NARCliM

Hunter

Climate Change Snapshot

NSW GOVERNMENT

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Photo caption:

The Emu in the Sky is an Aboriginal constellation that is made up of the dark clouds of the Milky Way. With the movement of the Earth, the position of the Emu in the Sky changes throughout the year. Aboriginal people in some nations across NSW and Australia relate the position of the Emu in the Sky to the breeding behaviour of the emu on the land. Cultural astronomy teaches us about the relationship between the sky and land; and that we are all interconnected.

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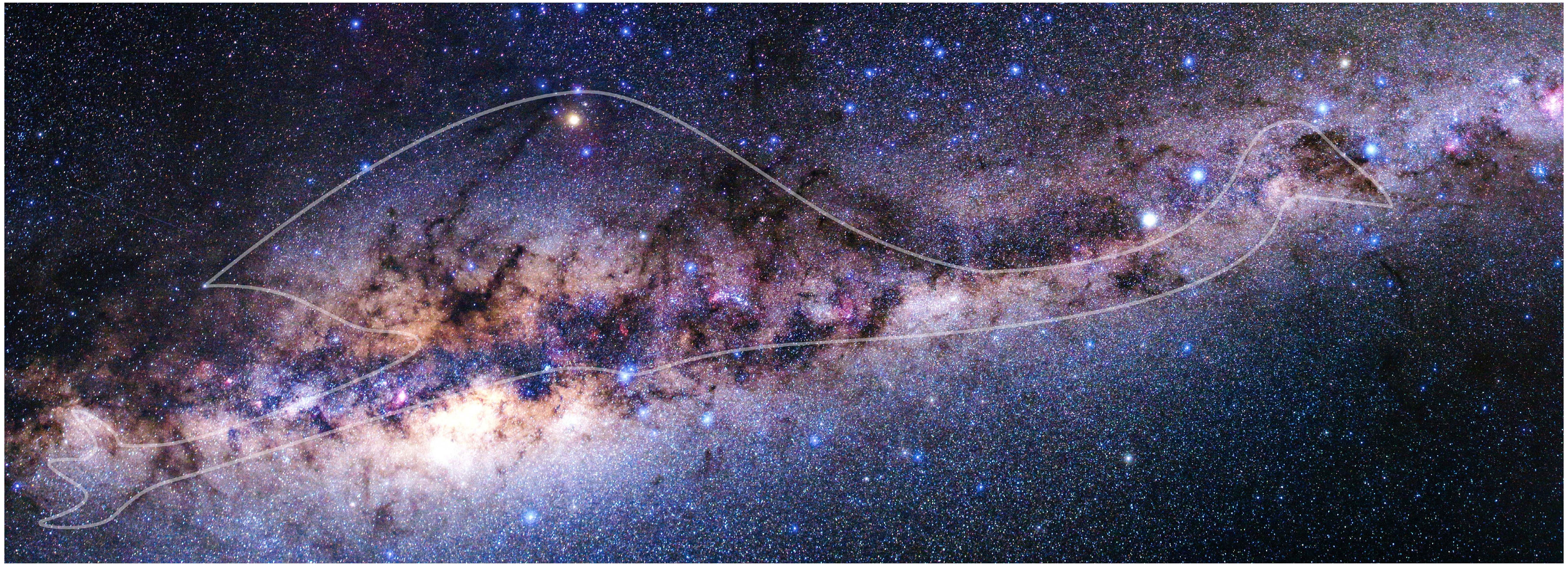


Acknowledgement of Country

The NSW Government acknowledges First Nations people as the first Australian people and the traditional owners and custodians of the country's lands and water. Australia's First Nations people have lived in NSW for over 60,000 years and have significant spiritual, cultural and economic connections with its lands, waters, seas and skies.

The Hunter region encompasses the traditional lands of the Guringai, Biripi, Geawgal, Worimi, Wonnarua, Darkinyung and Awabakal peoples.

They are the first astronomers and scientists who have been listening, reading and understanding natural processes and caring for Country for generations.

We pay respects to Elders past and present and acknowledge the significance of their traditional knowledge in adapting to changes in climate over tens of thousands of years.

We recognise the importance of their cultural knowledge and guidance at this pivotal moment in time

About this snapshot

The New South Wales (NSW) and Australian Regional Climate Modelling (NARCliM) project delivers high-resolution climate change projections for NSW and south-east Australia.

This snapshot provides the latest NARCliM2.0 climate projections for the Hunter under low, medium and high emissions scenarios for the middle of the century (2050) and end of the century (2090). It includes projections for key climate variables including temperature, average rainfall, hot days (days ≥35°C), cold nights (<2°C), and severe fire weather days (Forest Fire Danger Index >50). The projections help illustrate potential climate changes and their impacts, as well as associated climate risks.

NSW is already experiencing climate change. This document provides local-scale climate modelling insights to help the Hunter communities understand and plan for the impacts of climate change on their infrastructure, environment and way of life; and to support informed planning, risk assessment and action.

This snapshot offers a high-level overview, with more detailed data available through the AdaptNSW Interactive Map, Climate Data Portal and AdaptNSW.

How to use this snapshot

While there are several different ways to engage with the information in this snapshot, here are some key things to consider:

- **Explore each climate variable across scenarios –** review projections under low (SSP1–2.6), medium (SSP2–4.5), and high (SSP3–7.0) emissions scenarios to understand how climate risk differs depending on emissions pathways (Shared Socioeconomic Pathways, SSPs).
- **Compare scenario-based changes over time –** examine how each climate variable responds to different emissions scenarios for the middle of the century (2050) and the end of the century (2090) to understand how risks may evolve.
- **Identify where projections of climate variables align or diverge –** look for patterns across emissions scenarios and timeframes to see where risks remain consistent and where they escalate or diverge significantly.

Time periods in this snapshot

The projections for each time period represent averaged data across all climate models used for NARCliM for a 20-year period:

- **Baseline period: baseline** → The modelled average for each climate variable from 1990–2009, used for comparison with future projections.
- **Middle of the century: '2050' projection** → The projected average for each climate variable for 2040–2059.
- **End of the century: '2090' projection** → The projected average for each climate variable for 2080-2099.

About this snapshot

NARCliM climate projections

NARCliM is NSW's regional climate modelling project. NARCliM combines carefully selected global and regional climate models through a process known as dynamical downscaling, to generate detailed, locally relevant climate projections. These simulate a range of plausible future climates, helping to inform climate risk assessments and support planning at local and regional levels.

Launched in 2024, NARCliM2.0 provides nation-leading climate model data that span the range of plausible future changes in climate.
It offers:

- climate projections out to the year 2100, and simulations of the past climate from 1951 to 2014
- 4-km scale projections for south-east Australia
- 20-km scale projections for the broader Australasian region
- projections for key climate variables and extremes.

There is more information About NARCliM, as well as specific information on Downscaling in NARCliM and Global and regional climate models used by NARCliM at AdaptNSW.

Methods and uncertainty

To help address future uncertainty, NARCliM2.0 is built on a selection of emissions scenarios, global climate models and regional climate models that, together, capture a range of climates that could occur. This is referred to as the NARCliM model ensemble. The NARCliM2.0 model ensemble is made up of different combinations of 5 global climate models and 2 regional climate models, giving 10 model combinations in total.

The data presented in this snapshot is generally an average for different 20-year time periods (e.g. the 2050 projection is the average for the 2040–2059 time period). Time series data are presented as annual averages. Combining multiple models through averaging and other statistical methods produces better projections by providing a comprehensive representation of possible future climate scenarios.

To ensure that NARCliM models adequately simulate regional climate, scientists use them to simulate the past climate and compare the results with actual observations. Outputs undergo rigorous quality control and scientific technical peer review.

There is more information on The NARCliM modelling methodology and NARCliM data processing, testing and validation at AdaptNSW.

Mental health support

Climate change information can be distressing for some readers, with many Australians of all ages experiencing significant eco-anxiety.
For supporting information, please visit the Black Dog Institute or Australian Psychological Society or speak with your local healthcare provider.

About this snapshot

Shared Socioeconomic Pathways

NARCliM2.0 uses Shared Socioeconomic Pathways (SSPs), which are the most recent emissions scenarios adopted in Coupled Model Intercomparison Project Phase 6 (CMIP6) models and used in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report.

The SSPs are a type of storyline-based emission scenario that estimate the world's future emissions and how these will affect the climate. SSPs outline different global development trajectories based on factors such as population, economic growth, education, urbanisation and land use, and technological advancement.[1] By analysing SSPs, we can better understand the long-term consequences of today's decisions and determine if we are heading toward higher-risk scenarios.[2]

For more information on emissions scenarios visit Emissions scenarios used by NARCliM on AdaptNSW and Summary for policymakers report by the IPCC.

Why do we use 3 SSPs?

The future is uncertain. There are many plausible futures on the horizon, and the one we reach depends on the path we take to get there. NARCliM provides projections for 3 SSPs (low-, medium- and high-emissions), each representing a distinct future with varying levels of climate risk.

Considering a range of SSPs and understanding where these scenarios align or diverge – in both the middle of the century (2050) and the end of the century (2090) – helps inform better planning and decision-making. NARCliM data highlights just how stark the differences between futures can be.

For more information about how to integrate this information into your risk assessments see Climate risk ready guide and Limitations and appropriate use on AdaptNSW.

Low-emissions future

SSP 1–2.6

SSP1–2.6 describes a **low-emissions future** with a global transition towards sustainable and equitable development.

Medium-emissions future

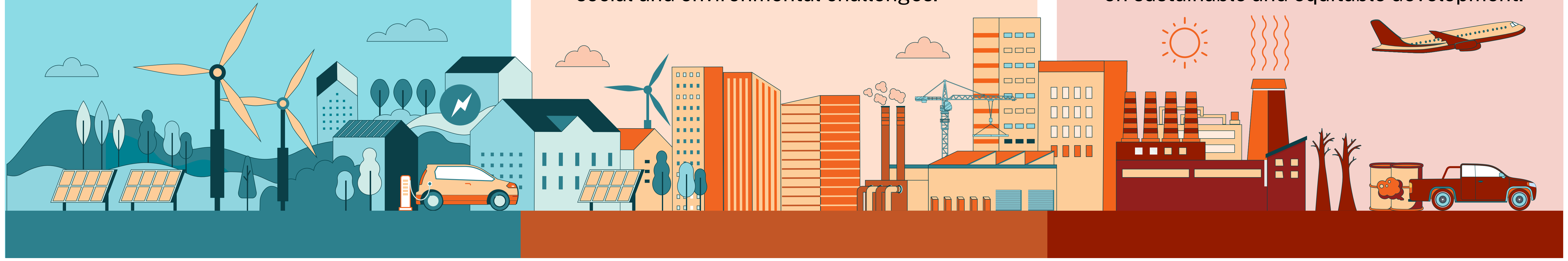
SSP 2–4.5

SSP2–4.5 describes a **medium-emissions future** with uneven economic growth, slow sustainability progress, ongoing environmental degradation, and persistent social and environmental challenges.

