New England North West
Climate change snapshot

Overview of **New England North West Region** climate change

Based on long-term (1910–2011) observations, temperatures have been noted to have been increasing since about 1970, with higher temperatures experienced in recent decades.

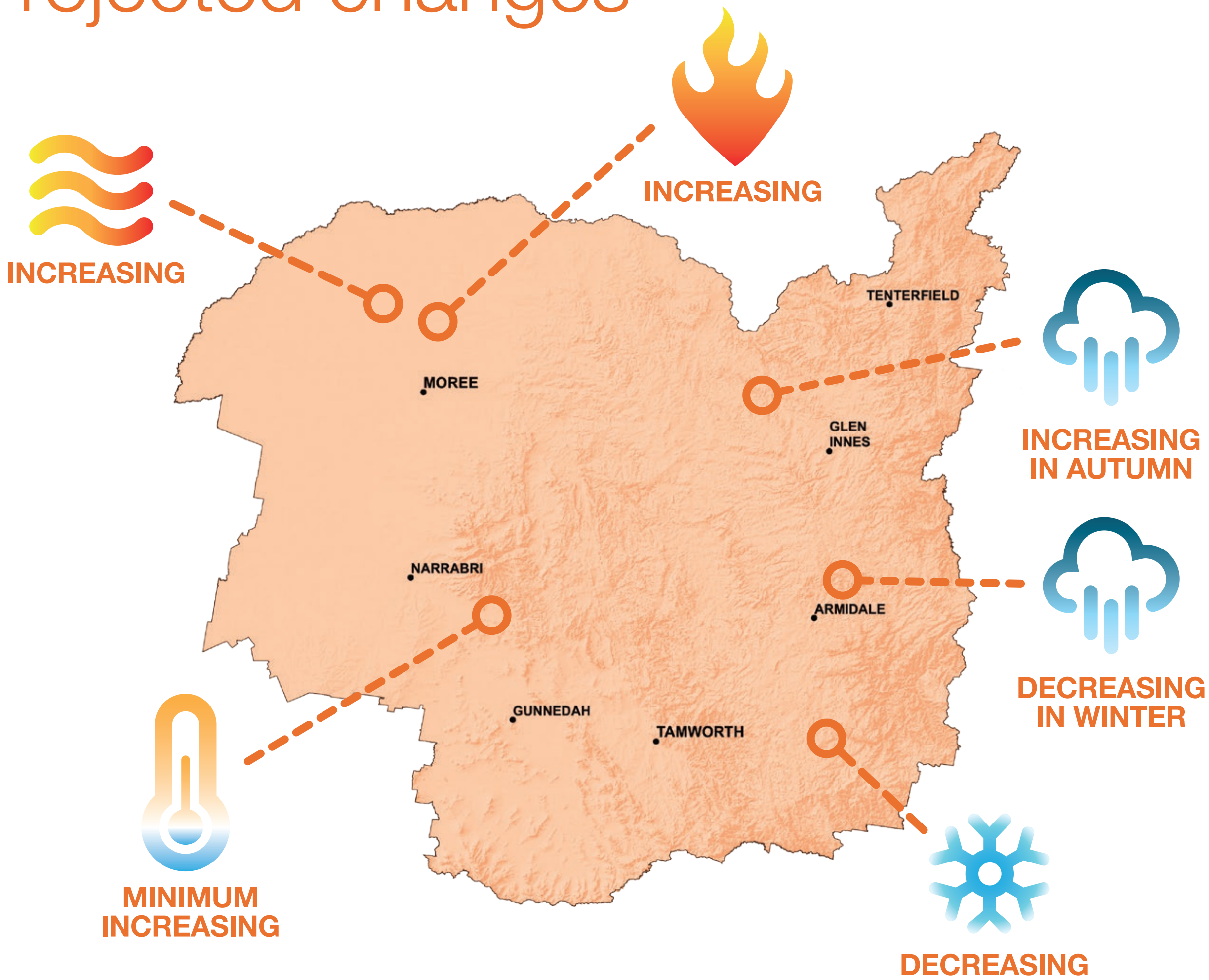
The New England and North West Region is projected to continue to warm during the near future and far future, compared to recent years (1990–2009). The warming is projected to be on average about 0.7°C in the near future, increasing to about 2.2°C in the far future. The number of high temperature days is projected to increase, with fewer potential frost risk nights anticipated.

The warming trend projected for the region is large compared to natural variability in temperature and is of a similar order to the rate of warming projected for other regions of NSW.

The region currently experiences considerable rainfall variability across seasons and from year-to-year and this variability is also reflected in the projections.

Front Cover: Sheep grazing. Copyright: Jack Scott. Page 2: Wollomombi Falls, one of the highest in Australia. Copyright: THPStock. Page 4: Namoi River in northern New South Wales, Australia. Copyright: Edward Haylan. Page 9: Mount Kaputar National Park, Australia; New South Wales. Copyright: Vaclav Mach.

Projected changes



Projected **temperature** changes

Maximum temperatures are projected to increase in the near future by 0.4 – 1.0°C	Maximum temperatures are projected to increase in the far future by 1.9 – 2.7°C
Minimum temperatures are projected to increase in the near future by 0.5 – 1.0°C	Minimum temperatures are projected to increase in the far future by 1.6 – 2.7°C
The number of hot days will increase	The number of cold nights will decrease

Projected **rainfall** changes

Rainfall is projected to decrease over most of the region in winter	Rainfall is projected to increase in autumn

Projected **Forest Fire Danger Index (FFDI)** changes

Average fire weather is projected to increase in summer, spring and winter	Severe fire weather days are projected to increase in summer and spring

Regional snapshots

NSW and ACT Regional Climate Modelling project (NARCliM)

The climate change projections in this snapshot are from the NSW and ACT Regional Climate Modelling (NARCliM) project. NARCliM is a multi-agency research partnership between the NSW and ACT governments and the Climate Change Research Centre at the University of NSW. NSW Government funding comes from the Office of Environment and Heritage (OEH), Sydney Catchment Authority, Sydney Water, Hunter Water, NSW Office of Water, Transport for NSW, and the Department of Primary Industries.

The NARCliM project has produced a suite of twelve regional climate projections for south-east Australia spanning the range of likely future changes in climate. NARCliM is explicitly designed to sample a large range of possible future climates.

Over 100 climate variables, including temperature, rainfall and wind are available at fine resolution (10km and hourly intervals). The data can be used in impacts and adaptation research, and by local decision makers. The data is also available to the public and will help to better understand possible changes in NSW climate.

Modelling overview

The NARCliM modelling was mainly undertaken and supervised at the Climate Change Research Centre. NARCliM takes global climate model outputs and downscales these to provide finer, higher resolution climate projections for a range of meteorological variables. The NARCliM project design and the process for choosing climate models has been peer-reviewed and published in the international scientific literature (Evans et. al. 2014, Evans et. al. 2013, Evans et. al. 2012).

Go to climatechange.environment.nsw.gov.au for more information on the modelling project and methods.

Interpreting climate projections can be challenging due to the complexities of our climate systems. 'Model agreement', that is the number of models that agree on the direction of change (for example increasing or decreasing rainfall) is used to determine the confidence in the projected changes. The more models that agree, the greater the confidence in the direction of change.

