NSW GOVERNMENT

Office of Environment & Heritage

AdaptNSW

Illawarra
Climate change snapshot

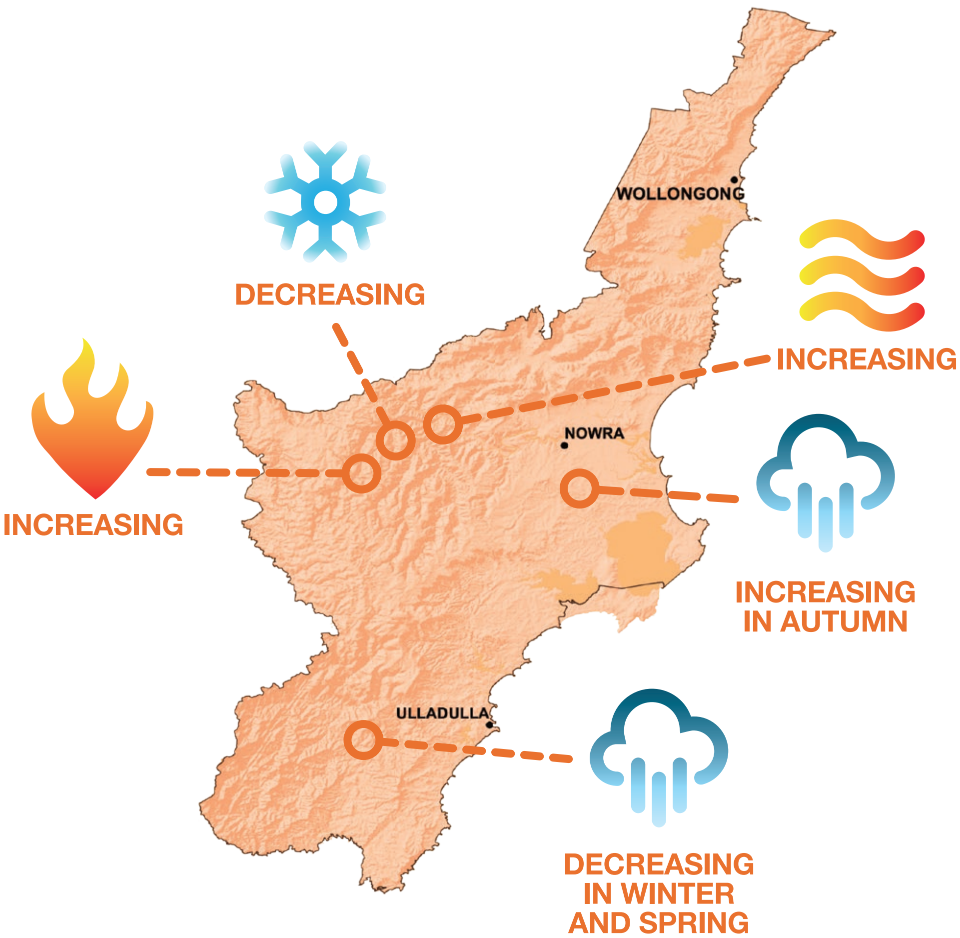
Overview of **Illawarra Region** climate change

Based on long-term (1910–2011) observations, temperatures in the Illawarra Region have been increasing since about 1960, with higher temperatures experienced in recent decades.

The region is projected to continue to warm in the near future (2020–2039) and far future (2060–2079), compared to recent years (1990–2009). The warming is projected to be on average about 0.6°C in the near future, increasing to about 1.9°C in the far future. The number of hot days is projected to increase, with fewer potential frost risk days anticipated in parts of the region.

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.

Projected changes



Projected **temperature** changes	
Maximum temperatures are projected to increase in the near future by 0.4 – 0.9°C	Maximum temperatures are projected to increase in the far future by 1.6 – 2.3°C
Minimum temperatures are projected to increase in the near future by 0.4 – 0.7°C	Minimum temperatures are projected to increase in the far future by 1.5 – 2.4°C
The number of hot days will increase	The number of cold nights will decrease
Projected rainfall changes	
Rainfall is projected to decrease in winter	Rainfall is projected to increase in summer and autumn
Projected Forest Fire Danger Index (FFDI) changes	
Average fire weather is projected to increase in spring	Severe fire weather is projected to increase in summer and spring in the far future

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 Illawarra and Shoalhaven regions 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 Illawarra and Shoalhaven region on the NSW coast south of Sydney covers over 7000 km^2 and has about 200 km of coastline. It stretches from Garie Beach in the Royal National Park in the north to Durras Lake in the south. The coastline is characterised by long sandy beaches, rivers, large protected estuaries and small coastal embayments protected by large sandstone headlands – much of which is Hawkesbury sandstone.

The coastal plain is clearly delineated from the rolling hills of the Southern Tablelands in the west, by the sharp rise of the Illawarra Escarpment, which stretches 120 km from the sea cliffs of the Royal National Park in the north to the junction of the Shoalhaven and Kangaroo rivers in the south. The escarpment rises from 300 m above sea level in the north to 700 m in the south around Albion Park.