High-emissions future

SSP 3–7.0

SSP3–7.0 describes a **high-emissions future** of regional conflict and development where countries do not collaborate on tackling climate change and do not focus on sustainable and equitable development.



About this snapshot

Understanding the baseline period

To assess future climate projections, a climate baseline is used. This is a reference point which future change is relative to. In this snapshot, the baseline is the 20-year period from 1990 to 2009. This period is termed the baseline period to represent the average climate across those 2 decades.

A 20-year baseline averages out natural climate variability and avoids misleading comparisons with unusually hot, cold, wet or dry years. Using a fixed reference point prevents issues that may arise from using shifting reference points to compare future change against.

Climate during the baseline period is described in 2 ways in this snapshot:

- **Historical model:** The NARCliM2.0 simulation of past climate conditions.
- **Observed:** What was actually measured using weather station data during this period.

These 2 values are similar but not the same. Climate models aim to capture long-term patterns and trends, rather than matching observations perfectly. Observed values give context for comparison of the historical model with what it was in reality.

Looking backwards from the baseline

Before the baseline period, +0.84°C of observed warming had already occurred across NSW and the Australian Capital Territory (ACT) since records began. This is the difference between the 20-year average temperature of the 2 periods centred on 1920 (1910–1929) and 2000 (1990–2009). The Bureau of Meteorology's national climate records for temperature begin in 1910, making 1910–1929 the first available 20-year average for comparison with the baseline.

Consider the following when incorporating past warming into future projections:

- Warming before the baseline (+0.84°C) is not included in projections of future change.
- Warming after the baseline period is already included in future projections and should not be added again.

Looking forwards from the baseline

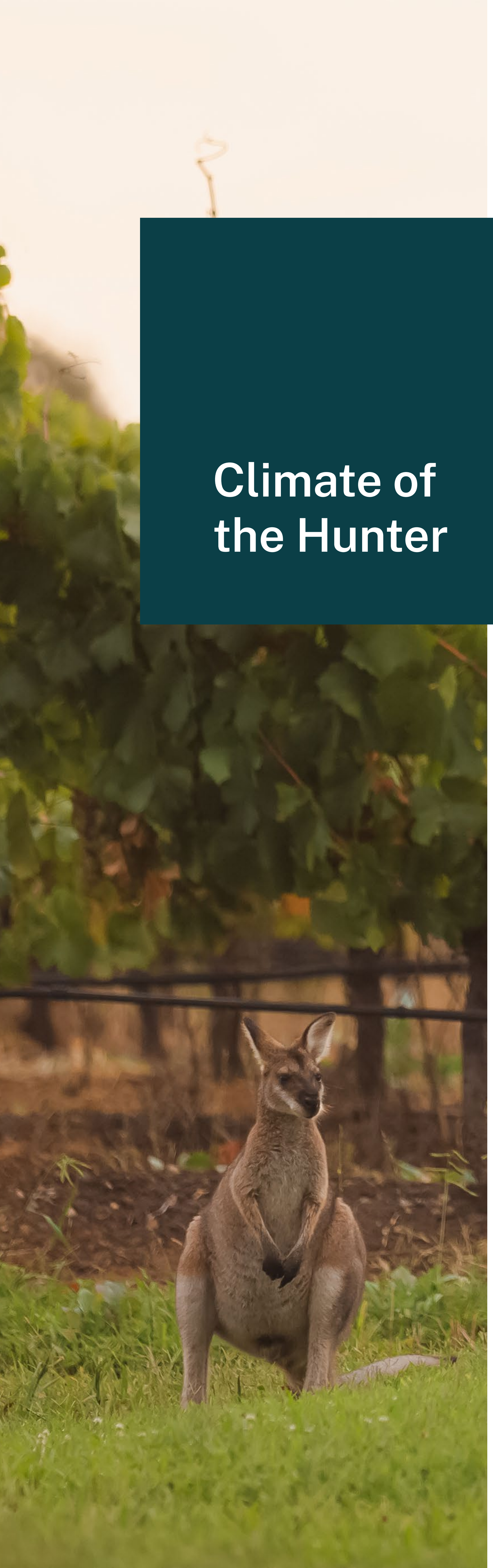
Use the historical model values in Table 1 as the baseline when interpreting both middle of the century and end of the century climate projections in this snapshot.

By comparing future projections to the historical model baseline values, we ensure the projected changes reflect genuine shifts, instead of also including the small differences between the modelled and observed data.

Table 1. Baseline climate for the Hunter

	Average temperature	Average maximum temperature	Average minimum temperature	Hot days	Cold nights	Rainfall	Severe fire weather days
Observed	16.6°C	22.7°C	0.6°C	8.7 days	22.9 days	917 mm	1.1 days
Historical model	16.5°C	22.6°C	11.7°C	8.1 days	19.5 days	855 mm	1.8 days

Table 1 outlines the annual average values for the baseline period in this snapshot. All observed data is calculated from Bureau of Meteorology products. Long-term temperature change data is from the long-term temperature record.[3] Observed information and data in graphs come from Australian Gridded Climate Data (AGCD).[4]



Climate of the Hunter

The climate of the Hunter underpins a diverse array of important lifestyles, industries and natural ecosystems. A stable climate is critical to support a range of values in the Hunter, including our unique biodiversity, recreational activities and food systems.

The Hunter region encompasses the traditional lands of the Guringai, Biripi, Geawgal, Worimi, Wonnarua, Darkinyung and Awabakal peoples.

The Hunter region covers 26,100 km^2 around the central NSW coast. The Hunter region includes the city of Newcastle and has a growing population as more people are attracted to the area for the lifestyles, natural spaces and jobs it offers. Other major towns in the region include Maitland, Lake Macquarie, Cessnock, Singleton, Muswellbrook and Scone.

The geography of the Hunter region affects local weather conditions, which together have led to a range of unique and important ecosystems. The proximity of the region to the coast and its topography result in a considerable variation in climate. The climate of the Hunter region is subtropical to temperate, creating a convergence zone for ecosystems that are characteristic of the North Coast, Western Slopes and Sydney Basin bioregions. The region contains several estuaries and large lake systems including Port Stephens and Lake Macquarie. The Hunter Estuary Wetlands Ramsar site (Kooragang Nature Reserve and Shortland Wetlands) is of international significance and Barrington Tops National Park forms part of the Gondwana Rainforests of Australia World Heritage Area.

People aged 65 and over make up 21.1% of the population (slightly higher than the NSW and ACT average of 17.4%), while people aged 0–14 years represent 17.9% and working-aged people (15–64 years) represent 61% of the region's population.[5]

The Hunter supports a diverse range of industries that are vital for NSW's economy, with the highest number of businesses in construction, specialised services (professional, scientific and technical), property and rental services as well as health care and social assistance. The largest industries of employment for the region are health care and social assistance (17.3%), construction (9.4%), retail trade (9.3%), education and training (8.5%) and accommodation and food services (7.5%).[5]

The region's climate has provided the foundation for many of the region's current social, economic and ecological systems. These systems will be impacted by increased temperatures, more hot days, fewer cold nights, greater fire danger and higher rainfall variability.

The following pages outline the projected changes in these key climate variables across the Hunter region.

PROJECTED CHANGES

	Low-emissions scenario 2050	Low-emissions scenario 2090	Medium-emissions scenario 2050	Medium-emissions scenario 2090	High-emissions scenario 2050	High-emissions scenario 2090
Increase in average temperature	+1.1˚C	+1.2˚C	+1.5˚C	+2.5˚C	+1.9˚C	+3.6˚C
Increase in hot days per year	+7.1	+7.7	+7.8	+16.0	+10.8	+23.9
Decrease in average winter rainfall	–10.7%	–12.4%	–21.6%	–23.6%	–27.0%	–26.2%
Increase in severe fire weather days per year	+0.9	+0.7	+0.9	+1.8	+1.2	+2.3

REGIONAL IMPACTS

Inland wetlands

Changes to rainfall

Bushland

Increased severe fire weather

Changes to rainfall

Hunter valley

Increased extreme heat

Agriculture

Data is based on NARCliM2.0 projections for SSP1–2.6 (low-emissions), SSP2–4.5 (medium-emissions) and SSP3–7.0 (high-emissions) and is presented relative to the baseline period of 1990–2009. Values presented are averages across the NARCliM2.0 model ensemble, and do not represent the full range of plausible climate futures. Regional climate change impacts are used to highlight how the region is likely to be affected by climate change, and impacts are not limited to the examples provided.

Temperature

In NSW, 8 of the 10 warmest years on record since 1910 have occurred since 2013.

3.6°C

rise in average temperature across the Hunter by 2090 under a high-emissions scenario.

Temperatures are projected to be higher by 2050 under a high-emissions scenario than by 2090 under a low-emissions scenario.

The Hunter is getting warmer

Temperature is the most robust indicator of climate change. In NSW, 8 of the 10 warmest years on record since 1910 have occurred since 2013. All 10 warmest years on record have occurred since 2005. The warmest year on record for both mean temperature and maximum temperature in the Hunter region was 2019, when the average temperature was 1.4°C above the 1990–2009 average.[4]

Projections

Across the Hunter region, average temperatures will increase throughout this century (Figure 1).

Under a low-emissions scenario, the average temperature increase across the region is projected to be 0.1°C between 2050 and 2090 (Table 2). However, temperature increases of 1.0°C under a medium-emissions scenario and 1.7°C under a high-emissions scenario are projected during the same period. Notably, the temperature projections for 2050 under a high-emissions scenario are expected to exceed the projections for 2090 under a low-emissions scenario.

Temperature increases are expected in all parts of the region (Figure 2) and across all seasons. The ocean's moderating influence results in lower temperature increases along the coast compared to inland areas. The Upper Hunter area of the region, including towns such as Muswellbrook and Singleton, will see the greatest relative increases in temperature. By 2090, Merriwa is likely to experience an increase in temperature of 1.5°C under a low-emissions scenario, 2.9°C under a medium-emissions scenario and 4.1°C under a high-emissions scenario. Comparatively, Newcastle is likely to experience an increase in temperature of 1.2°C under a low-emissions scenario, 2.4°C under a medium-emissions scenario and 3.5°C under a high-emissions scenario.

Table 2 and Figure 1 provide more information on how the projections differ across the 3 scenarios, and Figure 2 provides information on regional differences by 2090 across the 3 scenarios.

