

CLIMATE PROFILE

GLOUCESTER SHIRE COUNCIL LOCAL GOVERNMENT AREA

Introduction

The Gloucester Shire Council Local Government Area (LGA) covers an area of 2,952 square kilometres and includes a population of approximately 5,000 people. The LGA is home to the world heritage listed Barrington Tops National Park. Key economic drivers include agriculture (including beef, dairy and agribusines), eco-tourism, coal mining and timber.¹

Gloucester and the broader region is well known for its historic climate variability and extremes. Weather patterns and cycles of this nature have significantly raised community awareness of climate variability and the potential impacts of climate change. This profile aims to further increase understanding in these areas.

The information included in this profile has been sourced from research completed by the University of Newcastle and Macquarie University on behalf of the Hunter and Central Coast Regional Environmental Management Strategy (HCCREMS).

The profile provides an overview of the key results that have been produced by this research and the process by which they were generated. In particular, it provides the results of analysis of both historical climate variability and projected climate change as it relates specifically to the Gloucester LGA.



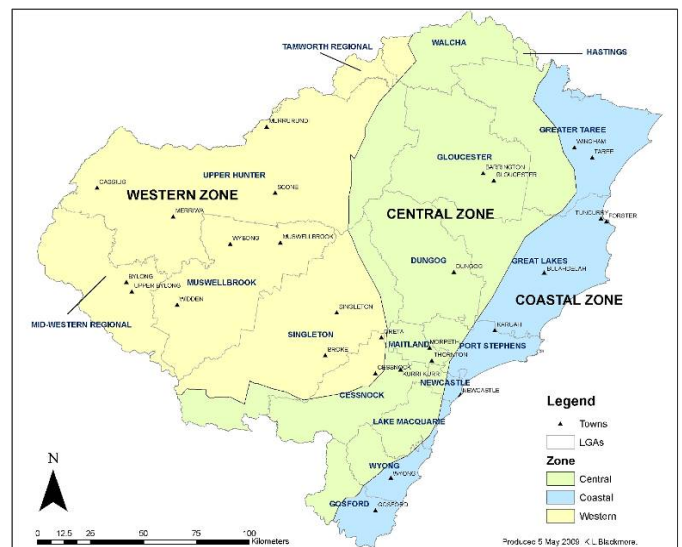
Climate Zones

A key element of the research was the identification of three climate zones for the Hunter, Central and Lower North Coast region. This was achieved through a process known as climate zonation; a statistical process which divides a region into distinct sub-regions or zones where climatic similarity is maximised within zones and minimised between zones.

Twelve synoptic patterns that “drive” climate variability in the region were also identified and a comprehensive review of climate history and an analysis of this variability was completed. This confirmed a relationship between historic climate patterns and these synoptic ‘weather drivers’ in each climate zone.

The CSIRO Global Climate Model (Mk3.5) was then used to identify projected changes in the 12 synoptic types for time periods of 2020-2040, 2040-2060 and 2060-2080. Projections were based on the A2F1 emissions scenario. Because of the strong historical relationship that exists between these synoptic types and weather patterns in the region, these changes could then be used to project changes in climate for each of the three climate zones. Full details of the methodology used are available at www.hccrems.com.au.

The climate zones that have been identified for the region are shown below. The results generated for the central zone underpin this climate profile for the Gloucester LGA.

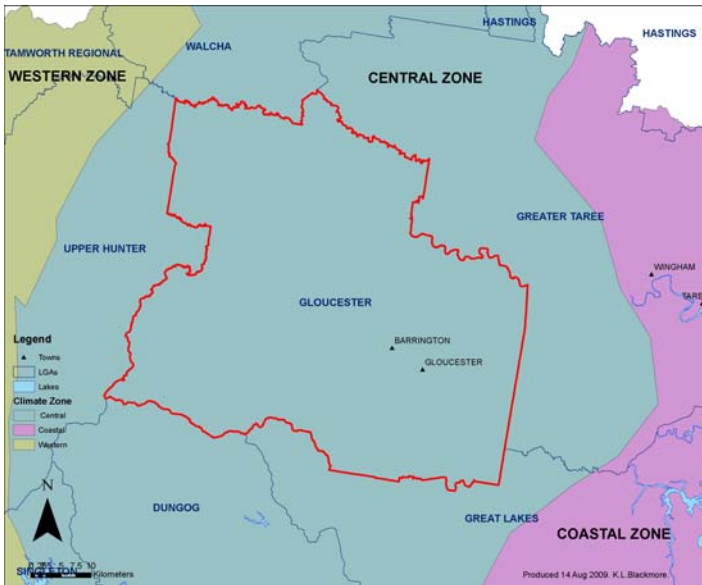


Climate zones within the Region



Gloucester Shire Council LGA

The Gloucester Shire Council LGA lies entirely within the central climate zone. Projected changes in climate for this zone are therefore relevant to the area.



