Hunter, Central and Lower North Coast Regional Climate Change Project

FACT SHEET
Research Methodology and Findings

Project aims

The Hunter, Central and Lower North Coast Regional Climate Change Project is an initiative of the Hunter and Central Coast Regional Environmental Management Strategy (HCCREMS) and its 14 member councils. Key objectives of the project include:

1. To research the potential regional impacts of climate change.
2. To raise awareness amongst local government, industry and the community of potential regional climate change impacts.
3. To improve the capacity of these groups to assess climate risk and to implement appropriate adaptation strategies.

Project area

The Project Area encompasses the 14 local government areas of the Hunter, Central and Lower North Coast region of NSW. As shown below, for the purpose of research and data capture, a 50 km buffer also surrounds the region.

Map showing the Project Area & adjoining 50km buffer

Research

The climate of the region is well known for its variability and extremes, both geographically and over time. Because of this variability, it is unlikely that the effects of climate change will be uniform across the region. Rather, it is likely that future changes in weather patterns driven by climate change will vary in their nature and impact.

Previous information and profiles of climate change for the region however, have not provided information at a fine enough scale to detect this variability. As such, a key element of the project has been to research the regional and sub regional scale impacts of climate change. The University of Newcastle were commissioned to complete this research.

The research itself is an Australian first, and differs from other approaches in that projections of future climate change are based on changes in the regions' "weather drivers". These weather drivers include 12 synoptic types that have been derived from the sea level pressure output of the CSIRO Mark 3.5 Global Climate Model. In contrast, more common research approaches project changes primarily on the values of key climate variables such as rainfall and temperature produced by Global Climate Models.

The actual research process has comprised a comprehensive review of the region's climate history, analysis of variability, and identification of the relationship between these historic climate patterns and the 12 synoptic types. Four distinct research stages have been implemented that include:

- Stage 1: identification of key regional synoptic patterns;
- Stage 2: Determining the relationship between synoptic types & climate variability in the region;
- Stage 3: downscaling CSIRO global climate model (GCM) projections for New South Wales to the region; and
- Stage 4: determining the potential impacts of climate change on the Study region using statistical downscaling.

Stage 1: Identification of key synoptic patterns

Data on key climate variables were obtained from the Bureau of Meteorology, including precipitation, temperature, humidity, evaporation, daily wind speed and wind gusts. Available data within the period 1948-2007 was used for this process to comply with data quality and duration standards established for the project.

In addition, a detailed climatic data set was obtained from the US National Oceanic and Atmospheric Administration. This contained daily and monthly data for the full range of climate parameters, from the surface through the atmosphere. Monthly sea level air pressure data was then used to define the variety of synoptic types that drive weather patterns, and therefore climatic variability, within the region.

The final twelve synoptic types were then identified using a pattern recognition technique known as 'self-organising mapping'. This technique clusters like features together to produce a resultant "map" which arranges the clusters by similarity (i.e. clusters with similar features will appear close together on the map). This process enabled those synoptic patterns most associated with key weather patterns in the region to be identified.

Stage 2: determining the relationship between synoptic types & climate variability

The 12 identified synoptic types generate a range of significant large-scale features that are known to influence the region's weather. They may induce clear seasonal trends in the location and intensity of features such as the subtropical anticyclone, the monsoonal trough, the circumpolar trough, the long wave trough, and ridge features in the Pacific and Indian Ocean. Data from Bureau of Meteorology recording stations within the region were related to each synoptic type to understand how these 12 patterns drive the region's climate variability.

This process confirmed that it is changes in the frequency of occurrence of these synoptic types between 1948 and 2007 that is responsible for the variability recorded in key climatic parameters during that period. Additionally, relationships between extreme events (high or low rainfall and temperature events) and synoptic types were also identified.

Stages 3 & 4: Determining potential impacts of climate change

Climate projections for the period 2020-2080 were assessed using data from the CSIRO Mk3.5 Global Climate Model (GCM). Because Global Climate Models generate coarse-scale outputs however, an additional process called Statistical Downscaling was employed. This allowed the data to be meaningfully interpreted at a much finer geographical scale suitable for projecting likely climatic changes at both regional and subregional levels.