Table 2. Projected annual average temperature increase – Hunter

2050

	Low-emissions	Medium-emissions	High-emissions
Temperature	**1.1°C** (0.6°C to 1.8°C)	**1.5°C** (1.0°C to 2.0°C)	**1.9°C** (1.1°C to 2.9°C)
Maximum temperature	**1.2°C** (0.6°C to 2.0°C)	**1.5°C** (0.9°C to 2.1°C)	**2.0°C** (1.2°C to 3.2°C)
Minimum temperature	**1.1°C** (0.6°C to 1.7°C)	**1.4°C** (0.9°C to 2.0°C)	**1.8°C** (1.0°C to 2.7°C)

2090

	Low-emissions	Medium-emissions	High-emissions
Temperature	**1.2°C** (0.5°C to 2.1°C)	**2.5°C** (1.7°C to 3.7°C)	**3.6°C** (2.5°C to 5.2°C)
Maximum temperature	**1.3°C** (0.4°C to 2.3°C)	**2.7°C** (1.7°C to 3.9°C)	**3.7°C** (2.6°C to 5.4°C)
Minimum temperature	**1.2°C** (0.6°C to 1.9°C)	**2.5°C** (1.8°C to 3.6°C)	**3.6°C** (2.5°C to 5.2°C)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Temperature increases are additional to the historical model baselines of 16.5℃ for average temperature, 22.6℃ for average maximum temperature and 11.7℃ for average minimum temperature.

Figure 1. Historical and projected average temperature change – Hunter

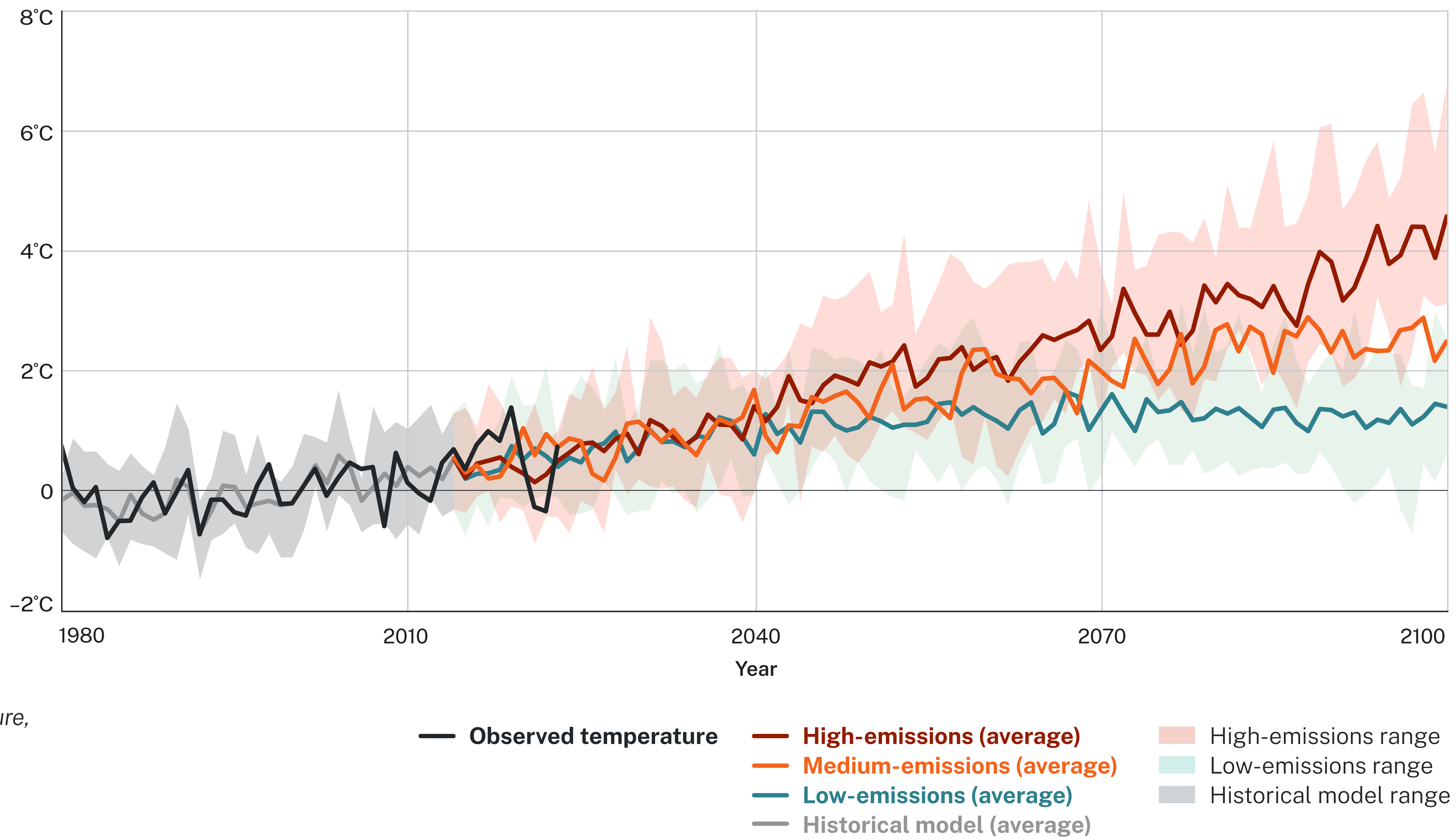
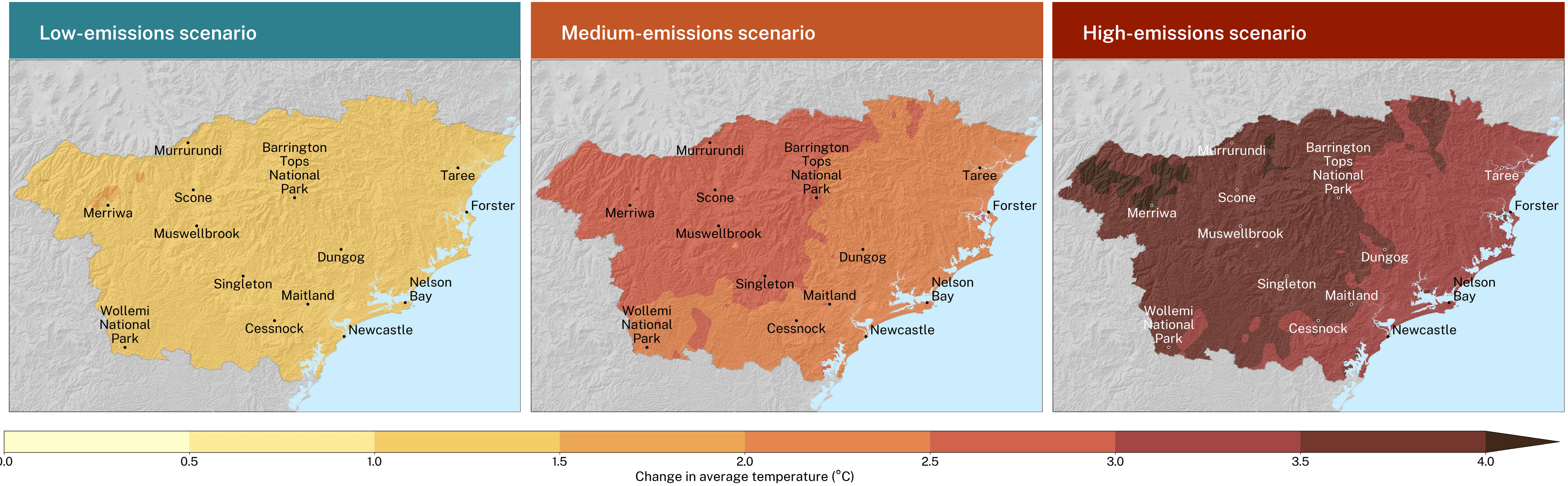


Figure 2. Projected change in average temperature by 2090 for the Hunter



Hot days

Changes to temperature extremes often have more pronounced impacts than changes in average temperatures.

4x

The number of hot days across the Hunter region is expected to nearly quadruple by 2090 under a high-emissions scenario.

Higher maximum temperatures affect health through heat stress and exacerbate existing health conditions.

Hot days will become more frequent

Prolonged hot days, where maximum daily temperatures are equal to or above 35°C, increase the incidence of illness and death – particularly among vulnerable people. Seasonal changes in the number of hot days could have significant impacts on bushfire danger, infrastructure and native species.

The number of hot days varies widely across the Hunter region. During the baseline period, areas near the coast had on average fewer than 5 hot days per year. Inland areas, such as the Upper Hunter, had on average 20 hot days per year, while higher elevation areas such as Barrington Tops had on average less than 1 hot day per year.

Projections

Across the Hunter region, the average number of hot days per year will increase throughout this century (Figure 3).

The number of hot days will increase for the Hunter region by 2050 for all emissions scenarios, with an even greater increase by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 3). The number of hot days is projected to increase across spring, summer and autumn, with the largest increase in summer.

Under a low-emissions scenario, there is a minimal increase in the number of hot days between 2050 and 2090, with less than 1 additional day projected across the region (Table 3). However, a substantial increase of 8.2 additional hot days per year under a medium-emissions scenario and 13.1 additional hot days per year under a high-emissions scenario is projected during the same period.

The Upper Hunter area, including Singleton and Scone, is projected to experience the greatest increase in the number of hot days (Figure 4). Coastal areas are projected to experience a comparatively lower increase due to the moderating influence of the ocean. By 2090, Singleton is projected to experience 13.3 additional hot days per year under a low-emissions scenario, 26.7 additional hot days per year under a medium-emissions scenario and 37.6 additional hot days per year under a high-emissions scenario. A medium-emissions scenario is projected to more than double Singleton's baseline period average of 22.3 hot days per year, while a high-emissions scenario is projected to nearly triple Singleton's baseline period average of hot days.

Comparatively, on the coast, Newcastle's baseline period average is 5.9 hot days per year. Increases to hot days will occur across all (Figure 4). By 2090, Newcastle is projected to experience an additional 5.5 hot days per year under a low-emissions scenario, 9.4 under a medium-emissions scenario and 15.0 under a high-emissions scenario.

Table 3 and Figure 3 provide more information on how the projections differ across the 3 scenarios, and Figure 4 provides information on regional differences by 2090 across the 3 scenarios.