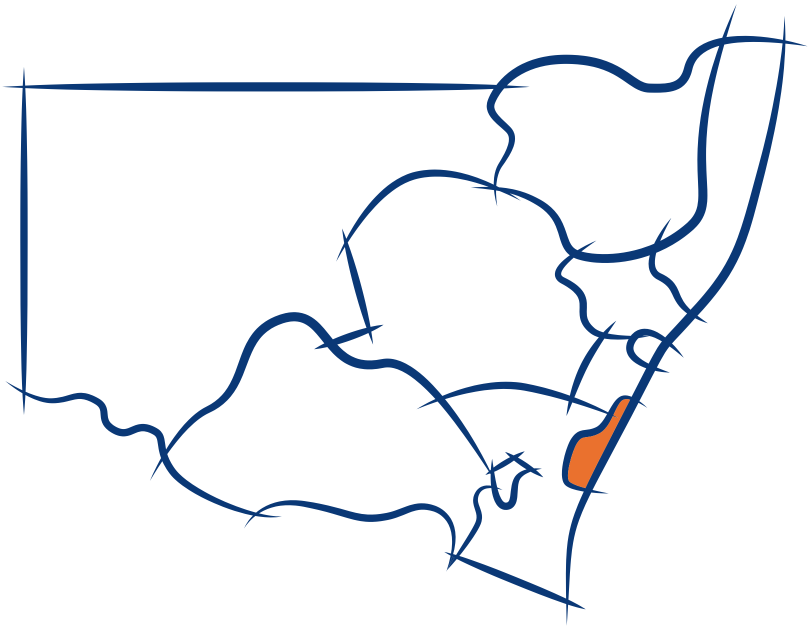
Natural ecosystems

In the north of the region, the natural ecosystems tend to be concentrated along the escarpment and sandstone plateau. Rainforests and tall eucalypt forest occur along the Illawarra Escarpment and in sheltered gorges. The sandstone plateau is largely covered in dry sclerophyll forest, interspersed with smaller patches of heath and upland swamps. Major reserves in these parts include Budderoo National Park, Barren Grounds Nature Reserve and the Illawarra Escarpment State Conservation Area.

In the southern half of the region, the escarpment and plateau forests and heaths are complemented by the diverse tall open forests of the coastal plain. Major reserves in this part include Morton, Budawang, Murramarang, Conjola and Jervis Bay national parks. The Shoalhaven River is the largest river in the region. Jervis Bay is well known for its spectacular scenery and rich coastal waters. There are numerous smaller estuaries and coastal lakes, varying in size from the large Lake Illawarra to the small Meroo Lake, and numerous creeks, many of which rise on the steep escarpment. Saline wetlands are found in all of the major estuaries, particularly the Crookhaven River. Freshwater wetlands occur around the margins of coastal lakes, on coastal sand plains and on the floodplains of the major rivers such as the Shoalhaven.

Population and settlements

The city of Wollongong and major centres of Nowra and Kiama are the commercial and retail hubs for the population of approximately 384,100 residents of the region. The major employers of the approximately 153,000 strong work force include hospitality, educational services and retail. The region is also well known for tourism, fisheries and primary industries, and international trade and steel production conducted at Port Kembla.



Climate of the region

The proximity of the region to the coast and its topography results in a considerable variation in climate conditions. The region has a mostly cool temperate climate, with an average annual rainfall or around 1100 mm. Rainfall is nearly uniformly distributed throughout the year with slightly more rain in summer and autumn. The highest rainfall occurs to the east of the escarpment inland from Kiama, with an average annual rainfall of around 1600 mm. Summers are mild throughout most of the region, with winters cool closer to the Southern Highlands.

Temperature

In summer average temperatures range from 20–22°C along the coast, and 18–20°C on the escarpment and close to the Southern Highlands. In winter, temperatures range from 4–6°C in the higher parts of the Morton National Park in the south-west, to 12–14°C along the coast.

Average maximum temperatures during summer range from 26–28°C inland along the Shoalhaven River to 22–24°C in elevated areas along the escarpment and the south-west. In winter, the average minimum temperature ranges from 0–2°C along the higher parts of Morton National Park to 8–10°C along much of the coast. Minimum temperatures in winter decrease as you move away from the coast, while summer maximum temperatures are more uniform across the region.

Temperatures have been increasing since the 1960s, with higher temperatures experienced in 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

On average, the Illawarra Region experiences fewer than 10 hot days per year (maximum daily temperatures greater than 35°C).

Cold nights

The number of cold nights (minimum temperatures less than 2°C) increases away from the coast. There are very few cold nights along the coast but up to 50 cold nights per year inland along the escarpment.

Rainfall

Rainfall varies considerably across the region. This variability is due to the complex interactions between weather patterns in the region, the influence of larger-scale climate patterns such as El Niño Southern Oscillation, the complex terrain of the region and the proximity to the coast.

The northern parts of the region generally receive more rainfall, with annual rainfall of up to 1600 mm occurring in some areas near Kiama. The coastal areas typically receive around 1200 mm of rainfall per year, with less rainfall inland in the Shoalhaven. Rainfall is fairly uniform throughout the year but is usually higher in autumn and summer.