In this report care should be taken when interpreting changes in rainfall that are presented as the average of all of the climate change projections, especially when the model outputs show changes of both wetting and drying. To understand the spread of potential changes in rainfall the bar charts should be considered along with the maps provided in this document. Help on how to interpret the maps and graphs in this report is provided in Appendix 1.

Summary documents for each of the state planning regions of NSW are available and provide climate change information specific to each region.

The snapshots provide descriptions of climate change projections for two future 20-year time periods: 2020–2039 and 2060–2079.

1. The climate projections for 2020–2039 are described in the snapshots as **NEAR FUTURE, or as 2030**, the latter representing the average for the 20-year period.
2. The climate projections for 2060–2079 are described in the snapshots as **FAR FUTURE, or as 2070**, the latter representing the average of the 20-year period.

Further information about the regions will be released in 2015.

Introduction

This snapshot presents climate change projections for the New England North West region of NSW. It outlines some key characteristics of the region, including its current climate, before detailing the projected changes to the region's climate in the near and far future.

Location and topography

The New England North West region covers an area of 98,600 square kilometres. It extends from Glen Innes and Armidale on the New England Tablelands in the north-east, through Inverell and Tamworth on the North West Slopes and on to the north-west plains of Moree. The regional landscape varies from elevated inland tablelands and slopes to broad floodplains on west-flowing rivers, including the Namoi, Gwydir and Macintyre.

The region contains some of the most fertile soils in Australia. The majority of the region is located in the Murray–Darling Basin. The main west-flowing river systems are the Namoi, Gwydir and Macintyre rivers. The region also contains the upper reaches of many coastal river systems, including the Clarence, Macleay and Manning.

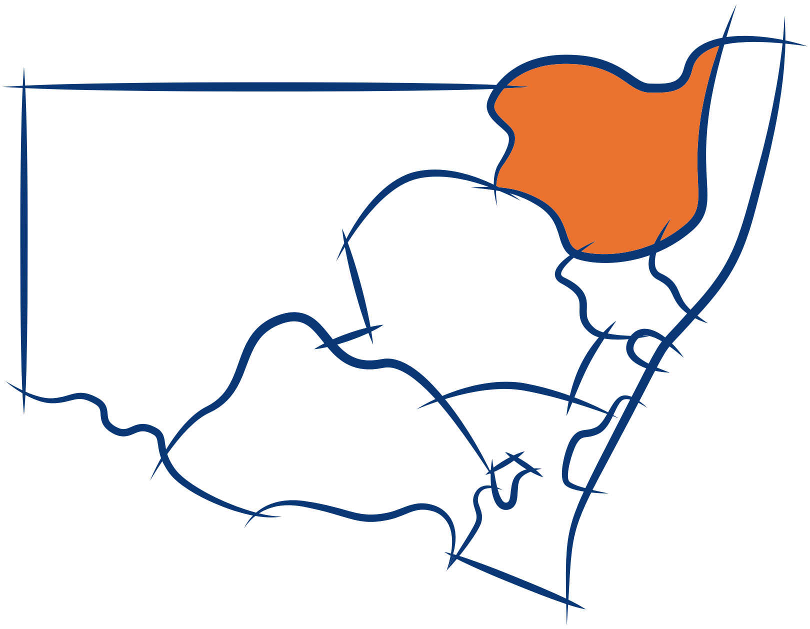
Population and settlements

The region's population is over 182,500, with about half of the population living in the main urban areas of the region, including the two major regional centres of Armidale and Tamworth and the five major towns of Glen Innes, Inverell, Moree, Narrabri and Gunnedah.

There are about 75,600 employees in the region, the largest employers include agriculture, tourism, retail and educational services. This region is a part of the Murray–Darling Basin, and plays a significant role in international exports of Australian agricultural products.

Natural ecosystems

Extensive national parks occur along the escarpment and other large parks include Mount Kaputar and Torrington on the tablelands and the Pilliga Community Conservation Areas on the western plains; however, most other national parks in the region are small and scattered, and many ecosystem types are not represented in reserves. The region's wetlands support a diversity of flora and fauna that mostly depend on fluctuating water regimes of wetting and drying. The region contains some major floodplain wetlands including the internationally significant Gwydir Wetlands (Gingham and Lower Gwydir [Big Leather] watercourses) and Little Llangothlin Lagoon.



Climate of the region

The region has a diverse range of climates from the cooler and more temperate Northern Tablelands through to the dryer and hotter North West Slopes and Plains in the west. The tablelands have a temperate climate with warm summers and cool winters. The far north-west of the region is hot and semi-arid, while much of the North West Slopes has a humid sub-tropical climate. The overall average rainfall is a moderate 700 mm per year, ranging from over 1200 mm on the tablelands to a minimum of less than 600 mm in the west. Rainfall is higher in summer and fairly uniform across other seasons.

Temperature

In summer, average temperatures range from 16–18°C along the Great Dividing Range to 26–28°C in the north-west. In winter, average temperatures range from 4–6°C along the Great Dividing Range, to 12–14°C on the north-west plains.

Average maximum temperatures in summer range from 36°C in the west of the region to 20°C along the higher areas of the New England Tablelands. The winter average minimum temperature ranges from –2–0°C on the Tablelands to 4–6°C on the north-west plains. The maximum summer and minimum winter temperatures increase away from the Great Dividing Range.

Seasonal variations are illustrated by average, minimum and maximum monthly temperatures averaged over the region (Figure 1). The average monthly temperatures range from around 9°C in July to just over 23°C in January.

The long-term temperature records indicate that temperatures in the New England North West region have been increasing since the 1960s. The longest period of continued temperature increase has occurred in the most recent decades.

Temperature extremes

Temperature extremes, both hot and cold, occur infrequently but can have considerable impacts on health, infrastructure and our environment. Changes to temperature extremes often result in greater impacts than changes to average temperatures.

Hot days

The number of days where the maximum temperature is above 35°C increases moving west away from the Great Dividing Range. The number of hot days ranges from typically none along the highest parts of the New England Tablelands through to over 50 days on the north-west plains west of Moree.

Cold nights

The number of cold nights (minimum temperature below 2°C) decreases moving west from the Great Dividing Range. The higher parts of the New England Tablelands see on average from 90–110 cold nights per year. On the north-western plains the number of cold nights ranges from fewer than 10 to up to 50 cold nights per year.