Table 3. Projected increase in average annual number of hot days – Hunter

2050

Low-emissions	Medium-emissions	High-emissions
7.1 days (3.1 to 11.5 days)	**7.8 days** (4.2 to 10.3 days)	**10.8 days** (4.6 to 22.0 days)

2090

Low-emissions	Medium-emissions	High-emissions
7.7 days (2.0 to 16.7 days)	**16.0 days** (8.3 to 27.8 days)	**23.9 days** (12.7 to 41.4 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Hot day increases are additional to the historical model baseline of 8.1 hot days

Figure 3. Historical and projected average annual number of hot days – Hunter

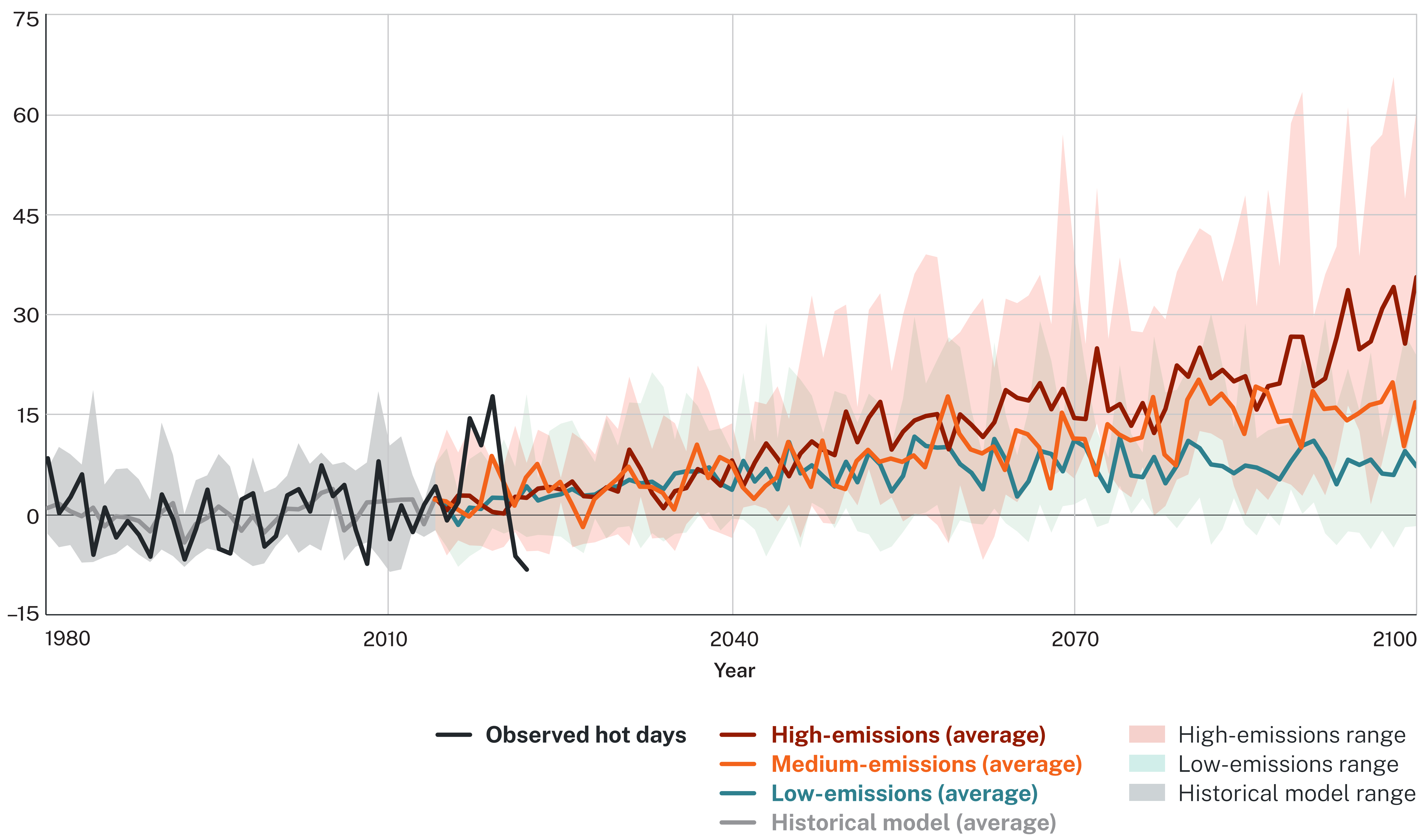
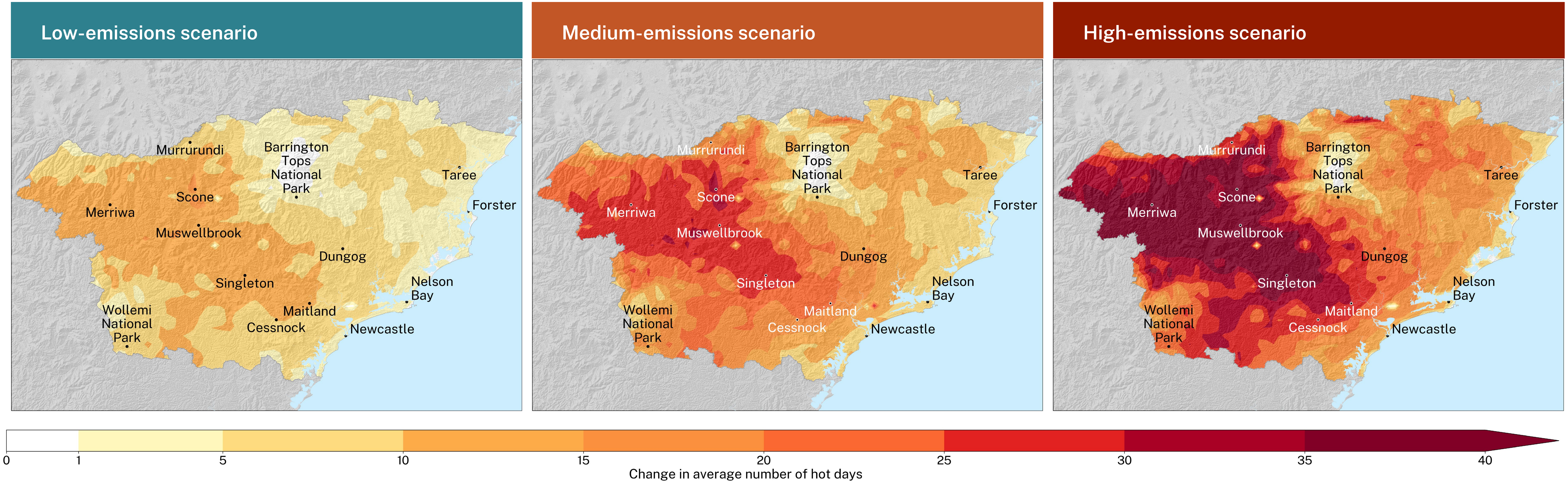


Figure 4. Projected change in annual number of hot days by 2090 for the Hunter



Increased heat stress

Significant population growth is expected in the Hunter region in the coming decades, increasing from a population of around 860,000 people in 2021 to nearly 950,000 people by 2041.[6] The Hunter region, with its aging population, faces significant impacts from an increase in the number of hot days. Older people have less ability to handle hot days, due to factors often associated to aging, such as poor fitness, body changes and long-term health problems.[7] This makes them more likely to suffer from symptoms of heat strain such as a faster heart rate, higher body temperature, and laboured breathing.[8]

Inland areas of the Hunter Valley such as Muswellbrook and Singleton will experience greater increases in the number of hot days.

Coastal areas will experience a relatively lower increase due to the moderating influence of the ocean.

The increasing urbanisation of the Hunter presents a risk of amplifying the average temperature increase from climate change through new built structures, the materials used in the built structures and vegetation removal to accommodate urban growth. Climate change impacts on urban heat intensity will be worse under a high-emissions scenario.

Cold nights

Cold nights are important for biodiversity in higher-elevation areas and the viability of important plant species, including some temperate fruits.

Under a high-emissions scenario, the number of cold nights for areas of the Hunter which experience them could reduce by more than 85% by 2090.

Under a low-emissions scenario, the number of cold nights across these areas of the Hunter could reduce by less than 40% by 2090

Cold nights will decrease

Cold nights are those where the minimum temperature drops below 2°C. These are important for the viability of some important plant species. For example, some common temperate fruit species require sufficiently cold winters to produce flower buds.

The number of cold nights varies widely across the Hunter region. During the baseline period, locations within the Upper Hunter area varied in number of cold nights. Singelton had on average 5 cold nights per year and Murrurundi had 60 cold nights per year. Towns in the Lower Hunter, such as Maitland and Dungog, had on average 2 cold nights per year. Areas along the coast do not typically experience cold nights.

Projections

Across the Hunter region, the average number of cold nights per year will decrease throughout this century (Figure 5).

The number of cold nights will decrease for the Hunter region by 2050 for all emissions scenarios, with an even greater decrease by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 4). The number of cold nights is projected to decrease across autumn, winter and spring, with the largest decreases in winter.

The number of cold nights will decrease across some of the region, particularly in inland areas in the north-west of the region (Figure 6). Coastal areas will not experience any changes, as they do not experience cold nights. The greatest decreases are projected to occur for the Upper Hunter and the Barrington Tops. By 2090, Barrington Tops National Park is projected to have 8.5 fewer cold nights per year under a low-emissions scenario, 15.8 fewer cold nights per year under a medium-emissions scenario and 18.7 fewer cold nights per year under a high-emissions scenario. A medium-emissions scenario is projected to reduce Barrington Tops National Park's 21.5 cold nights per year baselinee period average by more than 70%, while a high-emissions scenario is projected to reduce Barrington Tops National Park's baseline period average by nearly 90%.

Table 4 and Figure 5 provide more information on how the projections differ across the 3 scenarios, and Figure 6 provides information on regional differences by 2090 across the 3 scenarios.

Table 4. Projected decrease in average annual number of cold nights – Hunter

2050

Low-emissions	Medium-emissions	High-emissions
6.8 days (4.0 to 9.8 days)	**8.9 days** (5.6 to 11.6 days)	**10.8 days** (6.3 to 13.7 days)

2090

Low-emissions	Medium-emissions	High-emissions
7.6 days (4.3 to 10.1 days)	**13.8 days** (10.7 to 16.4 days)	**16.7 days** (13.2 to 19.3 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Cold night decreases are relative to the historical model baseline of 19.5 cold nights.

