CLIMATE PROFILE

CESSNOCK CITY COUNCIL LOCAL GOVERNMENT AREA

Introduction

The Cessnock City Council Local Government Area (LGA) covers an area of 1,966 square kilometres and includes a population of approximately 49,000 people. Famous for its coal mining history, Cessnock LGA is also Australia's oldest wine region. With approximately 4,500 acres under vine, the area's wine industry has created a thriving and growing tourism industry.

Cessnock and the broader region is well known for its historic climate variability and extremes. Major storm, flooding and bushfire events in recent years have had an impact on the Cessnock LGA. Events 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 Cessnock LGA.

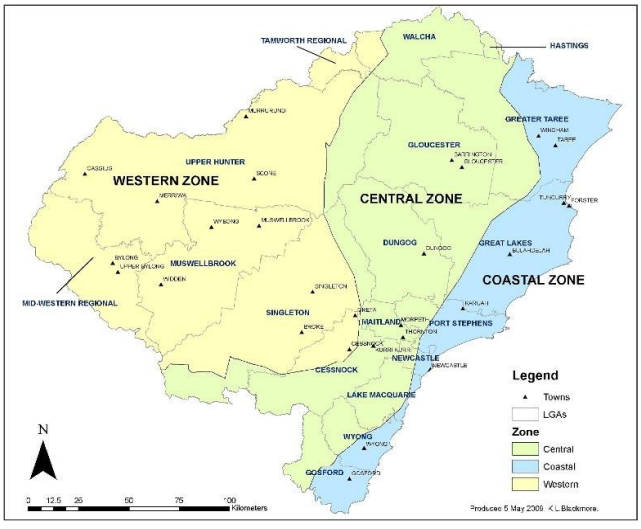
Climate Zones

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 Cessnock City Council LGA.

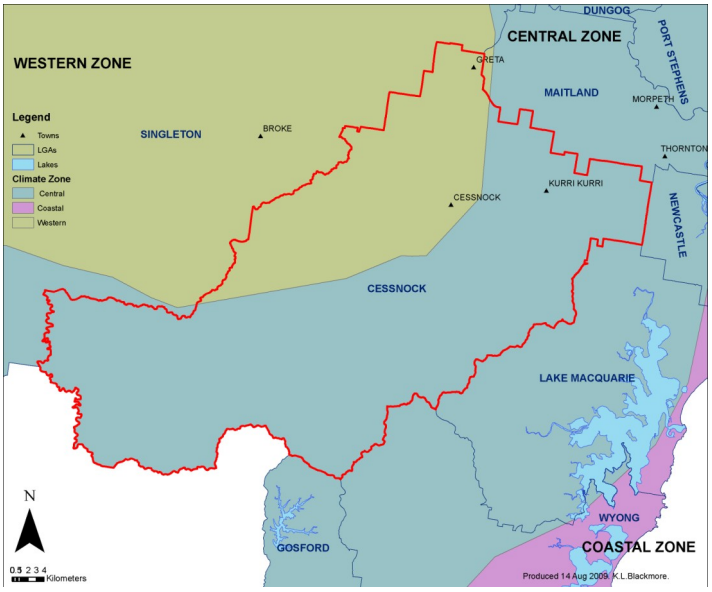


Climate zones within the Region

Cessnock City Council LGA

The Cessnock LGA spans both the western and central climate zones. Projected changes in climate for both of these zones are therefore relevant to the area. Because large areas of the LGA lie within both of these zones, historic and projected climate changes for the LGA as a whole are most accurately represented as the mean change between the two.

In this regard, it is also important to note that while each climate zone is represented by a defined boundary, climate is actually a gradual and continuous process between the two. For the purposes of this climate profile, information is provided for each of the zones.



Climate zones - Cessnock City Council LGA

Results

The following results provide both an historical analysis and future projections for a range of climate variables in the western and central climate zones. 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.