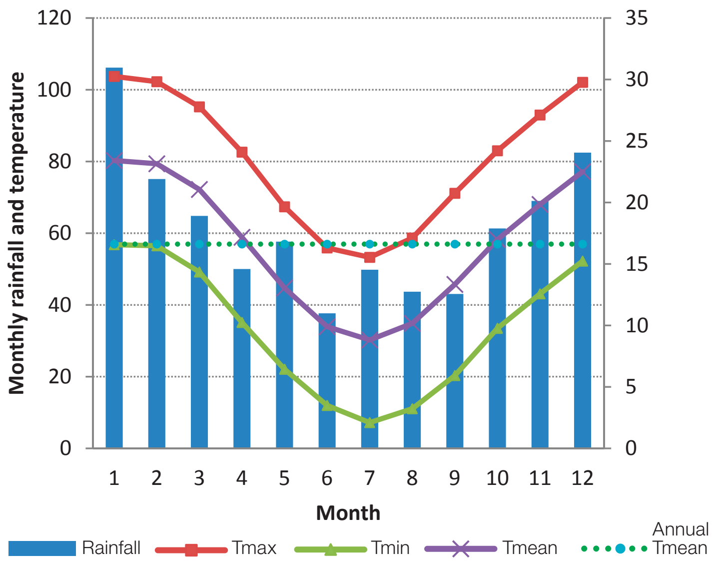
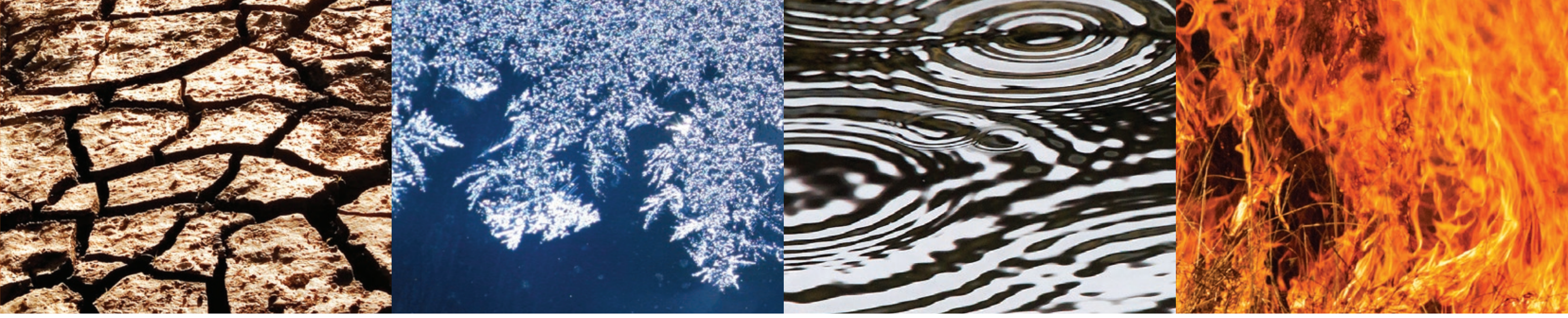


Figure 1: Seasonal rainfall and temperature variations (AWAP[1] data for 1960–1991).

1. Australian Water Availability Project, see www.csiro.au/awap/.



Rainfall

Rainfall varies considerably across the region. This variability is due to the complex interactions between regional weather patterns, the influence of larger-scale climate patterns such as El Niño Southern Oscillation and the topography of the Great Dividing Range and the north-west plains.

Average annual rainfall ranges from 1200–1600 mm along parts of the New England Tablelands through to 400–800 mm on the North West Slopes and Plains. Rainfall decreases as you move west.

More rain falls in summer than other seasons. Winter is the driest season with the plains west of Moree seeing less than 100 mm rain during June, July and August. The seasonal variations are fairly uniform throughout the North West Slopes, which receives 100–200 mm during autumn, winter and spring, with more rainfall in summer (200–300 mm).

Fire weather

The risk of bushfire in any given region depends on four 'switches'. There needs to be enough vegetation (fuel), the fuel needs to be dry enough to burn, the weather needs to be favourable for fire to spread, and there needs to be an ignition source (Bradstock 2010). All four of these switches must be on for a fire to occur. The Forest Fire Danger Index (FFDI) is used in NSW to quantify fire weather. The FFDI combines observations of temperature, humidity and wind speed with an estimate of the fuel state.

Long-term observations of FFDI come from daily measurements of temperature, rainfall, humidity and wind speed at only a small number of weather stations in Australia, with 17 stations located in NSW and the ACT (Lucas 2010).

FFDI estimates are available for one station within the New England North West Region, Moree (Table 1). The average annual FFDI estimated for 1990–2009 is 12.1. The highest average FFDI occurs in spring and the lowest in winter.

Fire weather is classified as 'severe' when the FFDI is above 50, and most of the property loss from major fires in Australia has occurred when the FFDI reached this level (Blanchi et al. 2010). FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Severe fire weather conditions are estimated to occur on average three days per year at Moree. These days are more likely to occur in summer and spring.

Mean FFDI					
Station	Annual	Summer	Autumn	Winter	Spring
Moree	12.1	13.8	11.9	7.5	15.3
Number of severe fire weather days (FFDI>50)					
Moree	3.3	1.6	0.2	0	1.5

Table 1: Baseline FFDI values for meteorological stations within the New England North West Region.

Temperature

Climate change projections are presented for the near future (2030) and far future (2070), compared to the baseline climate (1990–2009). The projections are based on simulations from a suite of twelve climate models run to provide detailed future climate information for NSW and the ACT.

Temperature is the most reliable indicator of climate change. Across the New England North West Region all of the models agree that average, maximum and minimum temperatures are **increasing.**

Summary temperature

Maximum temperatures are projected to increase in the near future by 0.7°C

Maximum temperatures are projected to increase in the far future by 2.2°C

Minimum temperatures are projected to increase by near future by 0.7°C

Minimum temperatures are projected to increase by far future by 2.3°C

There are projected to be more hot days and fewer cold nights

Projected regional climate changes

The New England North West is expected to experience an increase in all temperature variables (average, maximum and minimum) for the near future and the far future (Figure 2).

Maximum temperatures are increasing by 0.7°C in the near future and by 2.2°C in the far future (Figure 2b). Spring will experience the greatest changes in maximum temperatures increasing by 2.5°C by 2070 (Figure 2b). Increased maximum temperatures are known to impact human health through heat stress and increasing the numbers of heatwave events.

Minimum temperatures are projected to increase by 0.7°C in the near future and by 2.3°C in the far future (Figure 2c). Increased overnight temperatures (minimum temperatures) can have a considerable effect on human health.

These increases are projected to occur across the region (Figures 3–6).

The long-term temperature trend indicates that temperatures in the region have been increasing since approximately 1960, with the largest increase in temperature in the most recent decades.

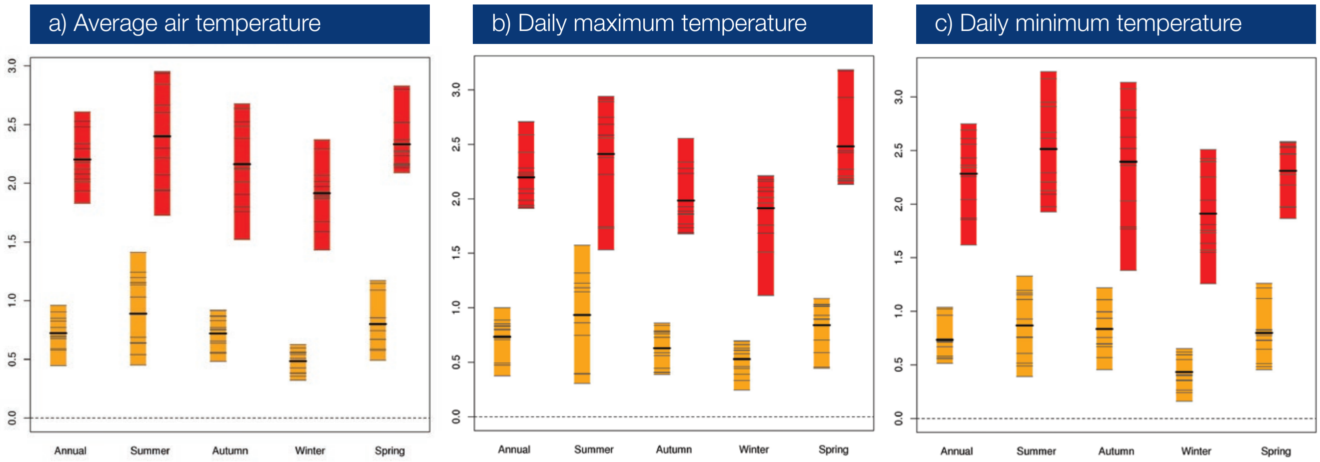


Figure 2: Projected air temperature changes for the New England North West Region, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