Figure 5. Historical and projected change in annual number of cold nights – Hunter

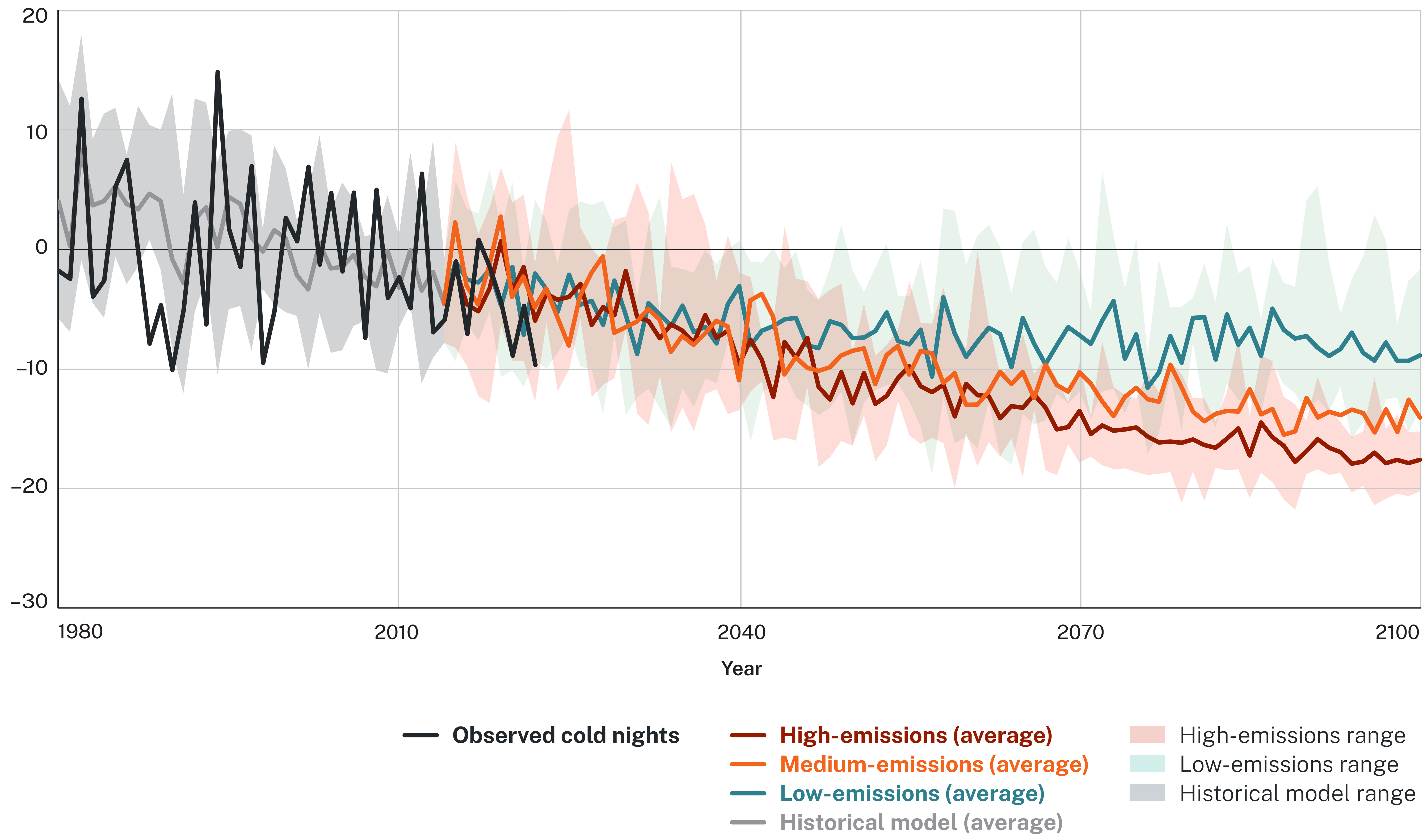
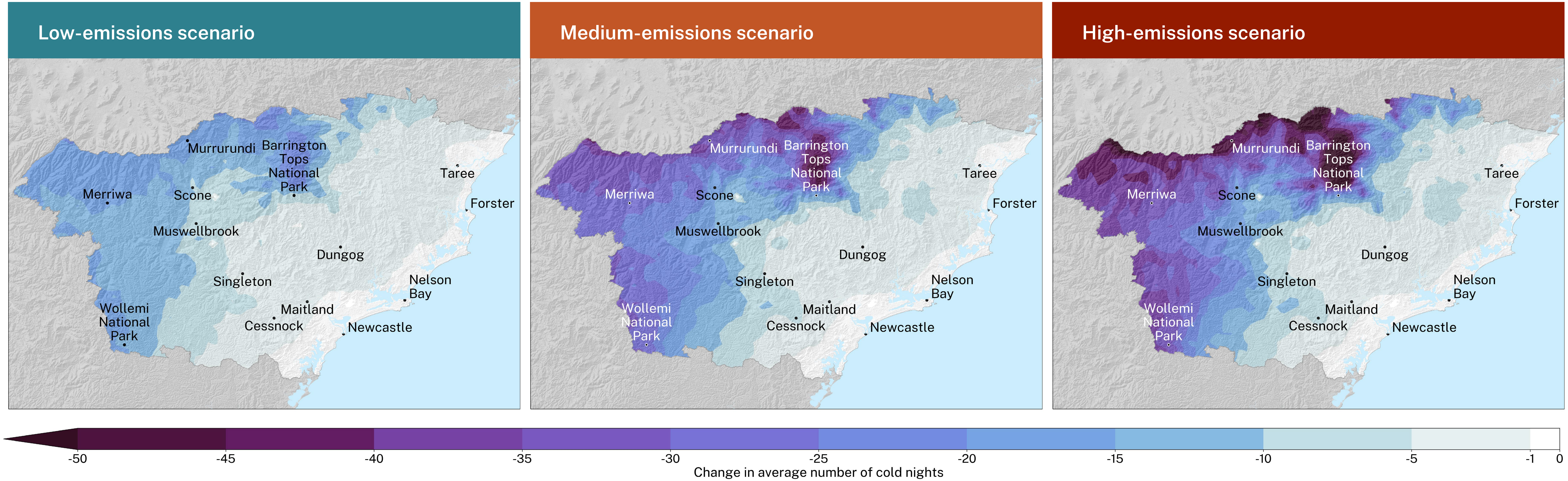
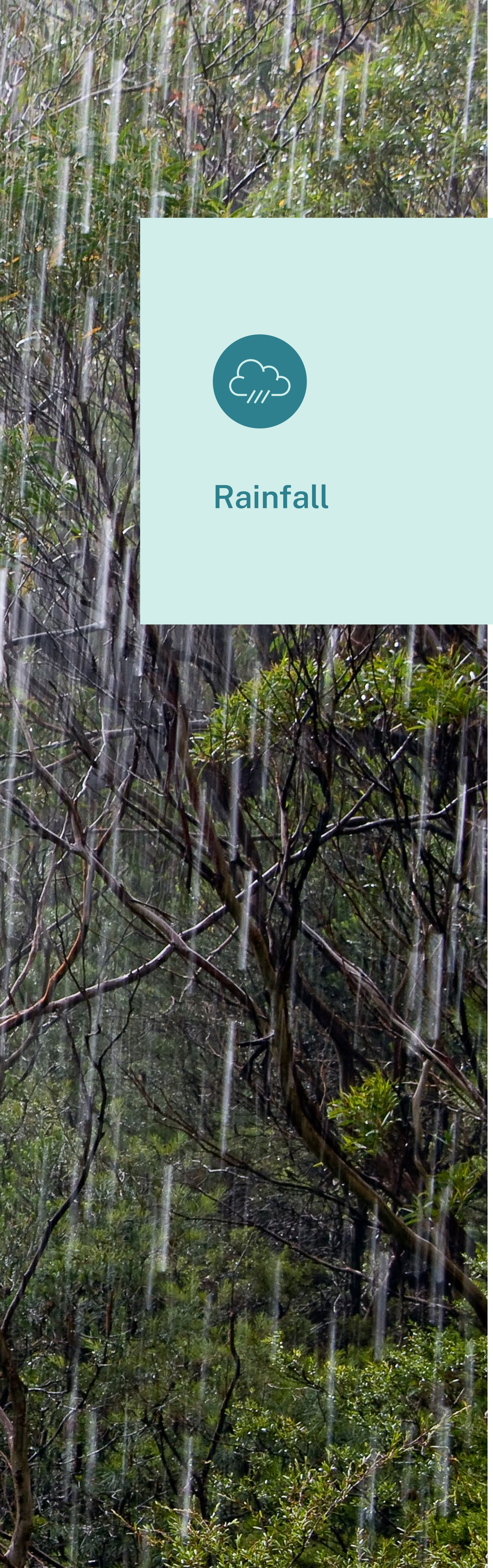


Figure 6. Projected change in annual number of cold nights by 2090 for the Hunter





Rainfall

Rainfall is projected to remain variable

Climate change will influence rainfall patterns and the amount of rainfall that NSW receives. These changes may have widespread impacts on water security, agricultural productivity and native species' reproductive cycles. For example, subtropical rainforest communities in the north may contract due to more variable rainfall and changes to humidity and evapotranspiration. NSW has experienced rainfall extremes in recent decades, with significant impacts on communities, infrastructure and natural ecosystems

Modelling rainfall is more difficult than modelling temperature due to the complexities of the weather systems that generate rain. NARCliM projections capture a range of plausible climate futures under the 3 emissions scenarios, including wet and dry outcomes. This means that rainfall is inherently more variable in the NARCliM projections than temperature, and the full range of rainfall projections should be taken into account. This can be explored further on the AdaptNSW Interactive Map.

This snapshot provides data on average rainfall change and does not provide data on rainfall extremes or the impacts of climate change on flooding.

Observed annual rainfall across the Hunter region averages about 920 mm.[4] Rainfall varies as you move from the coast inland, ranging from more than 1300 mm per year on the coast and on the Barrington Tops, down to less than 600 mm per year around Merriwa.[4] Rainfall is greatest in summer and autumn, with a higher proportion of winter rainfall on the coast than inland. The driest year on record was 2019, with an average of only 480 mm across the region.[4]

A decrease in average winter rainfall of approximately 25% by 2090 is projected for the Hunter under medium-emissions and high-emissions scenarios.

Projections

Annual average rainfall in the region is projected to remain variable throughout this century (Figure 7). By 2090, on average, annual rainfall is projected to decrease by 8% under a low emissions scenario, by 13% under a medium-emissions scenario and by 9% under a high-emissions scenario (Table 5). Changes to average rainfall will occur in all seasons (Figures 8 to 12), with the largest changes expected in winter.

By 2090, on average, winter rainfall is projected to decrease by 12% under a low-emissions scenario, by 24% under a medium-emissions scenario and by 26% under a high-emissions scenario (Table 5). The Barrington Tops and southern hinterland areas of the region including Wollemi National Park are projected to experience the greatest changes (Figure 11). By 2090, on average, winter rainfall is projected to decrease for Wollemi National Park by 20% under a low-emissions scenario, by 30% under a medium-emissions scenario and by 35% under a high-emissions scenario.

On average, summer, autumn and spring rainfall is projected to change by less than 14% across the region by 2090 under both a low-emissions scenario and a high-emissions scenario.

Refer to the Interactive Map for further seasonal information.

Table 5 and Figure 7 provide more information on how the projections differ across the 3 scenarios, and Figures 8 to 12 provide information on regional differences by 2090 across the 3 scenarios by season.