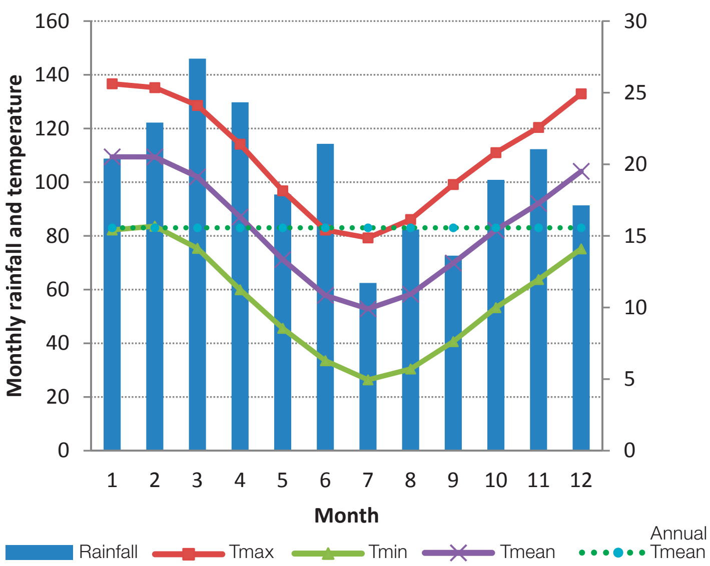
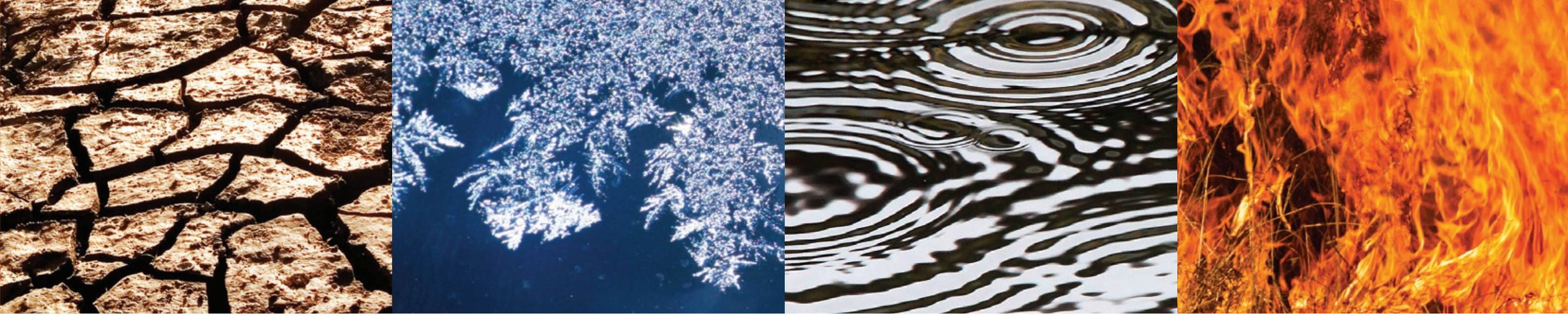


Figure 1: Seasonal rainfall and temperature variations (AWAP[1] data for 1960–1991).

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



The region has experienced considerable rainfall variability in the past with periods of both wetter and drier conditions. During much of the first half of the 20th century the region experienced drier conditions. The first decade of the 21st century saw a long period of below average rainfall during the Millennium Drought. This dry period ended with two of the wettest years on record for Australia (2010-2011), with 2010 being the third wettest year on record for NSW.

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). Although these stations are spread fairly evenly across the state, there are no stations in alpine regions.

FFDI estimates are available for one station in the region, Nowra where the annual average FFDI over the period 1990–2009 was 5.2. The highest average FFDI occurs in spring and the lowest in autumn and 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 one day per year at Nowra, and are more likely to occur in summer and spring.

Average FFDI					
Station	Annual	Summer	Autumn	Winter	Spring
Nowra	5.2	5.6	4.3	4.4	6.6
Number of severe fire weather days (FFDI>50)					
Nowra	1.1	0.6	0	0	0.5

Table 1: Baseline FFDI values for meteorological stations within the Illawarra 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 Illawarra 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 1.9°C

Minimum temperatures are projected to increase by near future by 0.6°C

Minimum temperatures are projected to increase by far future by 2.0°C

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

Projected regional climate changes

The region 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 projected to increase by 0.7°C in the near future and by 1.9°C in the far future (Figure 2b). Spring will experience the greatest changes in maximum temperatures with maximum temperatures increasing by 2.2°C in the far future (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 0.6°C in the near future and by 2° 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 1950, with the largest increase in temperature variables coming in the most recent decades.

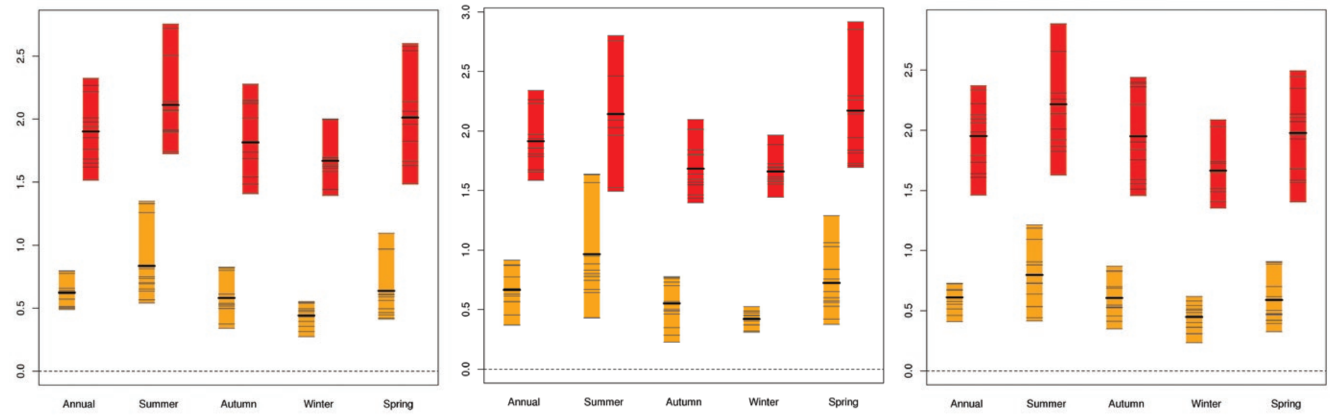


Figure 2: Projected air temperature changes for the Illawarra Region, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

Near future change in maximum temperature

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

Far future change in maximum temperature

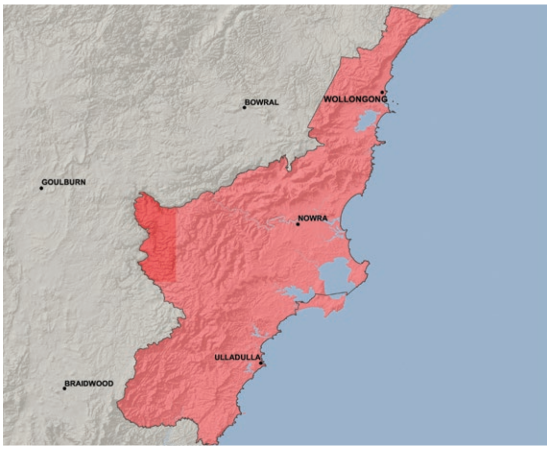


Figure 4: Far future (2060–2079) change in annual average maximum temperature, compared to the baseline period (1990–2009).