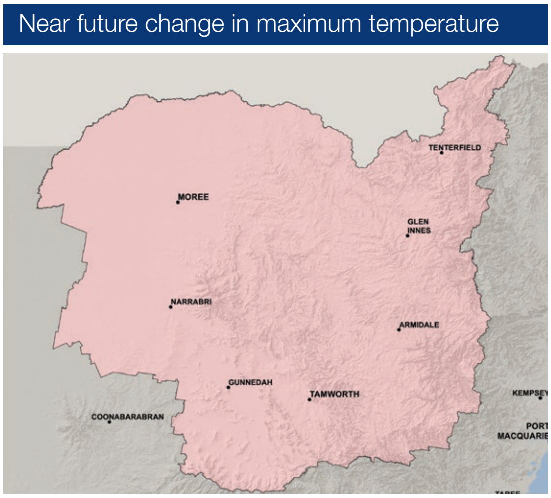


Figure 3: Near future (2020–2039) change in annual average maximum temperature, compared to the baseline period (1990–2009).

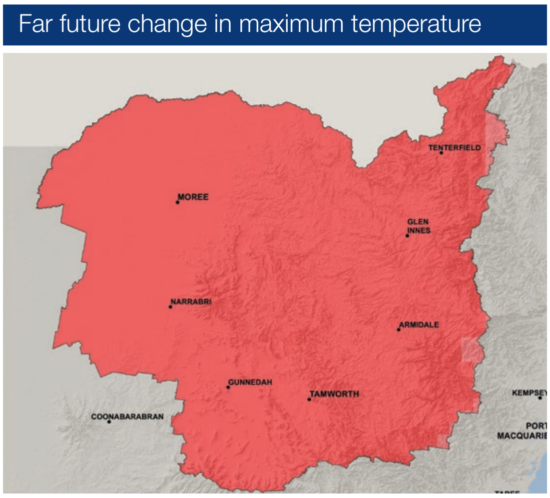


Figure 4: Far future (2060–2079) change in annual average maximum temperature, compared to the baseline period (1990–2009).

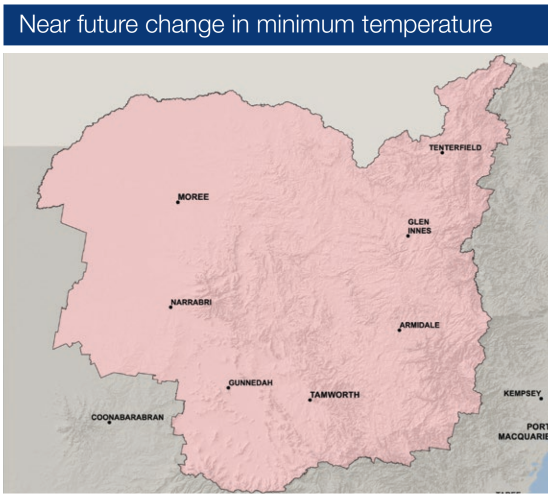


Figure 5: Near future (2020–2039) change in annual average minimum temperature, compared to the baseline period (1990–2009).

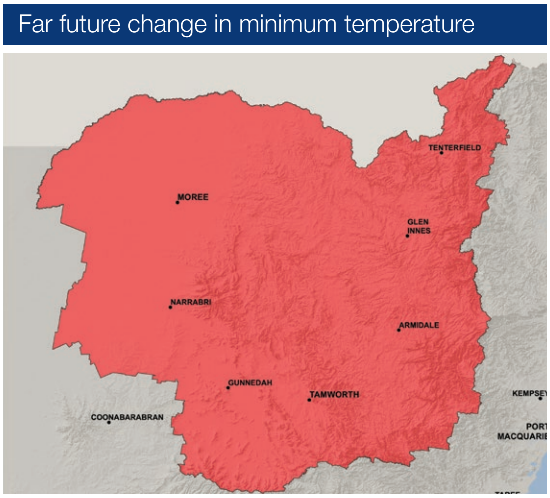
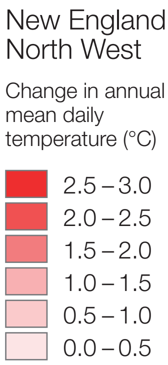


Figure 6: Far future (2060–2079) change in annual average minimum temperature, compared to the baseline period (1990–2009).



Hot days

DAYS PER YEAR ABOVE 35°C

Currently parts of the North West Plains experience an average of 50–60 days above 35°C each year. International and Australian experiences show that prolonged hot days increase the incidence of illness and death – particularly among vulnerable population groups such as people who are older, have a pre-existing medical condition or who have a disability. Seasonal changes are likely to have considerable impacts on bushfire danger, infrastructure development and native species diversity.

Projected regional climate changes

The New England North West is expected to experience more hot days in the near future and the far future (Figure 7).

The greatest increase is projected for the north-west plains with an additional 10–20 hot days in the near future (Figure 8), and over 40 more hot days per year by 2070 (Figure 9).

Averaged across the region there is projected to be an additional seven hot days in the near future (2–10 days per year across the 12 models) and 24 more hot days in the far future (14–29 days per year across the 12 models) (Figure 7).

These increases are mainly expected in summer though in the far future there is a substantial anticipated increase in hot days in spring and autumn (Figure 7).