Table 5. Projected change to average rainfall – Hunter

2050

	Low-emissions	Medium-emissions	High-emissions
Annual	**–8.1%** (–18.2% to +7.0%)	**–9.1%** (–21.8% to +10.5%)	**–15.0%** (–26.0% to +6.2%)
Summer	**–10.8%** (–27.8% to +4.7%)	**–8.8%** (–19.2% to +28.1%)	**–16.5%** (–36.6% to +5.3%)
Autumn	**–4.4%** (–24.0% to +11.1%)	**–4.7%** (–22.1% to +18.0%)	**–10.2%** (–26.1% to +12.8%)
Winter	**–10.7%** (–27.7% to +21.8%)	**–21.6%** (–37.0% to +22.1%)	**–27.0%** (–46.4% to +1.8%)
Spring	**–6.2%** (–15.3% to +25.4%)	**–4.0%** (–30.0% to +19.0%)	**–7.6%** (–28.6% to +16.5%)

2090

	Low-emissions	Medium-emissions	High-emissions
Annual	**–8.0%** (–18.9% to +7.2%)	**–13.4%** (–23.9% to +6.3%)	**–8.8%** (–32.3% to +22.9%)
Summer	**–10.7%** (–29.2% to +17.2%)	**–11.4%** (–29.6% to +30.9%)	**–0.8%** (–22.5% to +20.1%)
Autumn	**–2.2%** (–19.0% to +16.7%)	**–8.3%** (–26.3% to +15.7%)	**–6.2%** (–24.8% to +34.4%)
Winter	**–12.4%** (–25.3% to –1.7%)	**–23.6%** (–37.2% to +15.9%)	**–26.2%** (–59.8% to +24.4%)
Spring	**–7.2%** (–22.1% to +13.3%)	**–13.8%** (–32.9% to +15.7%)	**–9.4%** (–32.9% to +22.3%)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Percentages changes in annual average rainfall are relative to the historical model baseline of 855 mm. Average summer rainfall is relative to a baseline of 289 mm, average autumn rainfall is relative to a baseline of 230 mm, average winter rainfall is relative to a baseline of 162 mm and average spring rainfall is relative to a baseline of 174 mm.