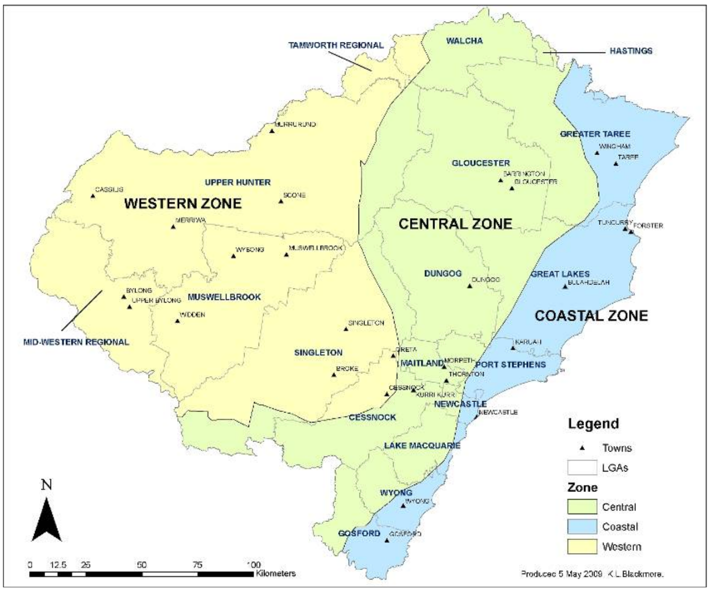
A weather typing approach to Statistical Downscaling was adopted for the research. This involved deriving the key synoptic types from the Global Climate Model output and identifying projected changes (to 2100AD) in the frequency of these synoptic types compared to their pattern of occurrence during the 1948-2007 time period. These changes in synoptic types were then combined with an understanding of how the region's weather is impacted by these types. This allowed the researchers to project the likely changes in climate variables across the region, such as temperature, rainfall and evaporation at both sub regional and seasonal scales.

The actual climate variables for which an analysis has been completed were identified through consultation with regional stakeholders including councils, government agencies and the agricultural sector. This aimed to ensure that the outputs of the research were directly relevant to regional stakeholders and could be readily applied to risk assessment and adaptation planning activities.

Climate Zones

To facilitate the sub regional analysis and interpretation of projected climate change impacts, three sub regional climate zones (coastal, central and western) have been established for the region. An analysis of both historic and projected climate change has been provided for each of these. These zones are shown in the Figure below.

These zones were identified through a process known as climate zonation, which divides a region into distinct sub-regions or zones where climatic similarity is maximised within zones and minimised between zones. This purely statistical process was based upon key seasonal climate variables including summer, autumn, winter and spring precipitation and average minimum and maximum temperature.



Climate zones within the Region

Results

The research outcomes project future changes in climate at both *seasonal* and *sub regional* scales. 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.

Projections are provided for a range of climate variables including rainfall, temperature (minimum, maximum and average annual), humidity, pan evaporation, water balance, wind, sea level rise and extreme sea levels, wave climate and extreme events. Examples of the projections generated for some of these climate variables is shown below.

Projected changes: minimum temperature

Across the region minimum temperatures are projected to be generally warmer, particularly in the western zone. More detailed seasonal and zonal projections are summarised below.

Minimum temperature (2020-2080)

Projected changes are relative to the 1970-2007 period

Zone	Summer	Autumn	Winter	Spring
Coastal	Cooler: ~0.9°C decrease	Warmer: ~1.4°C increase	Warmer: ~1.3°C increase	Cooler: ~0.2°C decrease
Central	Cooler: ~0.8°C decrease	Warmer: ~1.5°C increase	Warmer: ~1.2°C increase	Cooler: ~0.2°C decrease
Western	Warmer: ~4.2°C increase	Warmer: ~4.8°C increase	Cooler: ~0.8°C decrease	Cooler: ~1.2°C decrease

Projected changes: maximum temperature

Maximum temperatures are also projected to increase in the region with the most significant changes projected to occur during autumn and winter. More detailed seasonal and zonal projections are summarised below.