Climate zones - Gloucester Shire Council LGA

Results

The following results provide both an historical analysis and future projections for a range of climate variables in the central climate zone. These include rainfall, temperature (minimum, maximum and average annual), humidity, pan evaporation, water balance, wind and extreme events.

Historic trends are analysed for significance using regression analysis. An asterisk (*) is used to identify trends that are found to be statistically significant. The length of historic data used to analyse trends varies according to data available for each variable.

Projections are provided for the period 2020-2040, 2040-2060 and 2060-2080. Where minimal change between these periods is identified, projections are provided for the entire 2020-2080 period. Projected values are relative to the average historic recorded values for each climate parameter. The length of the relative historic period is determined by the availability and quality of historic data.

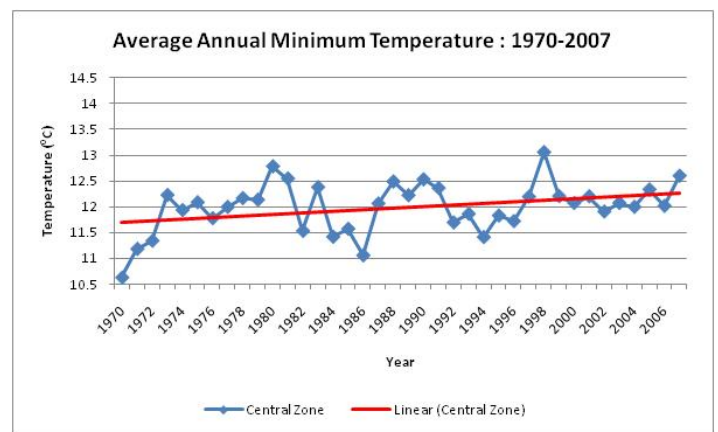
MINIMUM TEMPERATURE

Historical analysis: minimum temperature

Historically, the Gloucester LGA has experienced a statistically significant annual increase in average minimum temperature of $\sim 0.6^{\circ}\text{C}$ between 1970-2007. More detailed seasonal changes are summarised below.

| Minimum temperature (1970-2007) | | | | |
|---------------------------------|---|---|---|---|
| Zone | Summer | Autumn | Winter | Spring |
| Central | Warmer: $\sim 0.3^{\circ}\text{C}$ increase | Warmer: $\sim 0.5^{\circ}\text{C}$ increase | Warmer: $\sim 0.5^{\circ}\text{C}$ increase | Warmer: $\sim 0.9^{\circ}\text{C}^*$ increase |

* Statistically significant



Trend in average minimum temperature

Projected changes: minimum temperature

Generally, it is projected that the Gloucester Shire Council LGA is likely to experience warmer average minimum temperatures during autumn and winter, with summer minimums expected to decrease along with a slight decrease during spring. Projected increases during autumn and winter are greater than the projected decreases for summer and spring and thus an overall increase in annual average minimum temperatures is projected.

| Minimum temperature (2020-2080) | | | | |
|---|---|---|---|---|
| <i>Projected changes are relative to the 1970-2007 period</i> | | | | |
| Zone | Summer | Autumn | Winter | Spring |
| Central | Cooler: $\sim 0.8^{\circ}\text{C}$ decrease | Warmer: $\sim 1.5^{\circ}\text{C}$ increase | Warmer: $\sim 1.2^{\circ}\text{C}$ increase | Cooler: $\sim 0.2^{\circ}\text{C}$ decrease |