Figure 7. Historical and projected change in average rainfall – Hunter

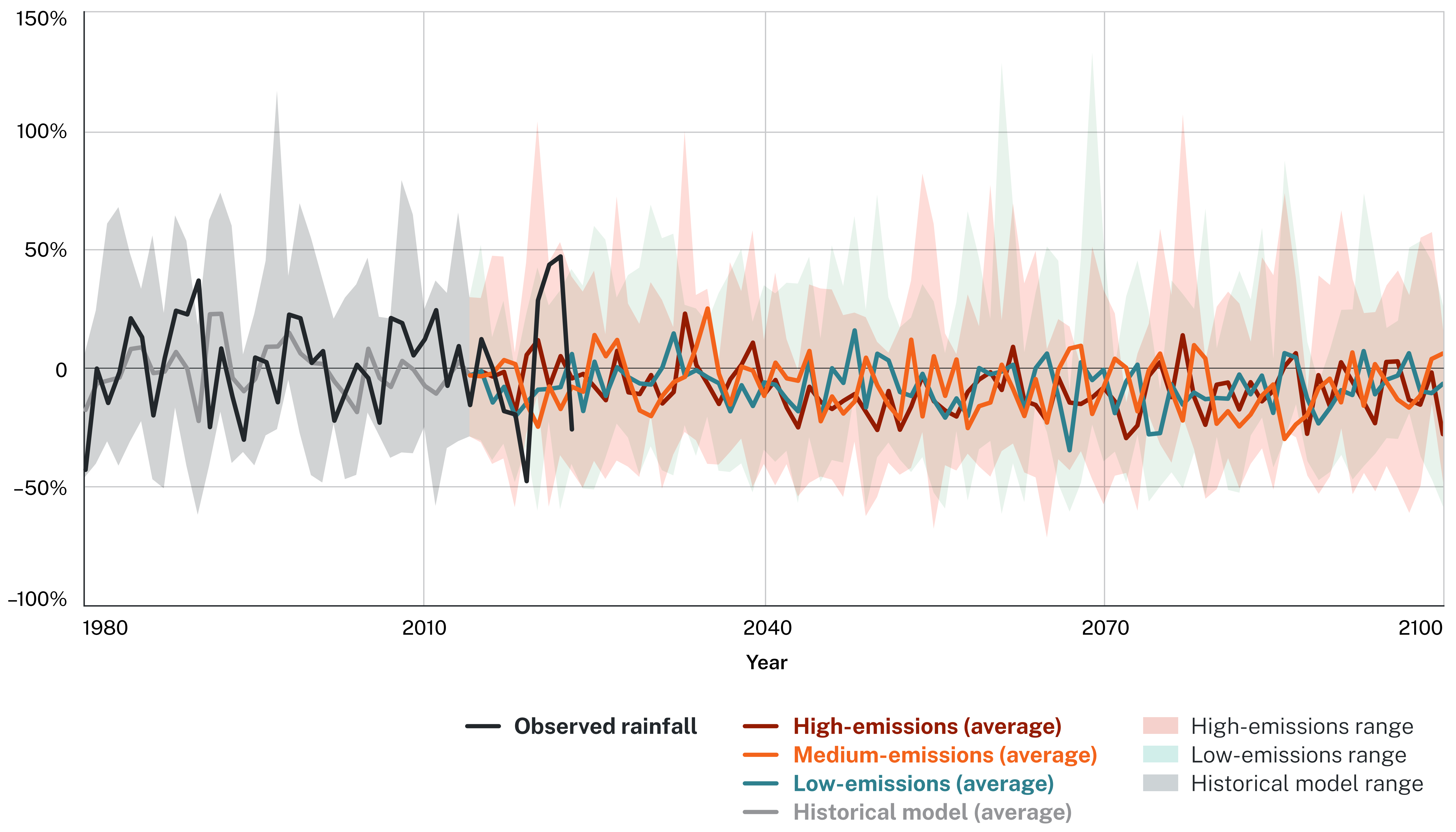


Figure 8. Projected change to average annual rainfall by 2090 for the Hunter

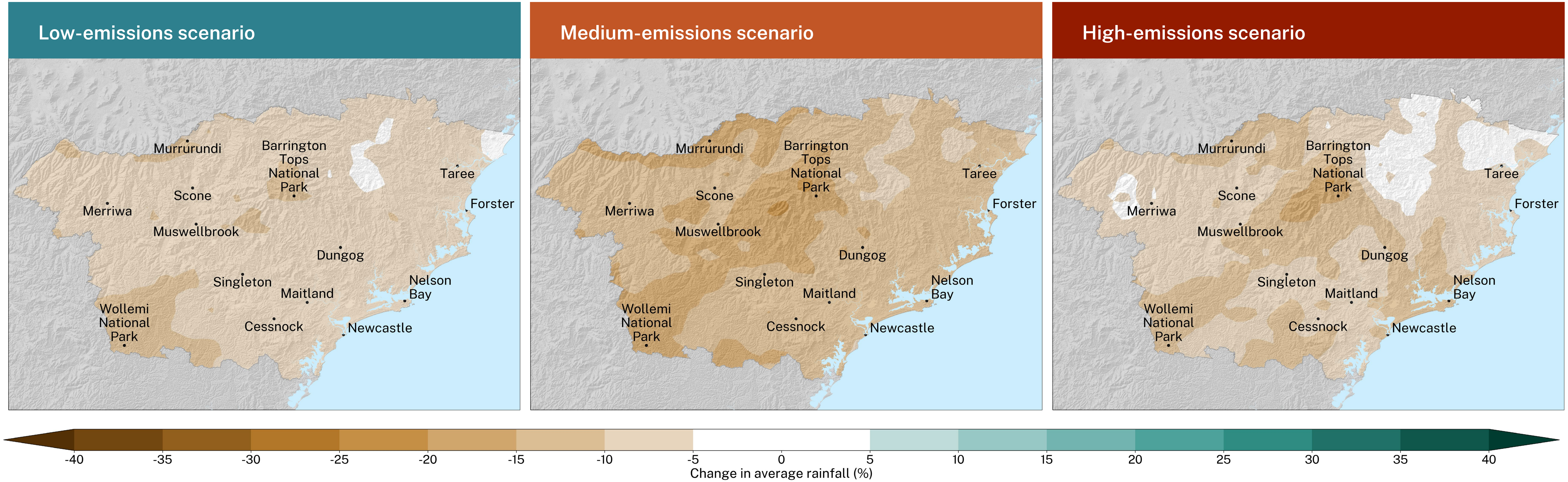


Figure 9. Projected change to average summer rainfall by 2090 for the Hunter

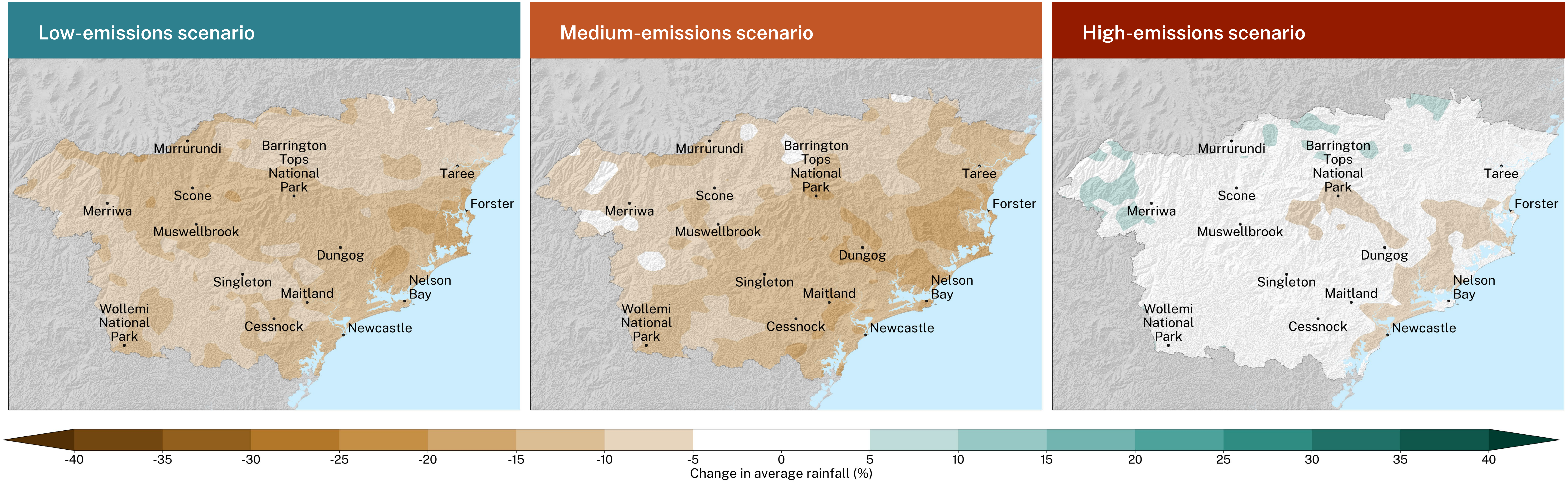


Figure 10. Projected change to average autumn rainfall by 2090 for the Hunter

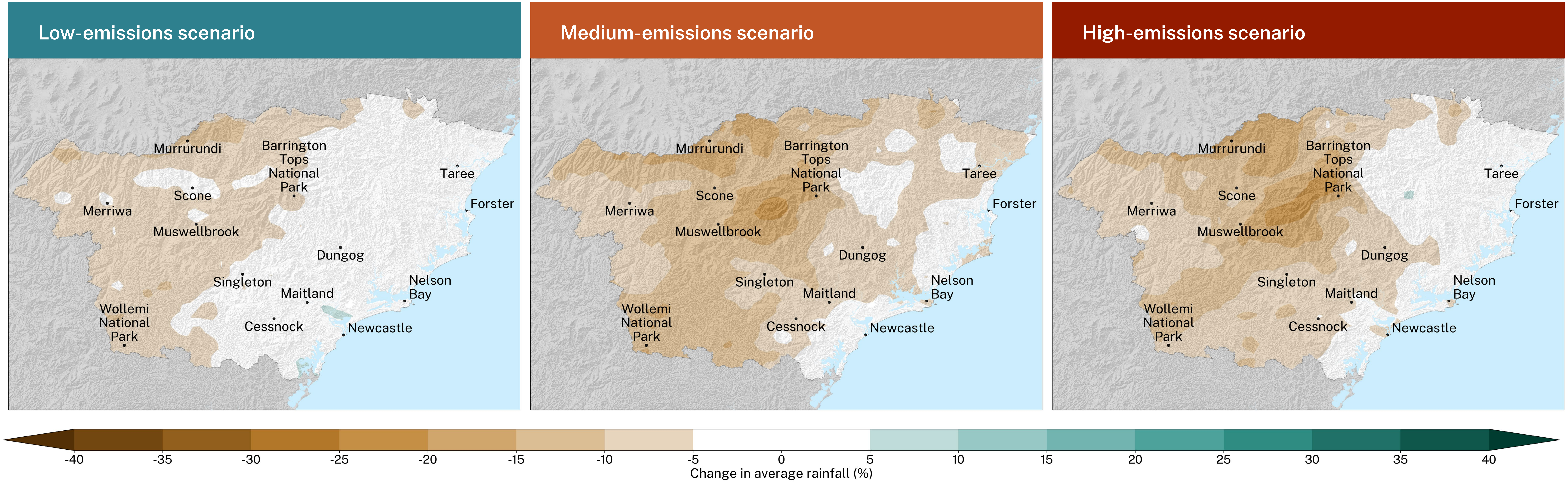


Figure 11. Projected change to average winter rainfall by 2090 for the Hunter

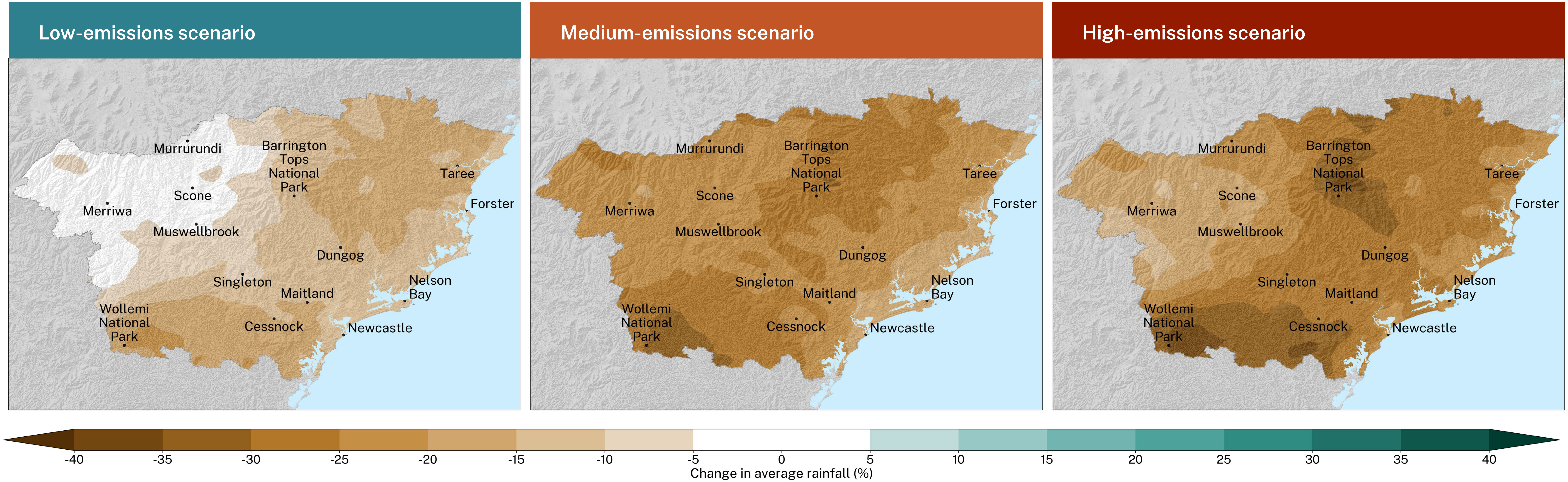
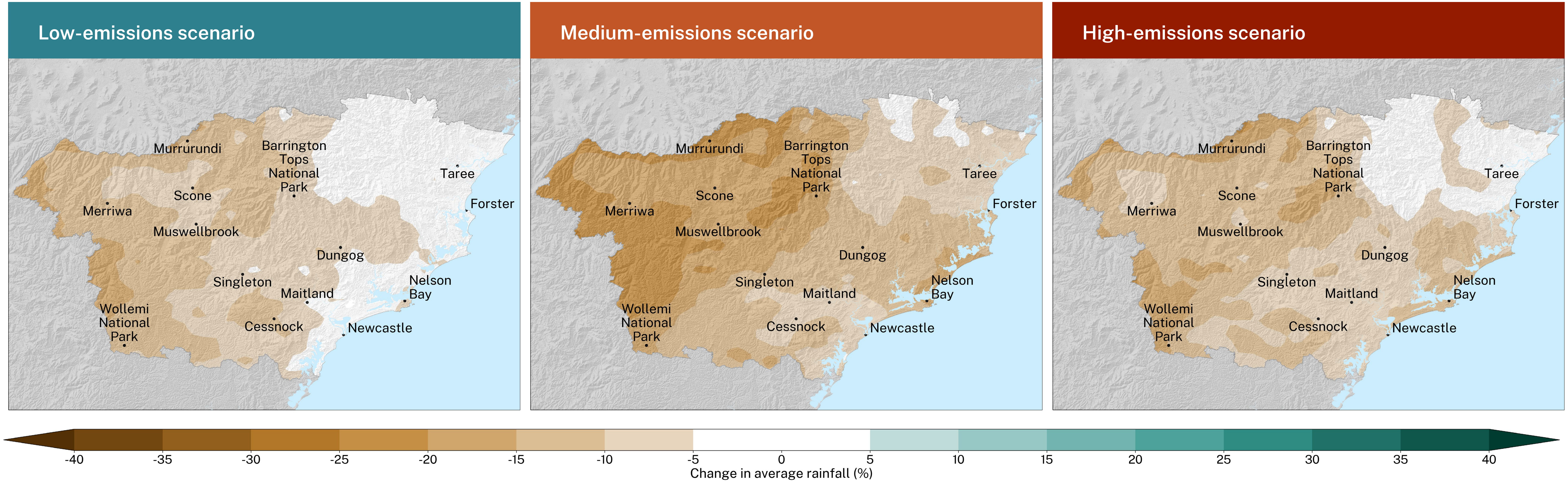


Figure 12. Projected change to average spring rainfall by 2090 for the Hunter



Severe fire weather

Severe fire weather will increase

The Forest Fire Danger Index (FFDI) represents an estimate of fire weather risk. The FFDI is calculated from temperature, relative humidity and wind speed, as well as an index representing fuel dryness.

Severe fire weather (FFDI greater than 50) is most likely in summer and spring. Fire weather was the strongest determining factor of house loss during the Black Summer bushfires.[8] FFDI was monitored by weather stations across NSW until the introduction in 2022 of the Australian Fire Danger Rating System. FFDI is used in this snapshot as it can be simulated using the NARCliM projections, whereas data used by the Australian Fire Danger Rating System currently cannot. FFDI also provides a long history of data and gives context to the NARCliM projections.

Projections

Across the Hunter region, the average number of severe fire weather days per year will increase throughout this century (Figure 13).

The number of severe fire weather days will increase for the Hunter region by 2050 for all emissions scenarios, with an even greater increase projected by 2090 under a medium-emissions scenario and a high-emissions scenario (Table 6). The number of severe fire weather days is projected to increase during spring and summer, with the largest increase in spring.

Increases to severe fire weather days are projected to occur across most of the region under a high-emissions scenario (Figure 14). The greatest increases are projected to occur for the Upper Hunter, including towns such as Merriwa, with only small increases projected in some coastal areas such as Forster. By 2090, Merriwa is projected to experience 1.9 additional severe fire weather days per year under a low-emissions scenario, 5.3 under a medium-emissions scenario and 5.8 under a high-emissions scenario. A high-emissions scenario is projected to nearly double Merriwa's baseline period average of 6.1 severe fire weather days per year. Comparatively, in the north-east of the region, Forster's baseline period average is 0.9 severe fire weather days per year. By 2090, Forster is projected to experience 0.1 additional severe fire weather days per year under a low-emissions scenario, 0.6 under a medium-emissions scenario and 0.3 under a high-emissions scenario.

2x

Under a high-emissions scenario, the number of severe fire weather days per year across the Hunter could more than double by 2090.

Fire weather was the strongest determining factor of house loss during the Black Summer bushfires.[9]

Table 6 and Figure 13 provide more information on how the projections differ across the 3 scenarios, and Figure 14 provides information on regional differences by 2090 across the 3 scenarios.

Table 6. Projected increase in average annual number of severe fire weather days – Hunter

2050

Low-emissions	Medium-emissions	High-emissions
0.9 days (0.2 to 2.2 days)	**0.9 days** (–0.1 to 2.2 days)	**1.2 days** (0.1 to 3.5 days)

2090

Low-emissions	Medium-emissions	High-emissions
0.7 days (–0.8 to 2.2 days)	**1.8 days** (0.2 to 4.4 days)	**2.3 days** (0.1 to 6.1 days)

The bold number is the ensemble average for the period. Underneath the average is the ensemble range. Severe fire weather increases are additional to the historical model baseline of 1.8 severe fire weather days.