Maximum temperature (2020-2080)

Projected changes are relative to the 1970-2007 period

Zone	Summer	Autumn	Winter	Spring
Coastal	Cooler: ~0.2°C decrease	Warmer: ~1.1°C increase	Warmer: ~1.3°C increase	Cooler: ~0.7°C decrease
Central	No significant change	Warmer: ~1.8°C increase	Warmer: ~1.6°C increase	Cooler: ~1.3°C decrease
Western	Cooler: ~0.2°C decrease	Warmer: ~2.0°C increase	Warmer: ~1.8°C increase	Cooler: ~1.3°C decrease

Projected changes: rainfall

No statistically significant change in overall average annual rainfall patterns are projected to occur. Overall rainfall extremes are also projected to stay within the limits of known natural variability.

Historically however, the region has been characterised by two distinct rainfall cycles that are directly linked to shifts in the Interdecadal Pacific Oscillation (IPO). These periods include 1948 -1976 (the wetter, more variable La Nina like negative phase) and 1977-2007 (drier, less variable El Nino like positive phase). It is projected that rainfall patterns during 2020 – 2080 will return to those higher and more variable rainfall patterns experienced during the 1948-76 La Nina like period. Projected seasonal and zonal changes are summarised below.

Rainfall (2020 – 2080)

Projected changes are relative to the 1948-1976 period

Zone	Summer	Autumn	Winter	Spring
Coastal	No significant change	No significant change	Drier: ~13% decrease	Wetter: ~15% increase
Central	No significant change	No significant change	Drier: ~12% decrease	Wetter: ~11% increase
Western	No significant change	Sig. wetter: ~33% increase	No significant change	No significant change

Projected changes: 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.

A decrease in water balance is projected for the Western Zone. Seasonal shifts in the Coastal and Central Zones balance out to produce no projected change on an annual basis. Projected seasonal shifts in water balance during the period 2020-2080 for each Climate Zone 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 ~0.9 mm Coastal Zone ~0.3 mm Western Zone	
Winter	~0.5 mm Central Zone	~0.7 mm Coastal Zone; ~0.2 mm Western Zone
Spring		~1.8 mm Coastal Zone ~1.3 mm Central Zone ~1.4 mm Western Zone

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 recording stations were analysed to project likely changes in their future occurrence.

This 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. Such events are often associated with coastal storm surge (elevated sea levels) caused by intense offshore low pressure cells, and may result in significant damage to beaches, dune systems and coastal structures.

There are also significant 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 all climate zones. 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 region during the period from 2020-2080. This has a variety of implications, including human health, bush fire risk and horticultural damage.

A summary of projected changes in the nature and occurrence of extreme events for the period 2020 – 2080 is included in the following table:

Extreme Event	**Projected Change**
Extreme storms	Increased frequency during Autumn & Winter
High rainfall events	Increased frequency during summer and autumn in all climate zones. This is matched by a decrease during winter and spring in all climate zones to produce no overall annual change
Extreme Heat Days	Increased frequency during summer and autumn
Frost	No change in winter frost events projected, however increases in autumn and spring are projected for the western and central climate zones.

How can the results be used?

The climate change projections resulting from the project provide the next order of detail and insight over previous CSIRO (2007) projections for the region. The results make it possible for local councils, government agencies, industry and the community to more accurately assess and prepare for the potential risks posed by climate change on both a subregional and seasonal basis.

To further communicate and interpret the research outcomes, a range of additional resources are also being developed. These will provide greater assistance and detail to organisations undertaking climate change risk assessment and adaptation planning activities. These resources will include:

1. Case studies that tailor the results of the research to key sectors or issues of significance to the region. Initial case studies will focus on Bushfires, Extreme Events in the Coastal Zone, Human Health (Extreme Heat) and the Hunter Wine Industry. Additional case studies focusing on regional biodiversity issues and additional agricultural sectors will also be developed during 2009/10;
2. Detailed climate profiles (historic and projected) for each of the coastal, central and western climate zones;
3. Climate profiles for individual council areas; and
4. Individual fact sheets detailing historic and projected changes for each of the climate variables analysed by the research (eg rainfall, maximum temperature & water balance).

More information

A full copy of the Final Research Report can be downloaded from the HCCREMS website:

www.hccrems.com.au

For further information on the project, please contact:

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