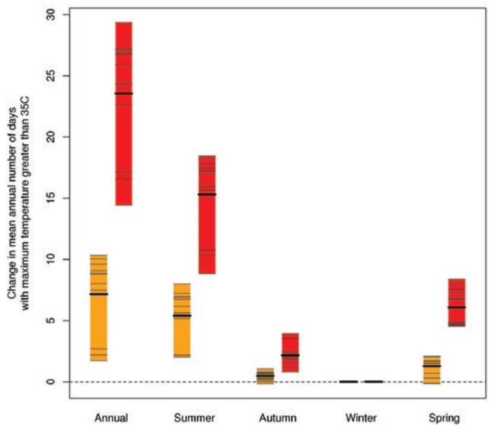


Figure 7: Projected changes in the number of hot days (with daily maximum temperature of above 35°C) for the New England North West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in days per year above 35°C

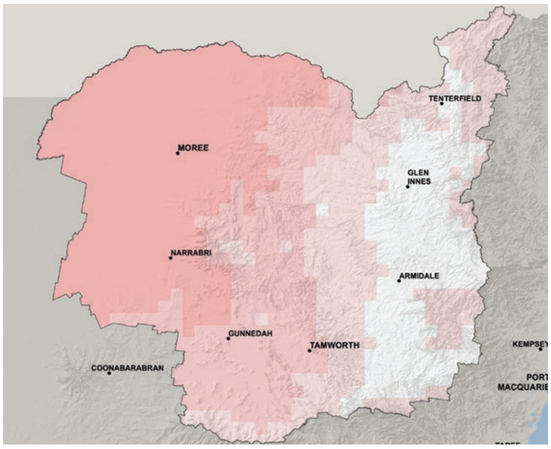


Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

Far future change in days per year above 35°C

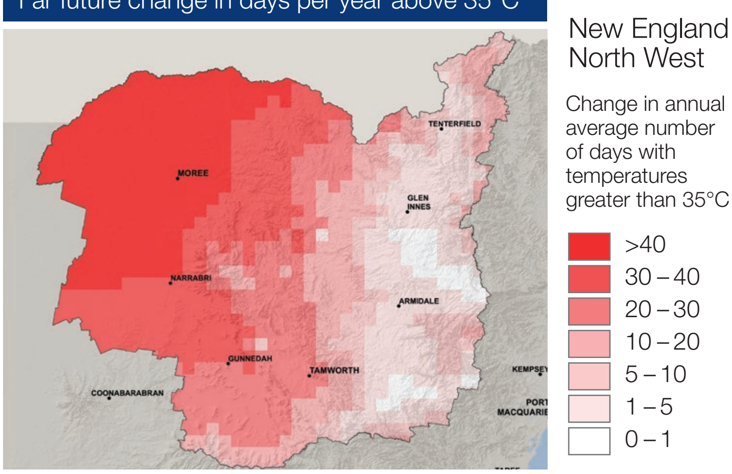
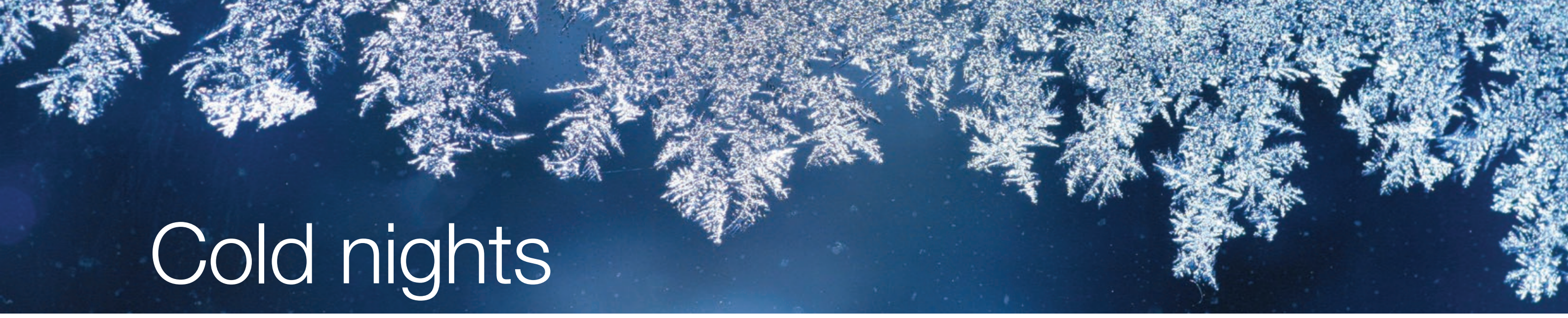


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.



Cold nights

DAYS PER YEAR BELOW 2°C

Most of the emphasis on changes in temperatures from climate change has been on hot days and maximum temperatures, but changes in cold nights are equally important in the maintenance of our natural ecosystems and agricultural/horticultural industries; for example, some common temperate fruit species require sufficiently cold winters to produce flower buds.

Projected regional climate changes

The New England North West is expected to experience fewer cold nights in the near future and the far future (Figure 10).

The greatest decreases are projected to occur along the tablelands which are projected to see 10–20 fewer cold nights per year in the near future and over 40 fewer nights by 2070 (Figures 11 and 12).

All models agree that the region as a whole will see a decrease in the number of cold nights with an average of approximately nine fewer cold nights per year in the near future, ranging from 5–12 nights across the individual models (Figure 10). The decrease in cold nights is projected to be even greater in the far future, with a decrease of 26 nights per year, ranging from 20–33 nights per year (Figure 10).

A decrease in the number of cold nights is projected for all seasons except for summer where there is no change. The decreases are predominantly in winter (Figure 10).

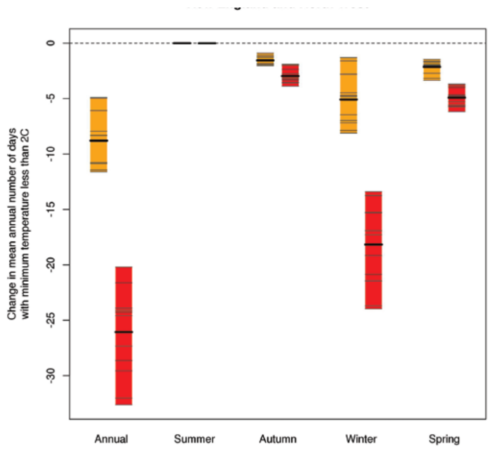


Figure 10: Projected changes in the number of low temperature nights for the New England North West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in number of cold nights (below 2°C) per year

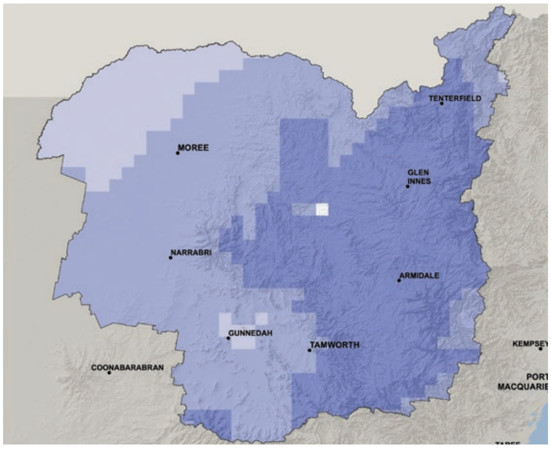
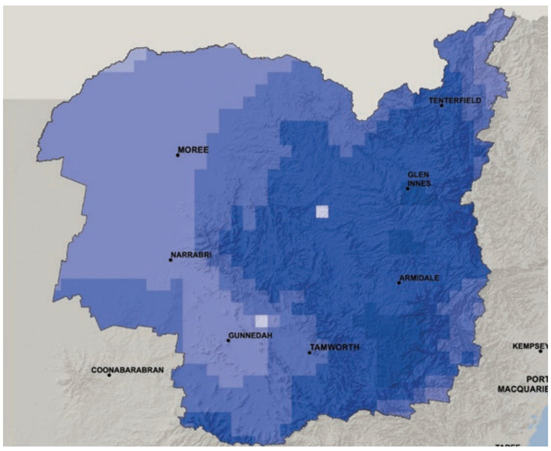


Figure 11: Near future (2020–2039) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Far future change in number of cold nights (below 2°C) per year



New England North West

Change in annual average number of days with temperatures less than 2°C

- -1 – 0
- -5 – -1
- -10 – -5
- -20 – -10
- -30 – -20
- -40 – -30
- < -40

Figure 12: Far future (2060–2079) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Rainfall

Changes in rainfall patterns have the potential for widespread impacts. Seasonal shifts in rainfall can impact native species' reproductive cycles as well as impacting agricultural productivity; for example crops that are reliant on winter rains for peak growth.