Near future change in minimum temperature

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

Far future change in minimum temperature

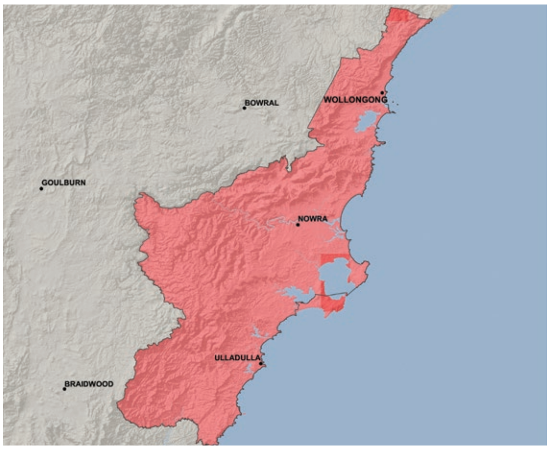


Figure 6: Far future (2060–2079) change in annual average minimum temperature, compared to the baseline period (1990–2009).

Illawarra

Change in annual average daily temperature (°C)

- 2.5 – 3.0
- 2.0 – 2.5
- 1.5 – 2.0
- 1.0 – 1.5
- 0.5 – 1.0
- 0.0 – 0.5

Hot days

DAYS PER YEAR ABOVE 35°C

Currently the Illawarra and Shoalhaven experience an average of fewer than 10 hot days 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

All models agree that the region is expected to experience more hot days in the near future and the far future (Figure 7).

The greatest increase is projected west of Nowra with an additional 1–5 hot days per year in the near future and 5–10 extra hot days per year by 2070 (Figures 8 and 9).

The region, on average, is projected to experience an additional two hot days in the near future (0–3 days per year across the 12 models) up to five days in the far future, (2–7 days per year across the 12 models) (Figure 7).

These increases are being seen mainly in spring and summer although in the far future hot days are also extending into autumn (Figure 7).

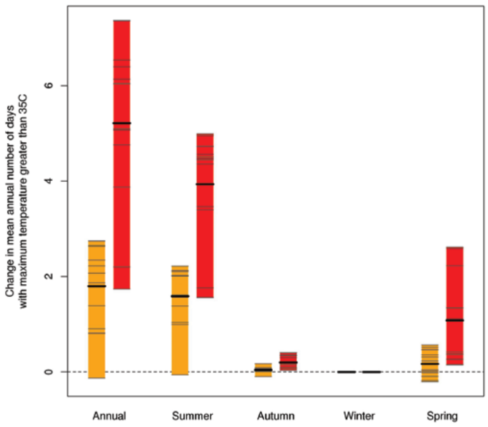


Figure 7: Projected changes in the number of hot days (with daily maximum temperature of above 35°C) for the Illawarra Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

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

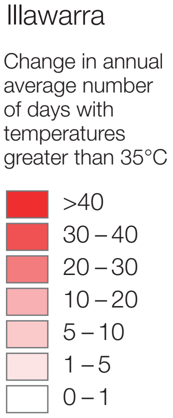
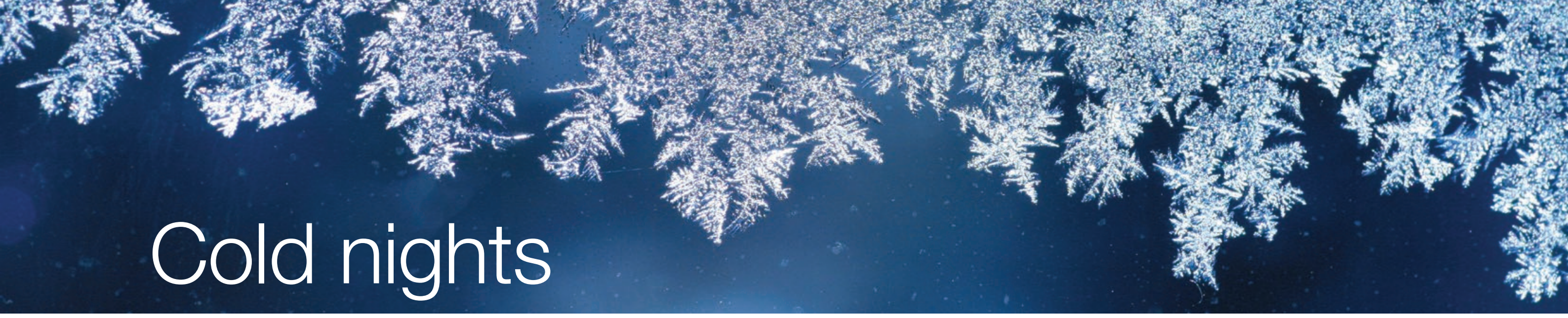


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.



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 Illawarra and Shoalhaven are expected to experience fewer cold days in the near future and the far future (Figure 10).

The decrease in cold nights is greatest away from the coast, along the escarpment. Along the higher parts of Morton National Park there are projected to be 10-20 fewer cold nights in the near future and 20–30 fewer cold nights by 2070. There are no changes projected for coastal areas (Figures 11 and 12).