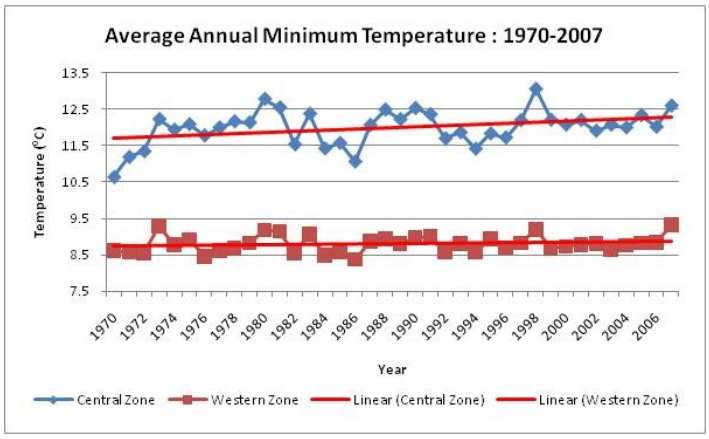
MINIMUM TEMPERATURE

Historical analysis: minimum temperature

Historically, the Cessnock LGA has experienced a statistically significant annual increase in average minimum temperatures of ~0.6°C in the central zone, however little change is evident in the western zone (~0.1°C). More detailed seasonal and zonal changes are summarised below.

Minimum temperature (1970-2007)				
Zone	**Summer**	**Autumn**	**Winter**	**Spring**
Western	Warmer: ~0.4°C increase	Warmer: ~0.2°C* increase	Cooler: ~0.1°C* decrease	Warmer: ~0.2°C* increase
Central	Warmer: ~0.3°C increase	Warmer: ~0.5°C increase	Warmer: ~0.5°C increase	Warmer: ~0.9°C* increase

* Statistically significant



Trend in average minimum temperature

Projected changes: minimum temperature

Average minimum temperature projections for the western and central zones are similar for all seasons. Generally, the Cessnock City 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) *Projected changes are relative to the 1970-2007 period*				
Zone	**Summer**	**Autumn**	**Winter**	**Spring**
Western	Warmer: ~4.2°C increase	Warmer: ~4.8°C increase	Cooler: ~0.8°C decrease	Cooler: ~1.2°C decrease
Central	Cooler: ~0.8°C decrease	Warmer: ~1.5°C increase	Warmer: ~1.2°C increase	Cooler: ~0.2°C decrease

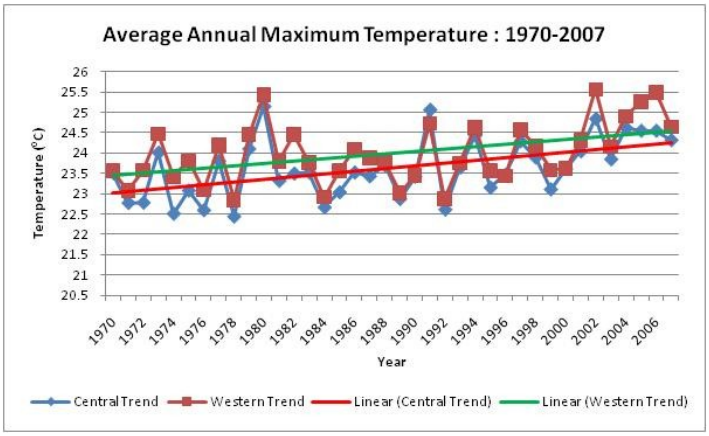
MAXIMUM TEMPERATURE

Historical analysis: maximum temperature

Historically, the Cessnock LGA has experienced a statistically significant annual increase in average maximum temperatures of ~1.1°C in the western zone and ~1.2°C in the central zone. More detailed seasonal and zonal changes are summarised below.

Maximum temperature (1970-2007)				
Zone	**Summer**	**Autumn**	**Winter**	**Spring**
Western	Warmer: ~1.6°C* increase	Warmer: ~0.7°C increase	Warmer: ~0.8°C increase	Warmer: ~1.4°C* increase
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

Generally, it is projected that average maximum temperatures in the Cessnock LGA will continue to increase during autumn and winter. Similar or slightly cooler average maximum temperatures are projected to occur during spring and summer. More detailed zonal and seasonal projections are summarised below.

Maximum temperature (2020-2080) *Projected changes are relative to the 1970-2007 period*				
Zone	**Summer**	**Autumn**	**Winter**	**Spring**
Western	Cooler: ~0.2°C decrease	Warmer: ~2.0°C increase	Warmer: ~1.8°C increase	Cooler: ~1.3°C decrease
Central	No signifi-cant change	Warmer: ~1.8°C increase	Warmer: ~1.6°C increase	Cooler: ~1.3°C decrease