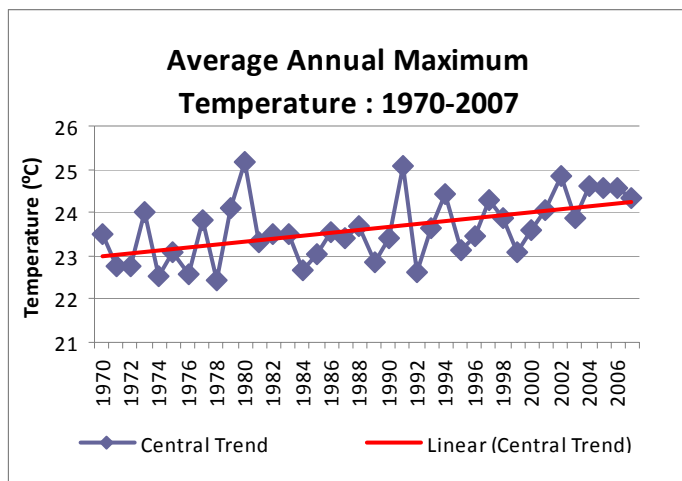
MAXIMUM TEMPERATURE

Historical analysis: maximum temperature

Historically the Gloucester LGA has experienced a statistically significant annual increase in average maximum temperatures of ~1.2°C. More detailed seasonal changes are summarised below.

| Maximum temperature (1970-2007) | | | | |
|---------------------------------|-------------------------|-------------------------|--------------------------|--------------------------|
| Zone | Summer | Autumn | Winter | Spring |
| Central | Warmer: ~1.6°C increase | Warmer: ~0.8°C increase | Warmer: ~1.0°C* increase | Warmer: ~1.7°C* increase |

* Statistically significant



Trend in annual average maximum temperature

Projected changes: maximum temperature

Maximum temperatures are projected to continue to increase in the Gloucester Shire during autumn and winter. Similar or slightly cooler average maximum temperatures are projected to occur during summer and spring. More detailed seasonal projections are summarised below.

| Maximum temperature (2020-2080) | | | | |
|---|-----------------------|-------------------------|-------------------------|-------------------------|
| <i>Projected changes are relative to the 1970-2007 period</i> | | | | |
| Zone | Summer | Autumn | Winter | Spring |
| Central | No significant change | Warmer: ~1.8°C increase | Warmer: ~1.6°C increase | Cooler: ~1.3°C decrease |

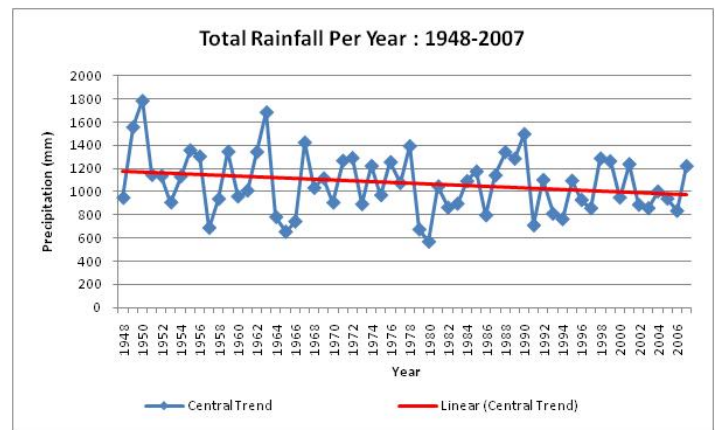
RAINFALL

Historical analysis: rainfall

Historically, the Gloucester LGA has experienced a statistically insignificant decrease in annual rainfall of ~196mm over the period from 1948-2007. More detailed seasonal changes are summarised below.

| Rainfall (1948-2007) | | | | |
|----------------------|------------------------|-----------------------|------------------------|------------------------|
| Zone | Summer | Autumn | Winter | Spring |
| Central | Drier: ~43mm* decrease | Wetter: ~9mm increase | Drier: ~43mm* decrease | Wetter: ~10mm increase |