All models agree with a decrease in the number of cold nights. The average decrease across the region is four nights per year in the near future, (ranging from 3–6 nights across the individual models). The average decrease across the region is projected to be even greater in the far future, with an average decrease of 11 nights per year (ranging from 10–13 nights across the individual models) (Figure 12).

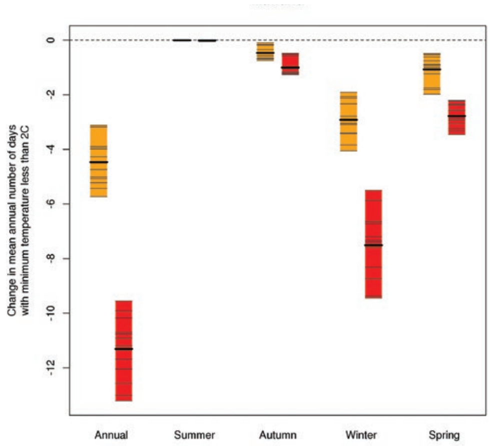


Figure 10: Projected changes in the number of low temperature nights for the Illawarra, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

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

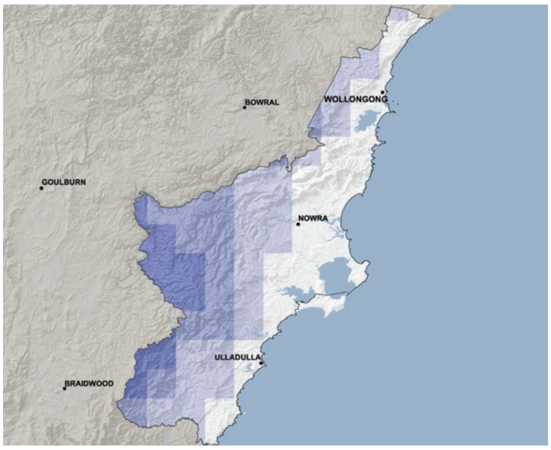


Figure 11: Near future (2020–2039) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009)

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

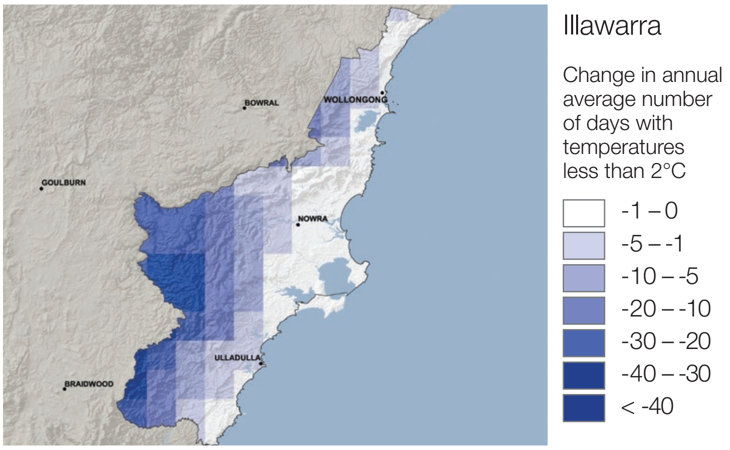


Figure 12: Far future (2060–2079) change in the number of days per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009)

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 spring and to increase in autumn

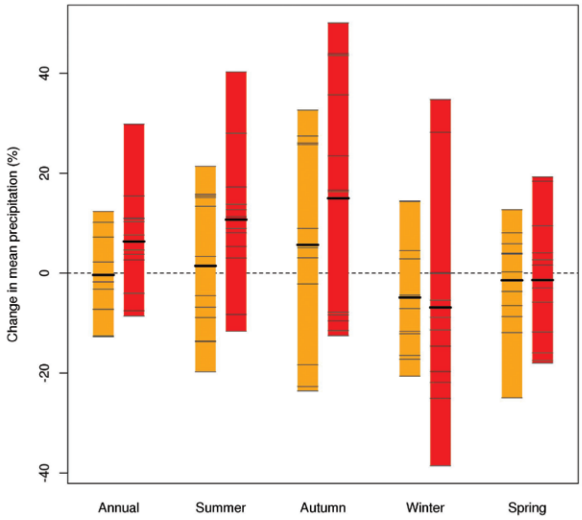


Figure 13: Projected changes in average rainfall for the Illawarra Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

Projected regional climate changes

In the region the majority of models (7 out of 12) agree that spring rainfall will decrease in the near future (Figure 13). Changes to spring rainfall in the far future are less clear.

The majority of models (8 out of 12) agree that autumn rainfall will increase and in the near and far future (7 out of 12 models) (Figure 13).

The majority of models (10 out of 12) also agree that summer rainfall will increase in the near future, but changes in the far future are less clear.

The majority of models project a decrease in winter rainfall in the near future (8 out of 12) and the far future (9 out of 12).

The greatest reduction in rainfall is projected in the south-west of the region in winter. Autumn increases are relatively uniform across the region (Figures 14 and 15).

Seasonal rainfall projections for the near and far futures span both drying and wetting scenarios. In the near future the changes are: summer –20% to +21%, autumn –24% to +33%, winter –21% to +14%, and spring –25% to +13%. In the far future the changes are: summer –12% to +40%, autumn –13% to +50%, winter –39% to +35%, and spring –18% to +19% (Figure 14 and 15).

Projections for the region's annual average rainfall range from a decrease (drying) of 13% to an increase (wetting) of 12% by 2030 and still span both drying and wetting scenarios (–9% to +30%) by 2070.