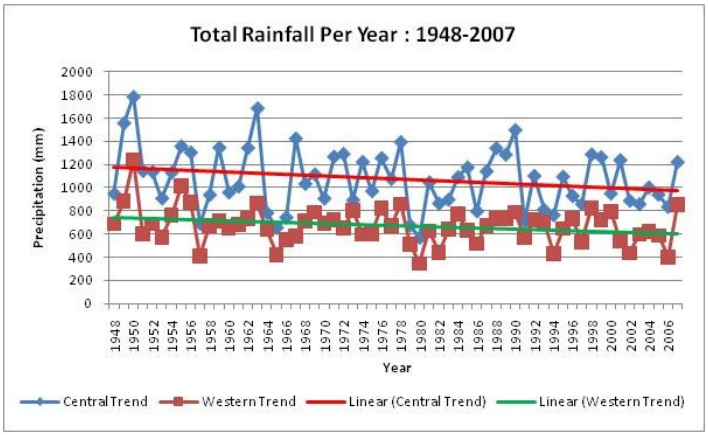
RAINFALL

Historical analysis: rainfall

Historically, the Cessnock City Council LGA has experienced a statistically significant decrease in annual rainfall (in the western zone only) of ~142mm over the period from 1948-2007. More detailed seasonal and zonal changes are summarised below.

Rainfall (1948-2007)				
Zone	**Summer**	**Autumn**	**Winter**	**Spring**
Western	Drier: ~32mm* decrease	Drier: ~5mm decrease	Drier: ~10mm decrease	Wetter: ~2mm increase
Central	Drier: ~43mm* decrease	Wetter: ~9mm increase	Drier: ~43mm* decrease	Wetter: ~10mm increase

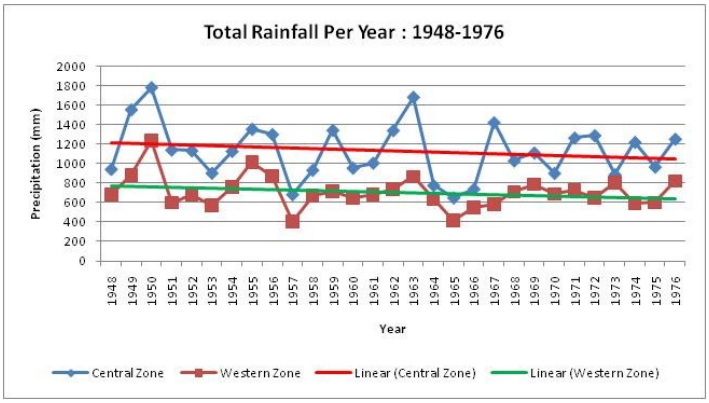
* Statistically significant

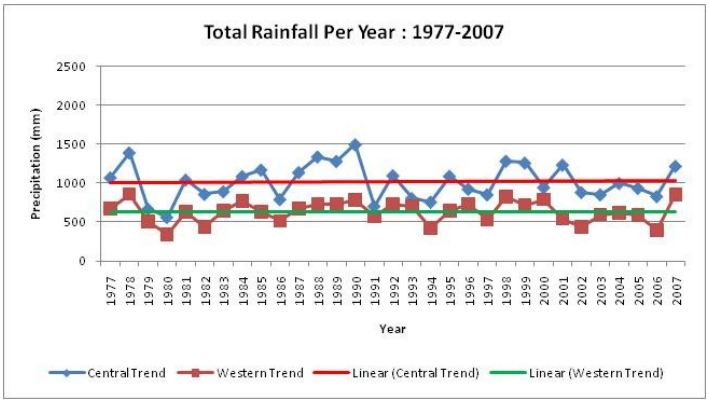


Historic climate records are marked by both annual and interdecadal variability. Interdecadal variability within the Australasian and South West Pacific regions is associated with the Interdecadal Pacific Oscillation (IPO).

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 Cessnock 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 and more variable conditions experienced during the 1948-1977 period, which are associated with the negative 'La Nina'-like phase of the Interdecadal Pacific Oscillation. Projected seasonal and zonal changes in rainfall are summarised in the following table.

Rainfall (2020 – 2080)

Projected changes are relative to the 1948-1977 period (ie La Nina –ve phase)

Zone	Summer	Autumn	Winter	Spring
Western	No significant change	Sig. wetter: ~33% increase	No significant change	No significant change
Central	No significant change	No significant change	Drier: ~12% decrease	Wetter: ~11% increase