Rainfall changes are also associated with changes in the extremes, such as floods and droughts, as well as secondary impacts such as water quality and soil erosion that occur as a result of changes to rainfall intensity.

Modelling rainfall is challenging due to the complexities of the weather systems that generate rain. 'Model agreement', that is the number of models that agree on the direction of change (increasing or decreasing rainfall) is used to determine the confidence in the projected change. The more models that agree, the greater the confidence in the direction of change.

Care should be taken when interpreting changes in rainfall from averaging climate change projections when the model outputs project changes of both wetting and drying. To understand the spread of potential changes in rainfall the bar charts should be considered along with the maps provided in this document.

Rainfall is projected to decrease in winter and to increase in autumn

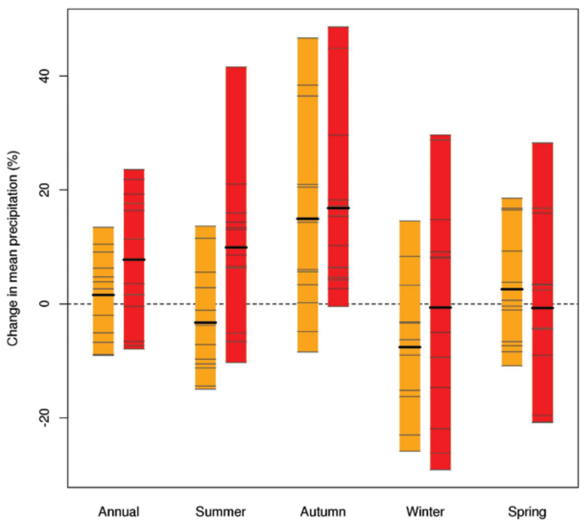


Figure 13: Projected changes in mean rainfall for the New England North West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the New England North West the majority of models (10 out of 12) agree that autumn rainfall will increase in the near future and the far future (Figures 13, 14 and 15).

In the New England North West the majority of models (8 out of 12) agree that winter rainfall will decrease in the near future (Figures 13, 14 and 15).

Summer rainfall is projected to decrease in the near future (8 out of 12 models), however, summer rainfall is projected to increase in the far future (9 out of 12 models) (Figures 13, 14 and 15).

Seasonal rainfall projections for the near future and far future span both drying and wetting scenarios. The range of changes projected in the near future are: summer –15% to +14%, autumn –9% to +47%, winter –26% to +15% and spring –11% to +19%. In the far future the projected range of changes are: summer –10% to +42%, autumn –1% to +49%, winter –29% to +30% and spring –21% to –28% (Figure 13).

Projections for change in annual rainfall also span both drying and wetting scenarios. In the near future the project range of change is –9% to +13% while the range projected for the far future is –8% to +24%.

The region currently experiences considerable rainfall variability across seasons and from year-to-year and this variability is also reflected in the projections.