* Statistically significant

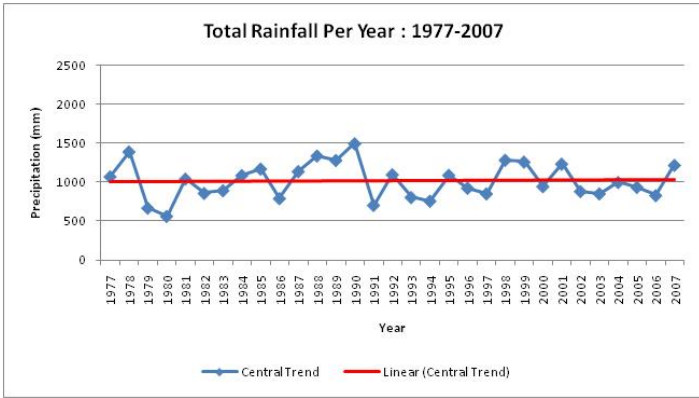
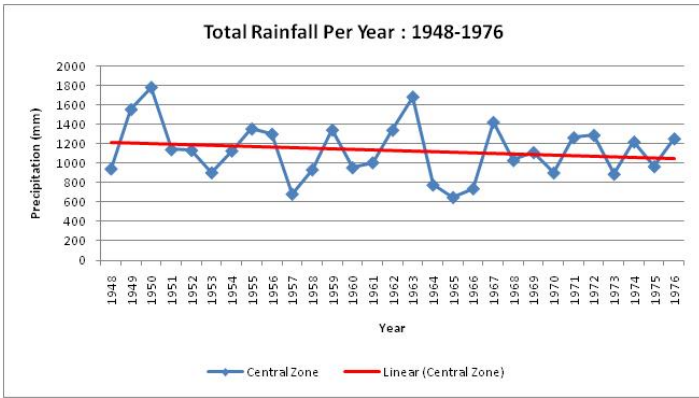


Trend in annual rainfall

Historic climate records are marked by both annual and interdecadal variability. Interdecadal variability within the Australasian and South West Pacific regions is associated with the Interdecadal Pacific Oscillation (IPO).

During the time period from 1948 to 2007 there have been two phases of this oscillation: IPO -ve phase (La Nina-like) from 1948 to 1976; and, IPO +ve phase (El Nino-like) from 1977 to 2007. Rainfall patterns within the region vary according to the IPO.

Although an overall decrease is evident from 1948-2007, a stepwise change occurs between IPO periods and there occurred no change in rainfall during the drier 1977-2007 period. The following graphs show annual rainfall patterns for the coastal zone during each IPO period.



Trend in annual rainfall for IPO periods

Projected changes: rainfall

Average annual rainfall patterns for the Gloucester LGA are projected to stay within the boundaries of existing known natural variability. However, it is projected that rainfall patterns during 2020-2080 will return to the generally wetter (than the 1977-2007 period) and more variable conditions experienced during the 1948-1976 period, which are associated with the negative 'La Nina'-like phase of the Interdecadal Pacific Oscillation. Projected seasonal changes in rainfall are summarised in the following table.

| Rainfall (2020 – 2080) | | | | |
|--|-----------------------|-----------------------|-------------|-----------------------|
| <i>Projected changes are relative to the 1948-1976 period (ie La Nina -ve phase)</i> | | | | |
| Zone | Summer | Autumn | Winter | Spring |
| Central | No significant change | No significant change | Drier: ~12% | Wetter: ~11% increase |

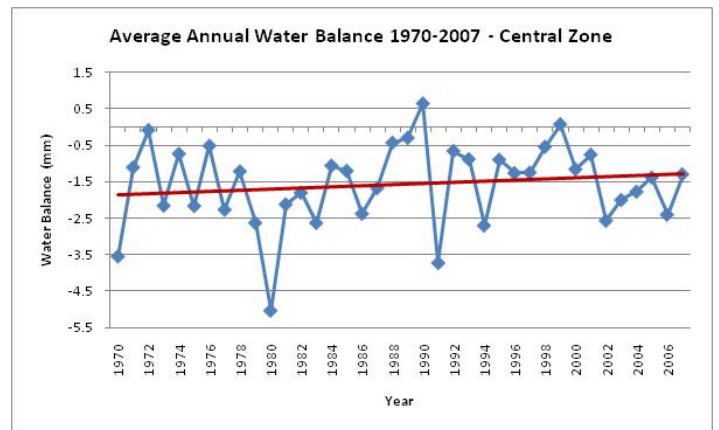
WATER BALANCE

Historical analysis: water balance

Water balance refers to the excess of precipitation over evaporation. It is affected by both the level of precipitation and prevailing temperature conditions.