WATER BALANCE

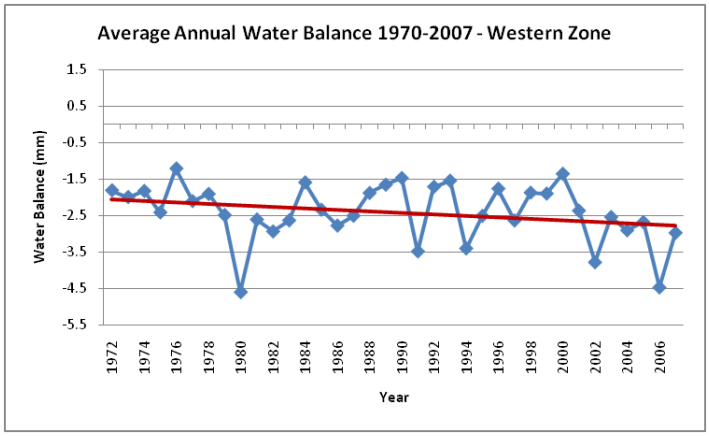
Historical analysis: water balance

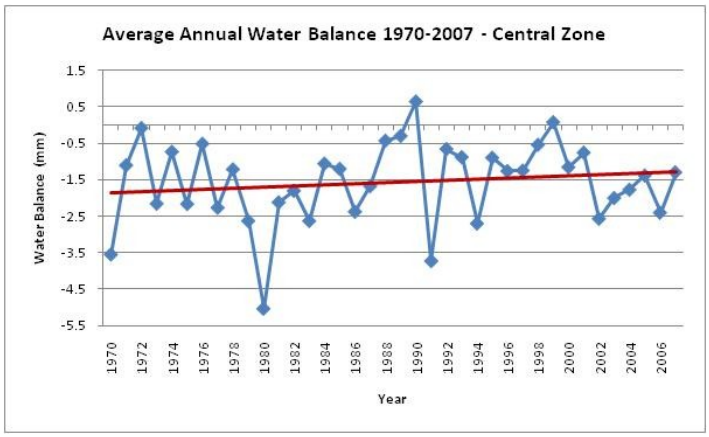
Water balance refers to the excess of precipitation over evaporation. It is affected by both the level of precipitation and prevailing temperature conditions.

Historically, the Cessnock LGA has experienced a total increase in annual average water balance of 0.3mm per day in the central zone between 1973-2007 and a decrease of 0.7mm per day in the western zone. More detailed seasonal changes are summarised below.

Water balance (1970-2007)

Zone	Summer	Autumn	Winter	Spring
Western	Drier: ~1.4mm/d decrease	Drier: ~0.9mm/d decrease	Wetter: ~0.5mm/d increase	Drier: ~0.8mm/d decrease
Central	Wetter: ~0.6mm/d increase	Wetter: ~0.3mm/d increase	Wetter: ~1.1mm/d increase	Wetter: ~0.9mm/d increase





Western and central zone trend in annual water balance

Projected changes: water balance

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

Water Balance (2020-2080)

Changes are reported in average mm per day relative to 1970-2007.

Season	Decrease	Increase
Summer		~1.3 mm Central Zone ~0.5 mm Western Zone
Autumn	~1.9 mm Central Zone ~0.3 mm Western Zone	
Winter	~0.5 mm Central Zone	~0.2 mm Western Zone
Spring		~1.4 mm Western Zone ~1.3 mm Central Zone

WIND SPEED

Historical analysis: wind speed

Historically, the Cessnock LGA has experienced a decrease in average annual wind speed in the western zone of ~1.2km/hr and a statistically significant decrease in annual average wind speed of ~6.5km/hr in the central zone. More detailed seasonal and zonal changes are summarised below.

Wind speed (1970-2007)

Zone	Summer	Autumn	Winter	Spring
Western	Calmer: ~1.0km/hr decrease	Calmer: ~1.7km/hr* increase	Calmer: ~1.5km/hr decrease	Calmer: ~0.5km/hr decrease
Central	Calmer: ~5.2km/hr* decrease	Calmer: ~5.8km/hr* decrease	Calmer: ~7.8km/hr* decrease	Calmer: ~7.2km/hr* decrease

* Statistically significant

Projected changes: wind speed

Seasonal shifts in the western and central zones 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)

Changes are reported in average km/hr relative to 1970-2007.

Season	Decrease	Increase
Summer	~0.1km/hr Central Zone	
Autumn		~1.0km/hr Western Zone ~1.2km/hr Central Zone
Winter	~0.2km/hr Central Zone	~0.3km/hr Western Zone
Spring	~1.3km/hr Western Zone ~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 and western climate zones. A decrease in extreme rainfall events during winter is projected with no changes anticipated for spring.

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 both the central and western zones 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 Cessnock 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. A decrease is projected during winter with no changes anticipated for spring
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 Cessnock City Council, government agencies, industry and the community to more accurately assess and prepare for the potential risks posed by climate change in the Cessnock City Council 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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