Figure 13. Historical and projected change in annual number of severe fire weather days – Hunter

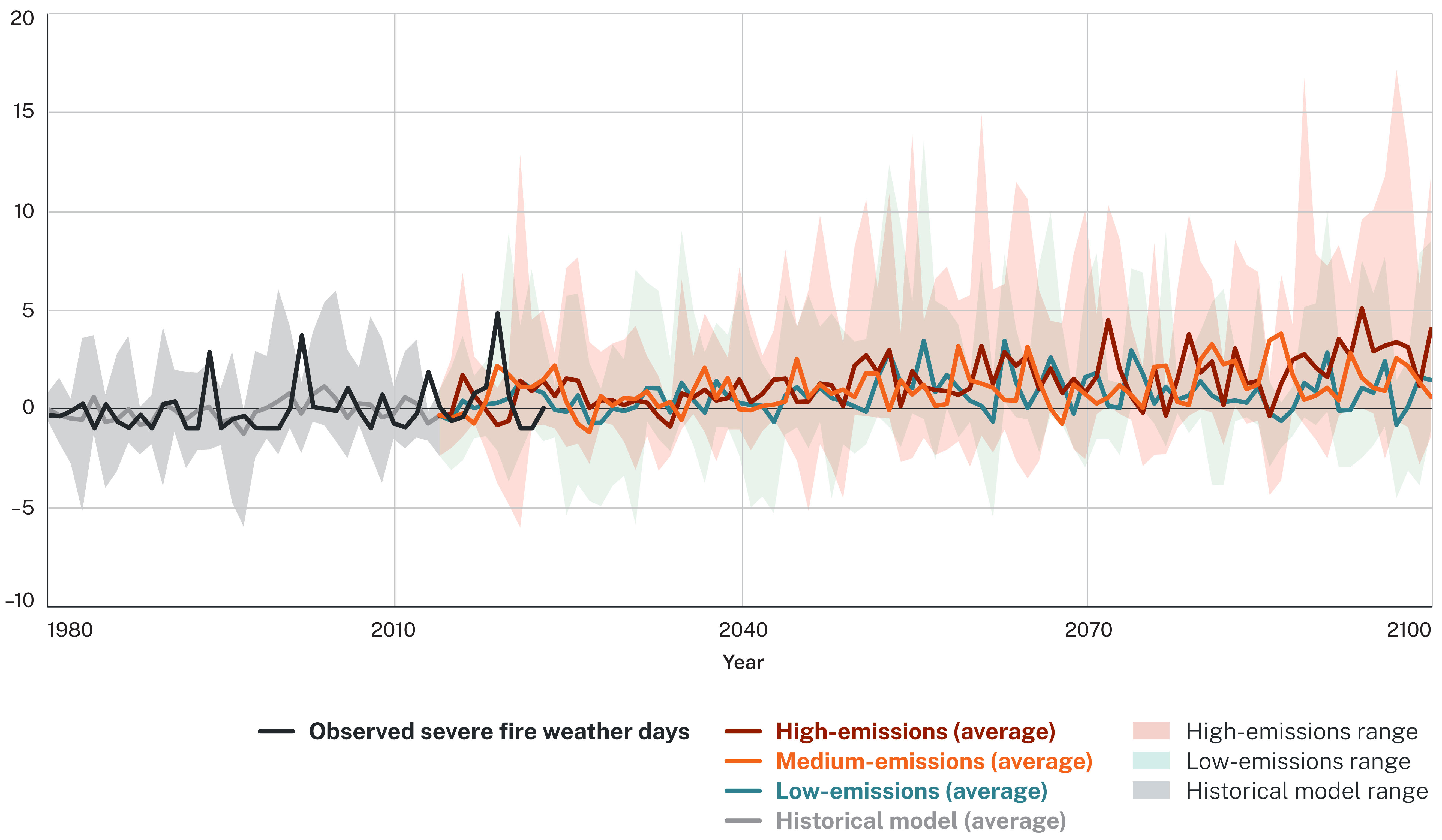
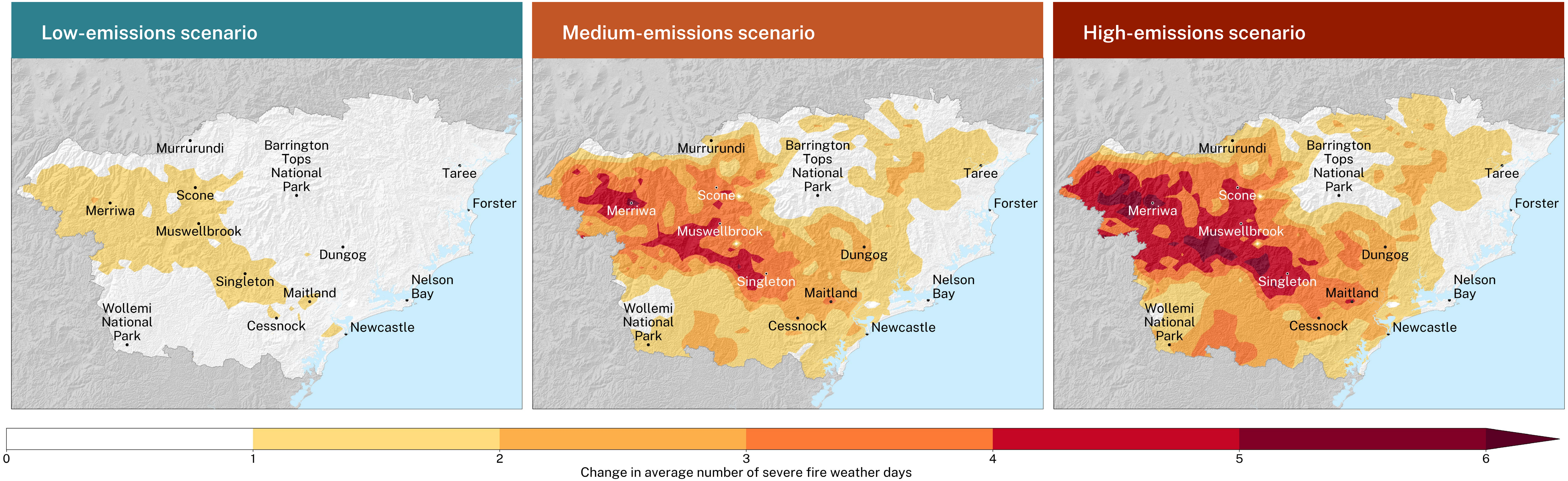


Figure 14. Projected change to average annual number of severe fire weather days by 2090 for the Hunter



Bushfires

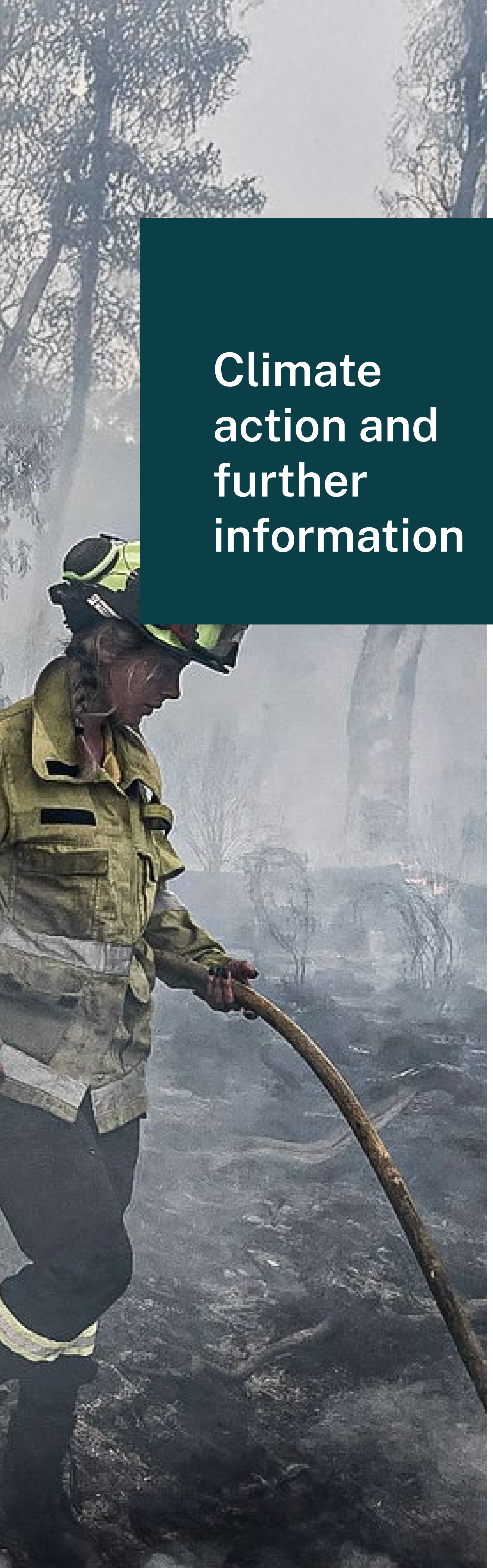
The 2019–20 bushfire season caused extensive damage to communities, infrastructure and natural ecosystems in the Hunter region. Over 227,000 hectares of the region were burnt and 15,663 buildings were impacted, including 147 homes which were destroyed.[10] There were 25 premature deaths, 38 cardiovascular disease and 129 respiratory disease hospitalisations across the region from poor air quality caused by the bushfires.[11]

Large areas of bushland experienced extreme fire severity, including Wollemi National Park. Wollemi National Park was affected by the Kerry Ridge fire, which burnt more than 320,000 hectares across regions and combined with the Gospers Mountain fire to form the largest bushfire ever recorded in NSW. Over 4,000 hectares of Barrington Tops National Park, which forms part of the Gondwana Rainforests of Australia World Heritage Area, was also burnt.[12]

The Hunter, with its extensive areas of bushland, is highly vulnerable to the impacts of increasing days of severe fire weather.

Climate change is expected to reduce the interval between fires, increase fire intensity, and shorten the window for safe fire management activities.[13] More frequent fires disrupt ecosystem structure and composition, potentially shifting ecosystems into different states and threatening biodiversity.[14]

Severe fire danger days, which create the underlying conditions for large-scale bushfires, are expected to become more common in the future, particularly under a higher-emissions scenario.



Climate action and further information

Climate action

The NARCliM projections for the low-, medium- and high-emissions scenarios highlight the stark difference in climate change impacts that will be experienced under each scenario. The differences provide a reminder of the required action across the world to reduce emissions, and the importance of the ACT playing its part through meeting the ACT Government's ambitious, legislated target of net zero emissions by 2045. This is our best chance at ensuring the future projections under the high-emissions scenario are avoided. The NARCliM projections highlight the importance of taking action to adapt to the impacts of climate change. Find out more about what the ACT Government is doing to mitigate and adapt to climate change here.

Additional resources

- ACT Government's Everyday Climate Choices
- Generate detailed climate information based on your Local Government Area using SEED
- Climate Data Portal
- AdaptNSW
- NARCliM case studies
- Climate Risk Ready NSW Guide

Further Information

NARCliM projections are delivered with support from: the ACT, South Australian, Victorian and Western Australian governments; National Computational Infrastructure; Murdoch University; and the University of New South Wales. Detailed information on the methodology and application of the projections can be found on the AdaptNSW website. Climate change information in this snapshot is delivered as part of the NSW Government's commitment to 'Publish regularly updated and improved local level climate change projections' under Action 3 of the NSW climate change adaptation strategy.

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