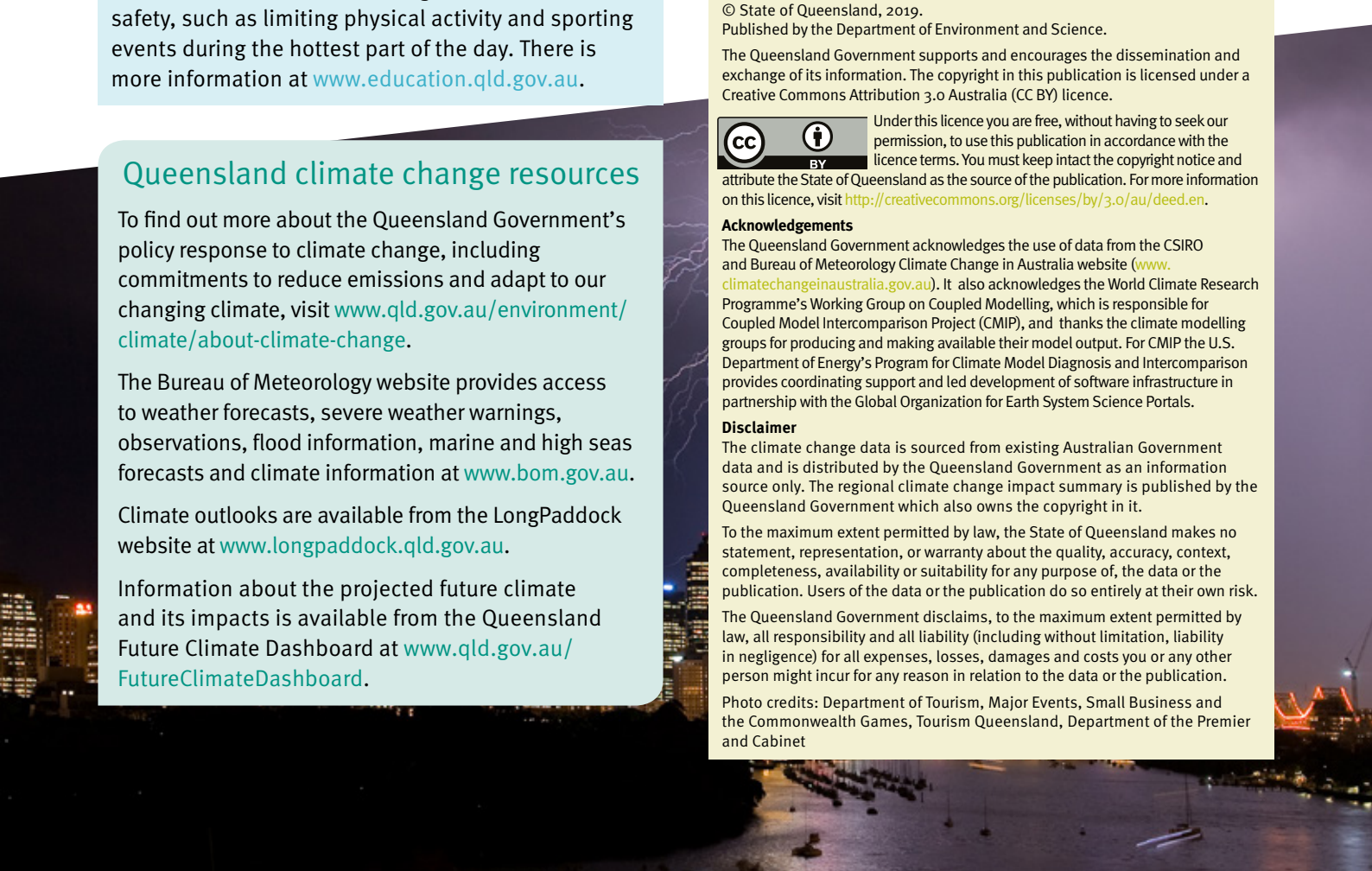
Queensland climate change resources

To find out more about the Queensland Government's policy response to climate change, including commitments to reduce emissions and adapt to our changing climate, visit www.qld.gov.au/environment/climate/about-climate-change.

The Bureau of Meteorology website provides access to weather forecasts, severe weather warnings, observations, flood information, marine and high seas forecasts and climate information at www.bom.gov.au.

Climate outlooks are available from the LongPaddock website at www.longpaddock.qld.gov.au.

Information about the projected future climate and its impacts is available from the Queensland Future Climate Dashboard at www.qld.gov.au/FutureClimateDashboard.



Acknowledgements
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