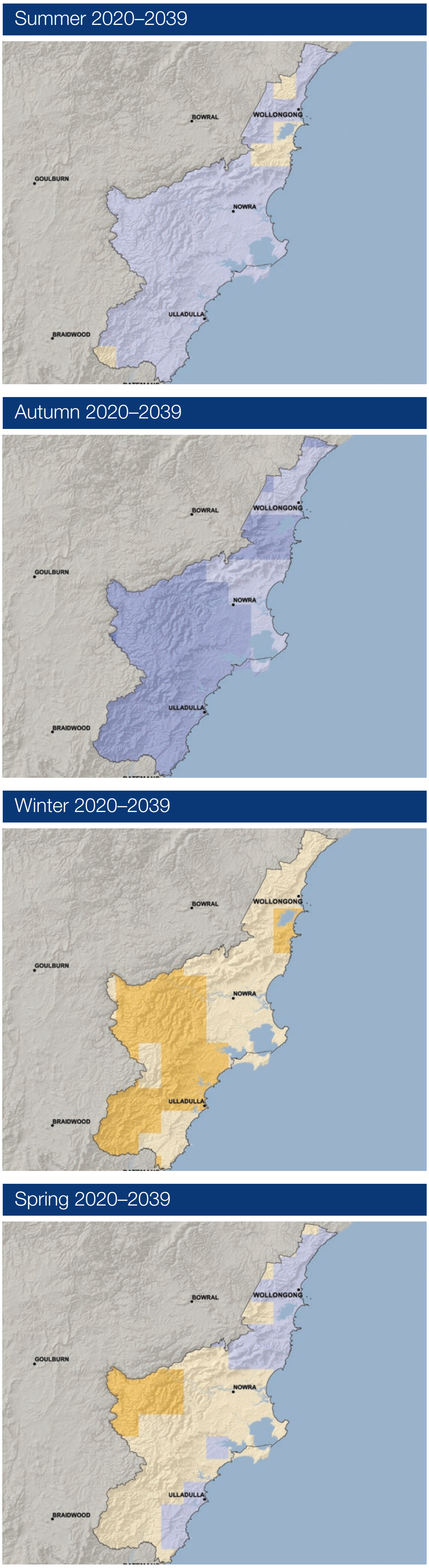


Figure 14: Near future (2020–2039) projected changes in average rainfall by season.

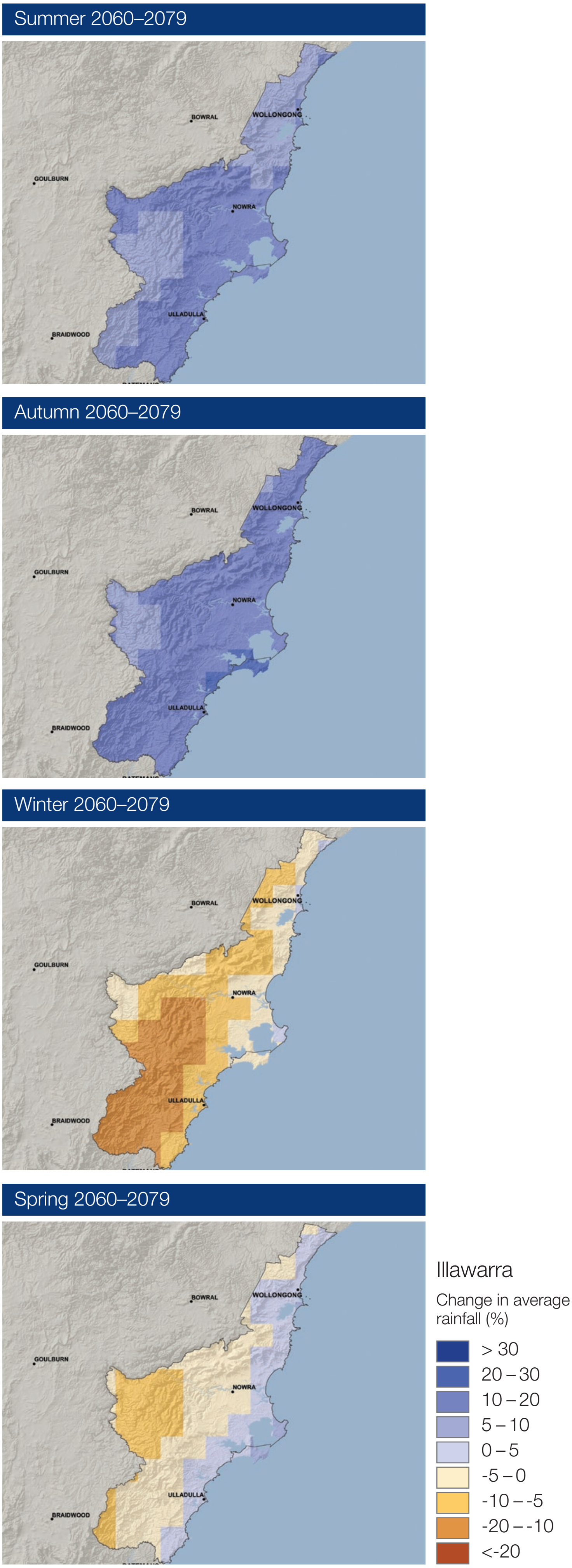


Figure 15: Far future (2060–2079) projected changes in average rainfall by season.

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.

Projected regional climate changes

The region is projected to experience an increase in average and severe fire weather in the near future and the far future (Figures 16 and 17).

Increases in severe fire weather are projected mainly in spring and summer in the far future. These changes are relatively small in magnitude (up to 1 more day per year) but they are projected in prescribed burning periods (spring) and peak fire risk season (summer) (Figure 19).