Historically, the Gloucester LGA has experienced a total increase in annual average water balance of 0.3mm per day between 1973-2007. More detailed seasonal changes are summarised below.

| Water balance (1973-2007) | | | | |
|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Zone | Summer | Autumn | Winter | Spring |
| Central | Wetter: ~0.6mm/d increase | Wetter: ~0.3mm/d increase | Wetter: ~1.1mm/d increase | Wetter: ~0.9mm/d increase |



Central zone trend in annual water balance

Projected changes: water balance

Seasonal shifts in the central zone balance out to produce no projected overall annual change. Projected seasonal shifts in water balance are summarised below.

| Water Balance (2020-2080) | | |
|--|----------------------|----------------------|
| <i>Changes are reported in average mm per day relative to 1970-2007.</i> | | |
| Season | Decrease | Increase |
| Summer | | ~1.3 mm Central Zone |
| Autumn | ~1.9 mm Central Zone | |
| Winter | ~0.5 mm Central Zone | |
| Spring | | ~1.3 mm Central Zone |

WIND SPEED

Historical analysis: wind speed

Historically, the Gloucester LGA has experienced a statistically significant decrease in annual average wind speed of ~6.5km/hr. More detailed seasonal changes are summarised below.

| Wind speed (1970-2007) | | | | |
|------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Zone | Summer | Autumn | Winter | Spring |
| Central | Calmer: ~5.2km/hr* decrease | Calmer: ~5.8km/hr* decrease | Calmer: ~7.8km/hr* decrease | Calmer: ~7.2km/hr* decrease |

Projected changes: wind speed

Seasonal shifts in the central zone balance out to produce no projected change on an annual basis. Projected seasonal shifts in wind speed during the period 2020-2080 are summarised below.

| Wind Speed (2020-2080) | | |
|---|------------------------|------------------------|
| <i>Changes are reported in average km/hr relative to 1970-2007.</i> | | |
| Season | Decrease | Increase |
| Summer | ~0.1km/hr Central Zone | |
| Autumn | | ~1.2km/hr Central Zone |
| Winter | ~0.2km/hr Central Zone | |
| Spring | ~0.8km/hr Central Zone | |

EXTREME EVENTS

Projected changes: extreme events

Extreme weather events such as major storms, flooding rains or extreme temperature days, are a key concern for the community. Their occurrence is a significant source of risk, whether in terms of personal injury, loss of life, economic damage, social disruption or environmental damage. Accordingly, extreme events in the 95th percentile (that is, events in the top 5%) at individual Bureau of Meteorology recording stations have been analysed to project likely changes in their future occurrence.

This analysis has found that the projected frequency of weather patterns responsible for extreme storm events along the NSW coast are likely to increase, suggesting a higher probability of east coast low formation during autumn/winter.

There are also projected changes in the frequency of occurrence of synoptic patterns associated with high rainfall events. An increase in the frequency of occurrence of high rainfall events in summer and autumn are projected in the central climate zone. A corresponding decrease in extreme rainfall events during winter and spring is also projected.

Projected increases in the synoptic pattern linked to high maximum temperatures during summer and autumn is likely to result in an increased frequency of extreme heat days in the Gloucester LGA during the period from 2020-2080. This has a variety of implications including human health and bush fire risk.

A summary of projected changes in the nature and occurrence of extreme events relevant to the Gloucester LGA for the period 2020 – 2080 are shown below.

| Extreme Event | Projected Change |
|----------------------|--|
| Extreme storms | Increased frequency during autumn & winter |
| High rainfall events | Increased frequency during summer and autumn. This is matched by a decrease during winter and spring to produce no overall annual change |
| Extreme Heat Days | Increased frequency during summer and autumn |
| Frost | No change in winter frost events, however increases in autumn and spring are projected. |

How can the results be used?

The climate change projections included in this LGA Climate Profile provide the next order of detail and insight over previous CSIRO (2007) projections available for the Hunter, Central and Lower North Coast region. These projections now make it possible for Gloucester Shire Council, government agencies, industry and the community to more accurately assess and prepare for the potential risks posed by climate change in the Gloucester Local Government Area.

More information

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References & Further Reading

- ◆ Blackmore, K.L. & Goodwin, I.D (2008). Report 2: Climate Variability of the Hunter, Lower North Coast and Central Coast Region of NSW. A report prepared for the Hunter and Central Coast Regional Environmental Management Strategy, NSW.
- ◆ Blackmore, K.L. & Goodwin, I.D (2009). Report 3: Climatic Change Impact for the Hunter, Lower North Coast and Central Coast Region of NSW. A report prepared for the Hunter and Central Coast Regional Environmental Management Strategy, NSW.
- ◆ HCCREMS (2009). Fact Sheet—Research Methodology & Findings. Hunter Councils Inc, NSW.
- ◆ Verdon, D & Goodwin, I.D. (2007). Progress Report 1 to HCCREMS on Stage 1 of the Regional Climate Change Study. A report prepared for the Hunter and Central Coast Regional Environmental Management Strategy, NSW.

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