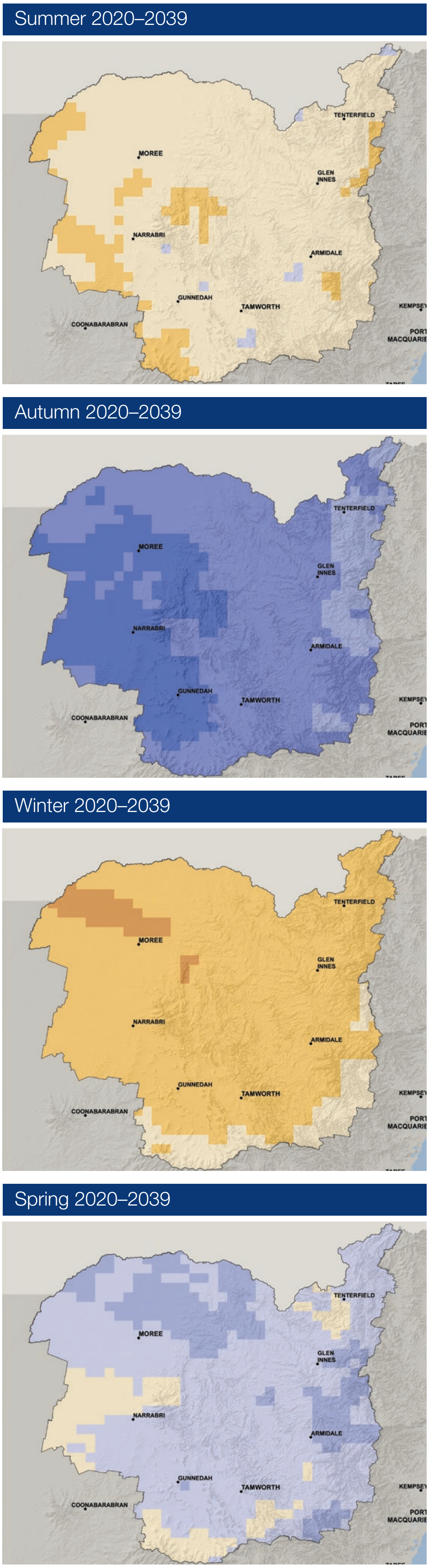


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

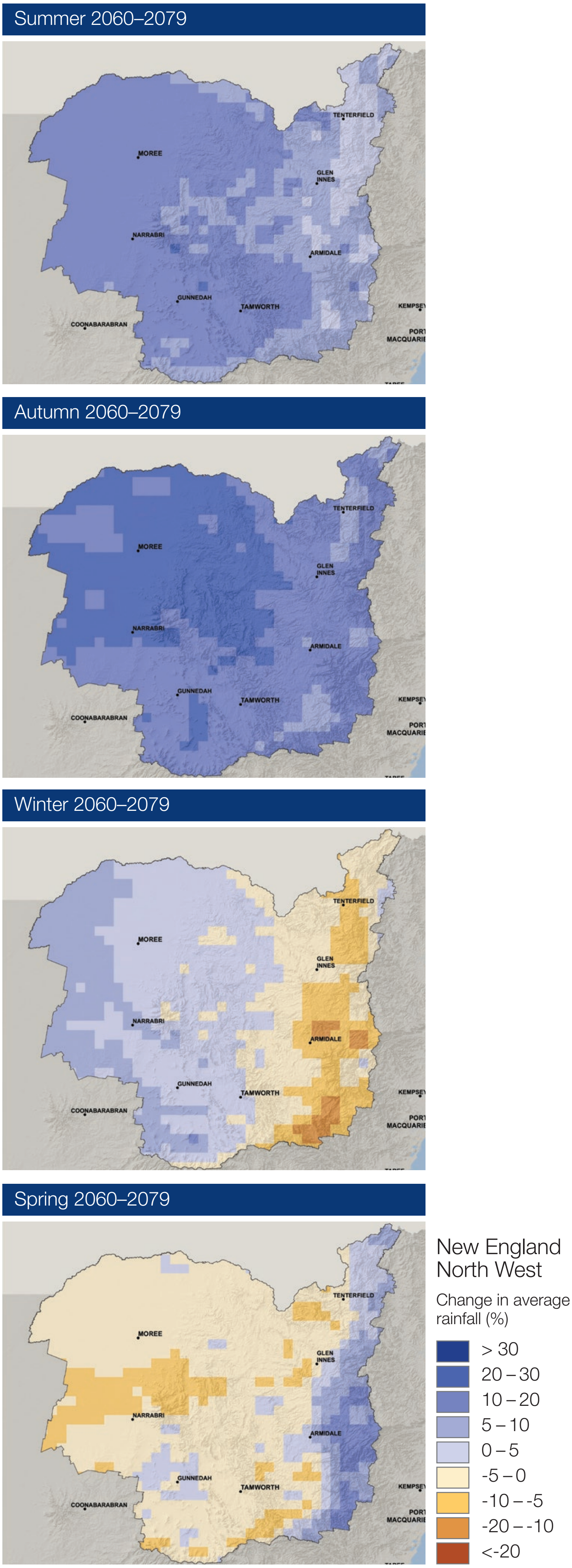


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

Fire weather

The Bureau of Meteorology issues Fire Weather Warnings when the FFDI is forecast to be over 50. High FFDI values are also considered by the Rural Fire Service when declaring a Total Fire Ban.

Average FFDI values are often used to track the status of fire risk. These values can be used when planning for prescribed burns and help fire agencies to better understand the seasonal fire risk. The FFDI is also considered an indication of the consequences of a fire if one was to start – the higher the FFDI value the more dangerous the fire could be.

FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Severe and average FFDI is projected to increase

Severe fire weather in the near future is projected to decrease in autumn

Projected regional climate changes

The New England North West Region is projected to experience an increase in average and severe FFDI values in the near future (2020–2039) and the far future (2060–2079) (Figures 16 and 17).

The greatest increases in severe fire weather are projected in the far west of the region in summer and spring. Although these changes are relatively small in magnitude (up to two more days every years) they are projected to occur in prescribed burning periods (spring) and the peak fire risk season (summer) (Figure 19).

Average fire weather is projected to increase in summer, spring and winter, potentially impacting on prescribed burning periods (spring) and the peak fire risk season (summer) (Figure 18).

Autumn is projected to have a decrease in fire weather (Figure 18 and 19). As fire weather measurements take into account rainfall, it is likely that the decrease in autumn FFDI is due to projected increases in autumn rainfall across the region (compare Figures 14 and 15 with Figures 18 and 19).

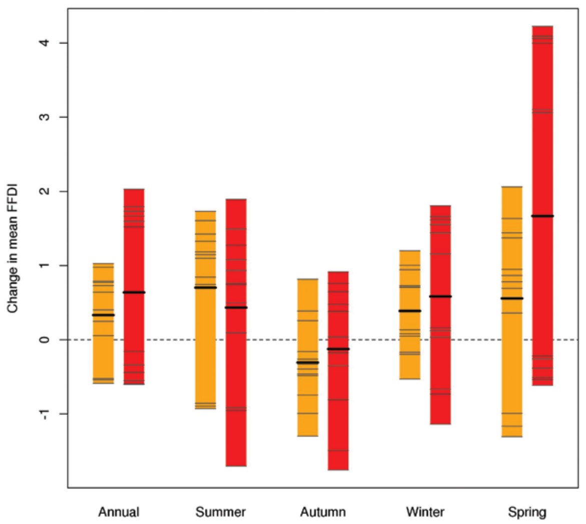


Figure 16: Projected changes in the mean daily forest fire danger index (FFDI) for the New England North West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

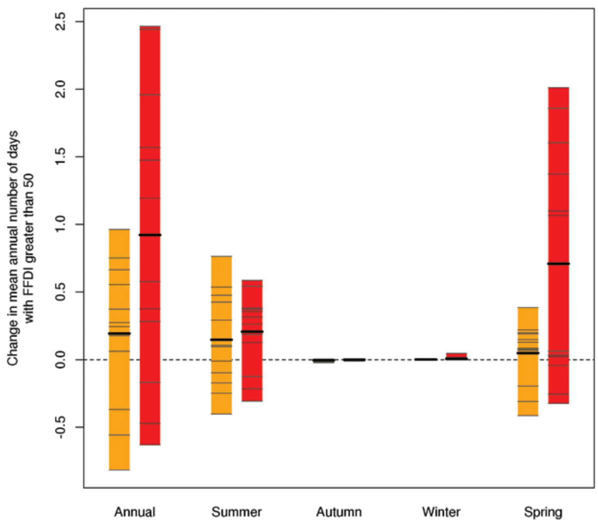


Figure 17: Projected changes in mean annual number of days with a forest fire danger index (FFDI) greater than 50 for the New England North West Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