Average fire weather is projected to increase in spring and winter. The western part of the region is projected to experience the greatest increase in spring by 2070 (Figure 18).

Summer is projected to show a slight increase in average fire weather in the near future but it may decrease in the far future. Spring is projected to show a slight increase in fire weather in both the near and far futures.

Autumn is projected to have a decrease in severe fire risk (Figure 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 14,15 with Figures 18 and 19).

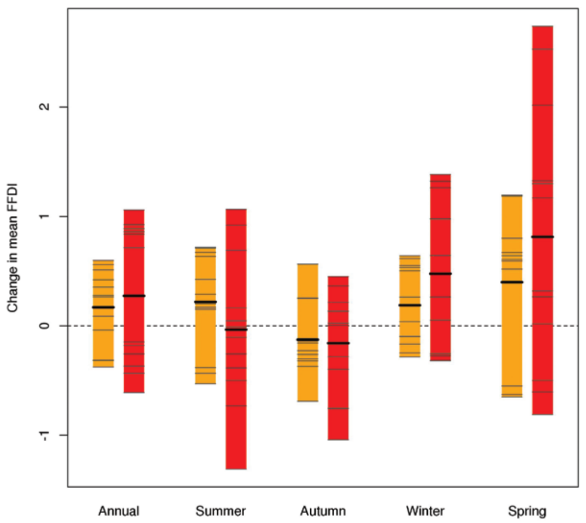


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the Illawarra Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

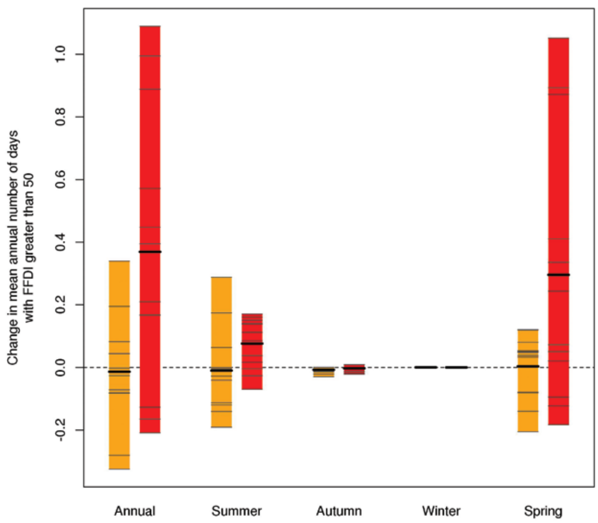


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the Illawarra Region, annually and by season (2030 yellow; 2070 red).

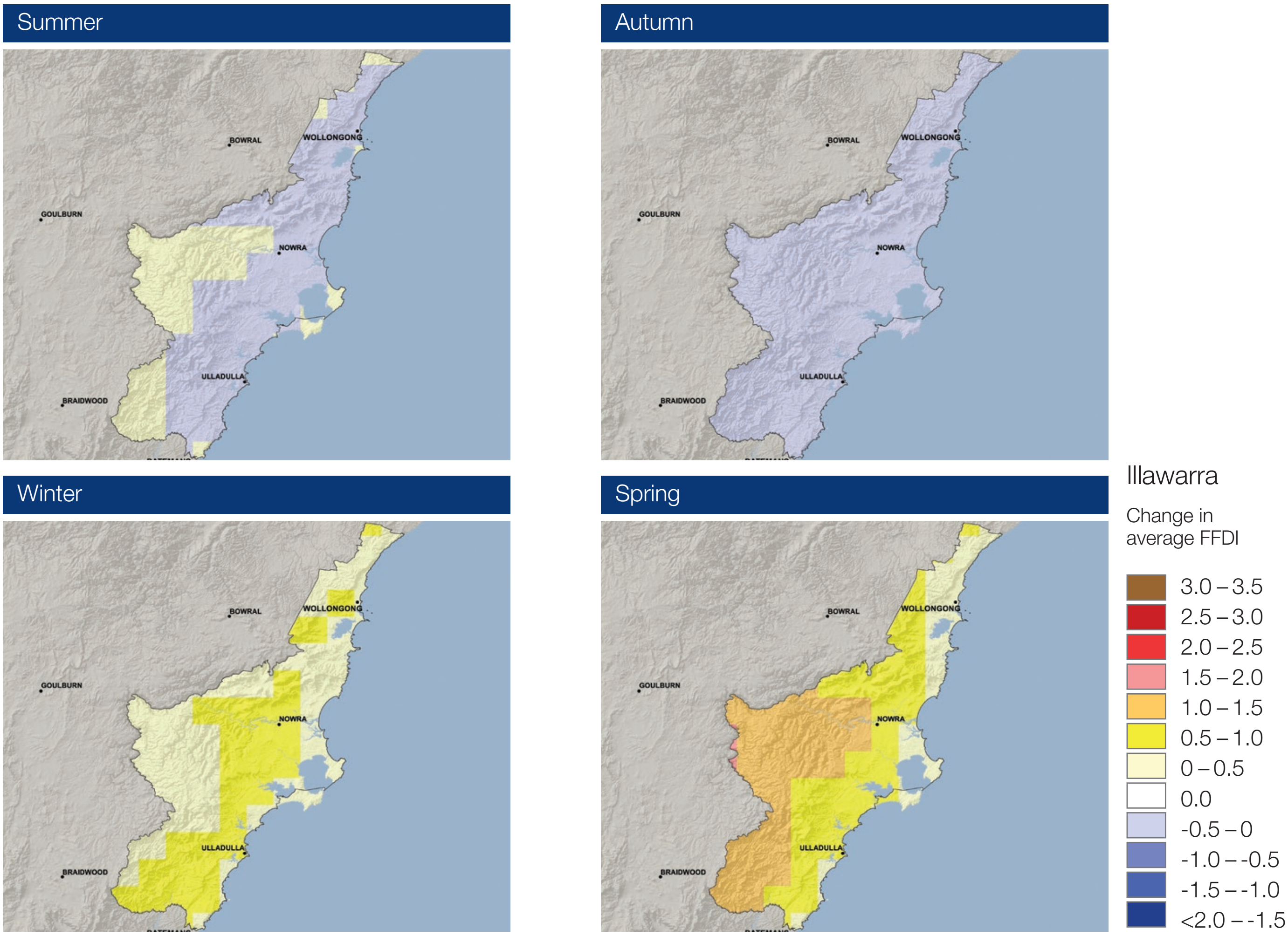


Figure 18: Far future (2060–2079) projected changes in average daily FFDI, compared to the baseline period (1990–2009).