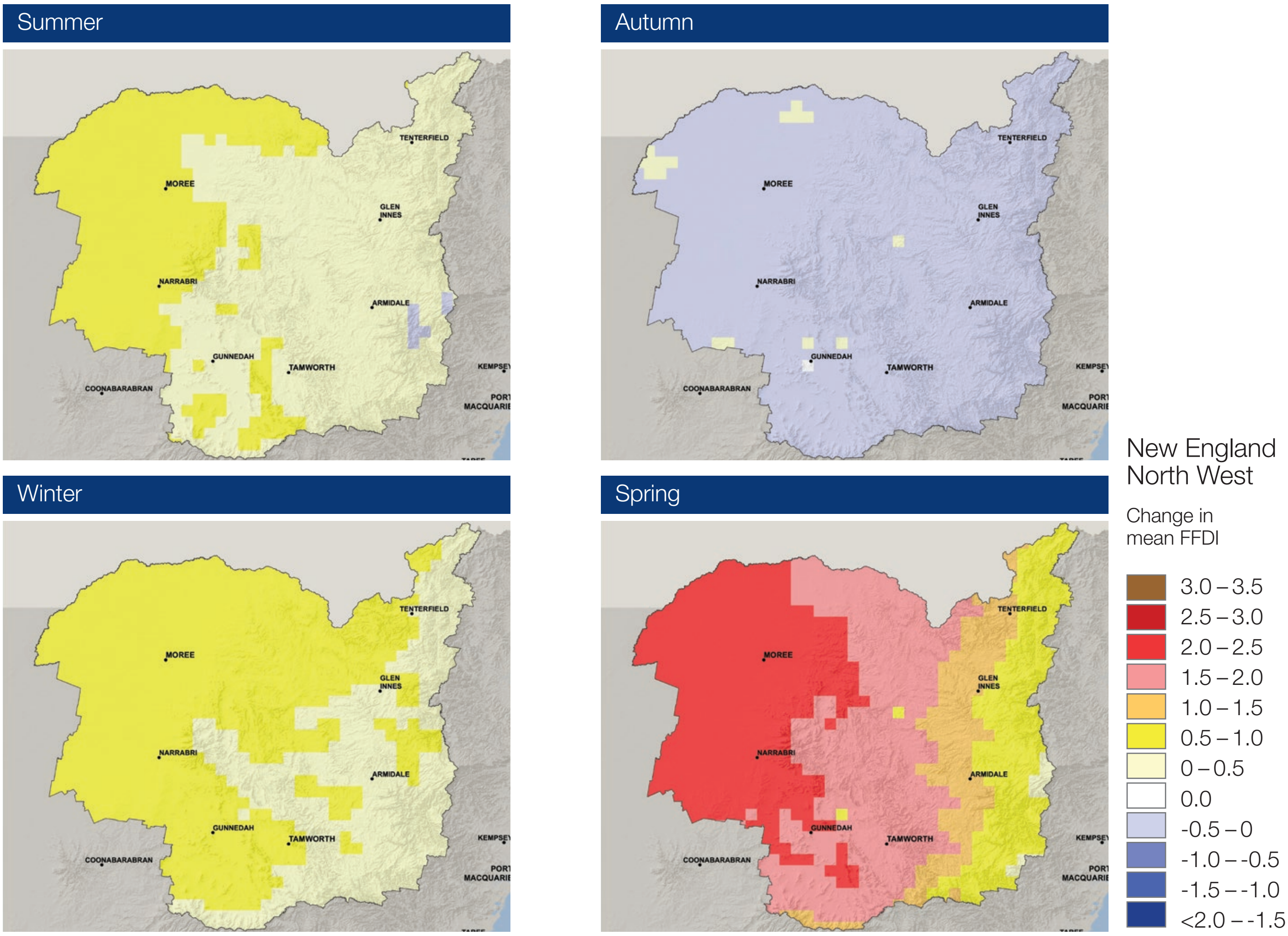


Figure 18: Far future (2060–2079) projected changes in mean daily FFDI, compared to the baseline period (1990–2009).

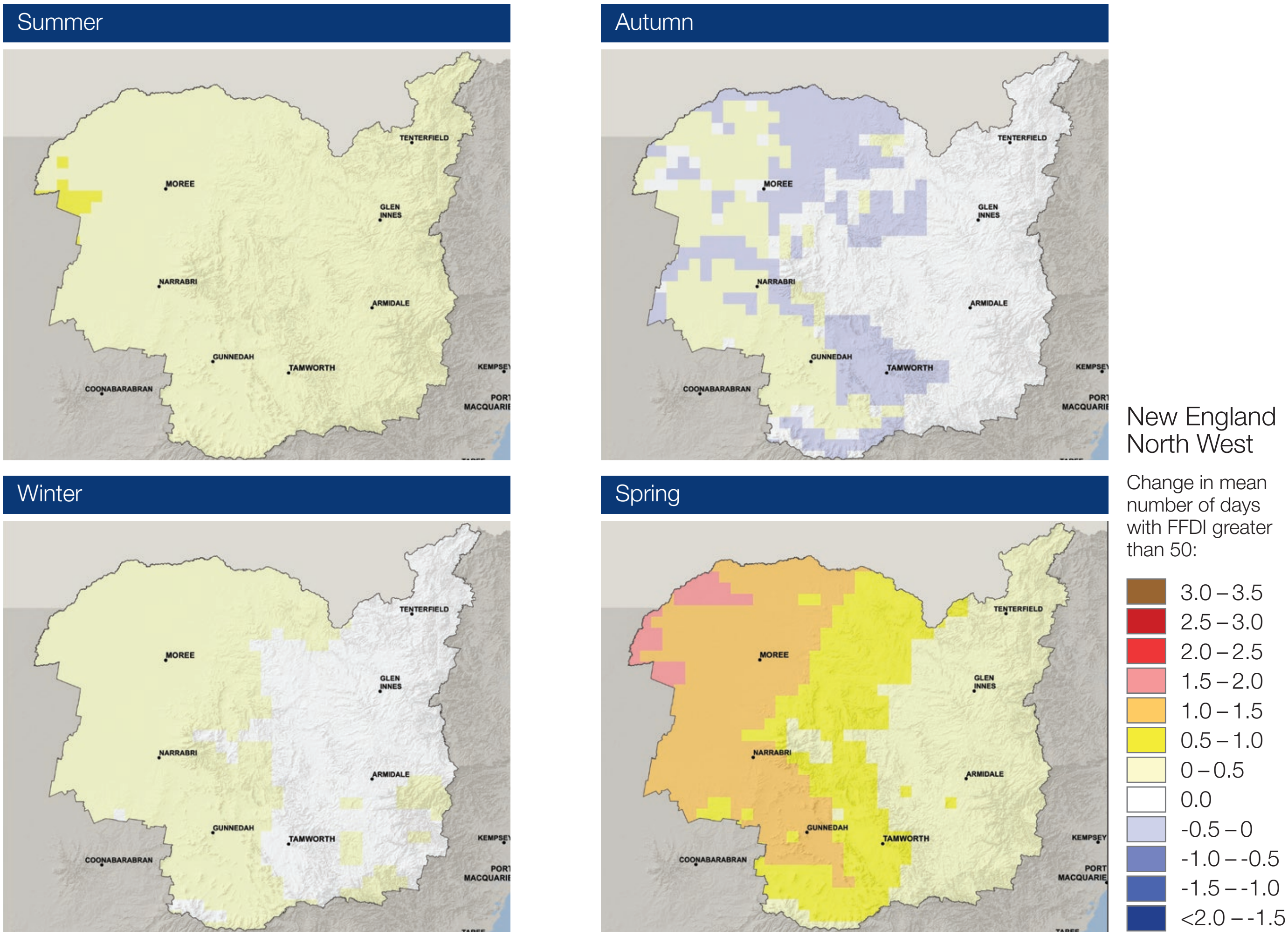


Figure 19: Far future (2060–2079) projected changes in mean annual number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

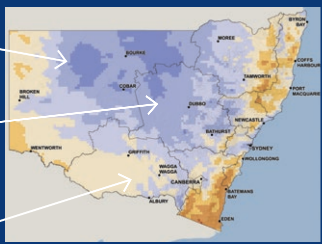
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs also show results from each individual model. See below for more information on what is displayed in the maps and bar graphs.

How to read the maps

The maps display a **10km** grid.

NSW has been divided into State Planning Regions and each region has a Local Snapshot report.

The colour of each grid is the **average of all 12 models** outputs for that grid.



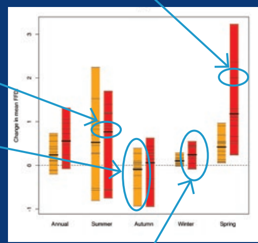
How to read the bar graphs

The thin grey lines are the **individual models**. There are 12 thin lines for each bar.

The thick line is **the average of all 12 models** for the region.

The length of the bar shows the **spread of the 12 model values** for the region

Each line is the **average for** the region. They do not represent a single location in the region.



Note: The yellow bars represent near future scenarios (2020–2039), while the red bars represent far future scenarios (2060–2079).

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