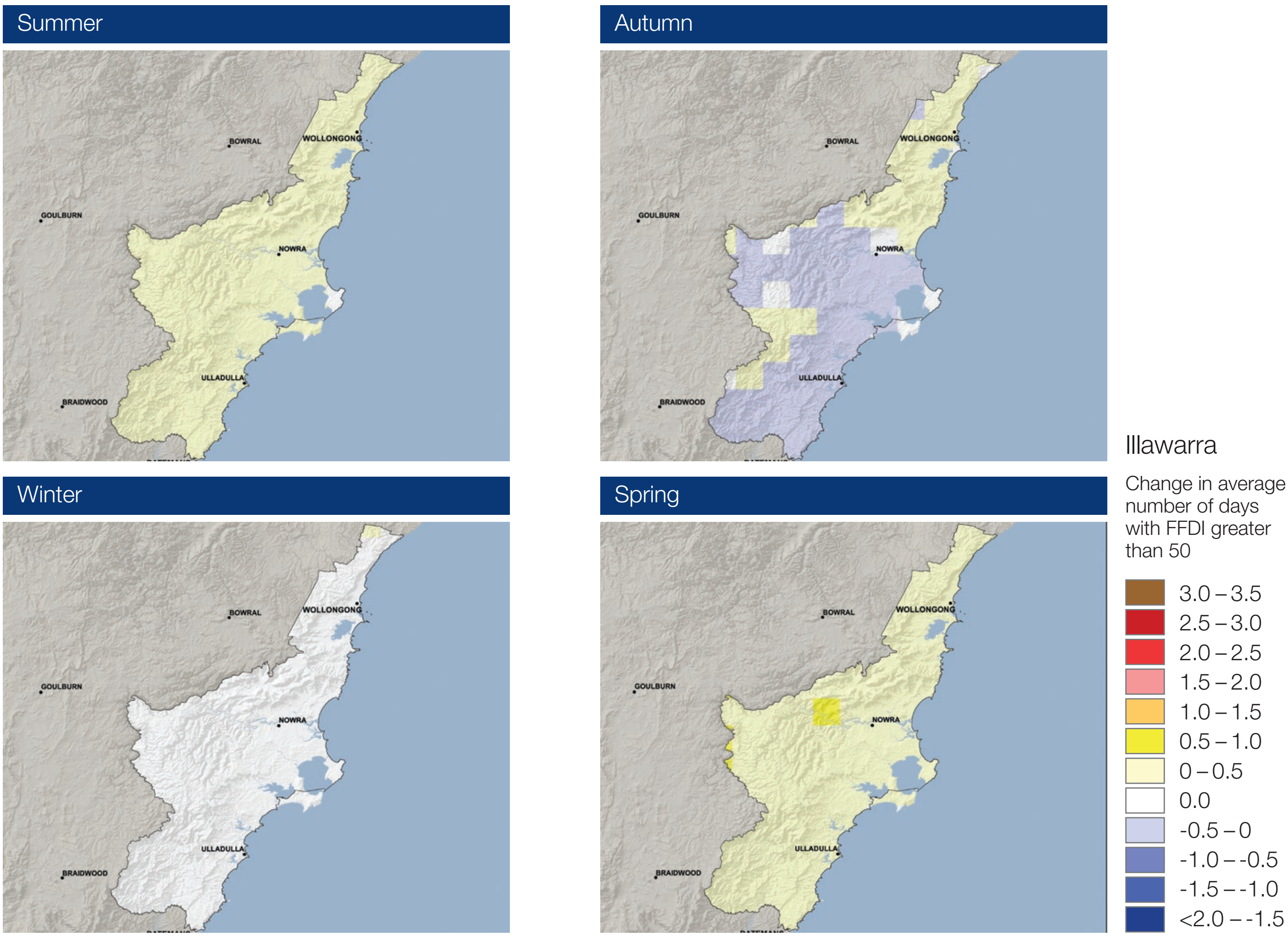


Figure 19: Far future (2060–2079) projected changes in average annual number of days with a FFDI greater than 50, compared to the baseline period (1990–2009).

Appendix 1 Guide to reading the maps and graphs

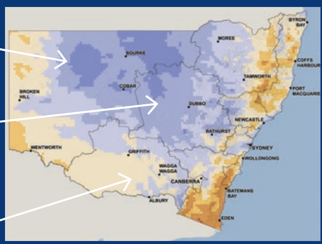
This document contains maps and bar graphs of the climate change projections. The maps present the results of the twelve models as an average of all twelve models. The bar graphs show projections averaged across the entire state and do not represent any particular location within the state. The bar graphs 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.



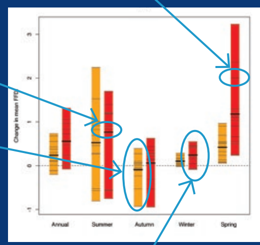
How to read the bar graphs

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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