DROUGHT RESILIENCE ASSESSMENT FOR CASTLEREAGH COUNTRY (DRAFT)

4 MARCH 2024

PREPARED FOR:

GILGANDRA SHIRE COUNCIL

WARRUMBUNGLE SHIRE COUNCIL

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<<Note on formatting/presentation of this DRAFT document>>

<<This DRAFT document has been produced by Projence for content review by the Castlereagh Country RDRP Project Control Group, and also for independent review by CSIRO in accordance with the Independent Review Guide (December 2023). Highlighted text within the document is for the information of reviewers>>

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Disclaimer

It is anticipated that elements of this inaugural Drought Resilience Assessment may require review and updating as new information and research become available.

This project received funding from the Australian Government's Future Drought Fund.

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1 Acknowledgements

We respectfully acknowledge the Wiradjuri, Kamilaroi and Wailwan nations, who are the Traditional Owners and original natural resource managers of the lands and waters in the Shires of Warrumbungle and Gilgandra. We pay our respect to their Elders and leaders, past, present and emerging.

We would like to thank the 149 people representing community, businesses and organisations in the region who contributed to the development of the Drought Resilience Assessment for Castlereagh Country incorporating the Gilgandra and Warrumbungle Shire Council local government areas (LGAs) through their participation in interviews, meetings and workshops.

In-kind contributions from representatives at the Department of Regional NSW and the work of consultants who undertook literature reviews and data syntheses on our behalf were integral to the development of this document.

This Drought Resilience Assessment was compiled by Dr Andrew Krause (Projence) with contributions from Associate Professor Anthony Kiem (University of Newcastle, Australia), Randall Medd (Projence) and Dr Mark Sargent (Aigis Group).

We thank the members of the Castlereagh Country Project Control Group (PCG) for their contributions to development, review and refinement of the drought resilience assessment.

This program is jointly funded through the Australian Government's Future Drought Fund and NSW Government.

2 Preface

Resilience is concerned with the ways in which people or systems may absorb the impacts caused by an event or hazard. Understanding resilience involves considering (i) exposure to a hazard, (ii) susceptibility to harm as a result of exposure to the hazard, and (iii) the adaptive capacity to cope and respond effectively to the hazard.

Conducting drought resilience assessments for each region in the Future Drought Fund Regional Drought Resilience Planning program is an important step in building the evidence base for Regional Drought Resilience Plans (RDRPs). Drought resilience assessments involves consulting with stakeholders and reviewing existing data on drought impacts in the focus regions. This consultation and review effort is an opportunity to better understand how the regions have been affected by drought in the past and what has already been done to mitigate the impacts of future droughts.

Responding to drought at a local level requires a holistic approach that considers resilience in the context of complex economic, environmental and social systems. In this report, we present a summary of the likely economic, environmental (including water) and social impacts of future drought based on the latest available information, including climate change scenarios. We report on results of engagement with stakeholders in the region about the ways in which drought has affected them in the past, including with First Nations people, farmers, representatives from local government, industry and the non-profit sector. We identify priority drought resilience actions which will inform the Castlereagh Country RDRP incorporating the Gilgandra and Warrumbungle Shire Council LGAs.

This program has alignment with aspects of the Strategic Community Plans of Gilgandra and Warrumbungle Shires, specifically the three key pillars of economic, social/cultural and environment. These existing Community Strategic Plans have a significant focus on diversifying and growing the economy, improving the community for the benefit of residents, to increase visitation and to improve the physical environment.

3 Executive Summary

This Drought Resilience Assessment identifies priority actions for increasing resilience to the impacts of drought in the Castlereagh Country region. It provides analysis, guidance and recommendations to local decision makers and managers in the region regarding the historical and projected impacts of drought and identifies where resilience-building efforts should be concentrated. This Drought Resilience Assessment is an important step in building the evidence base for the Castlereagh Country RDRP.

The main findings of this Drought Resilience Assessment are as follows:

- The Future Drought Fund provides Australia with a comprehensive program to build drought resilience in regional areas. There are many national and local agencies involved in drought preparedness, response and recovery and in delivering drought resilience programs. Improved communication around the support available to regional communities, and how to access that support, is required.
- Globally, and in Australia, policies have shifted away from treating drought as an unexpected disaster and reacting to recover when a drought occurs towards developing early warning systems and implementing proactive risk management strategies that build resilience to drought. Measures that promote self-reliance and preparedness against drought impacts are consider more desirable.
- Wheat for grain and cattle and sheep production are the primary economic outputs and dominant employers in the region, meaning economic dependence on agriculture is very high. Resilience building activities must focus on strengthening preparation and response capacity of the agriculture sector and allied industries to effectively deal with drought.
- In the future, it is projected that drought will continue to be a regular occurrence in the Castlereagh Country region with possible increases in the frequency and severity of drought impacts. There is high confidence in the best available climate modelling results which indicate average temperatures are projected to increase in all seasons, number of hot days and warm spells are projected to increase, and average winter/spring rainfall is projected to decrease.
- Assessment of historical drought impacts on economic commodities suggest drought is expected to continue to impact adversely on crop and livestock production in the region.
- Past droughts have far-reaching impacts on social well-being, causing younger people to move away and, in turn, reducing populations, access to skills and the availability of community services and support networks in the region.
- Nature conservation is the third highest land use of the Castlereagh Country region. This asset is unique for a rural area and provides an opportunity to enhance economic diversification via the visitor economy.
- The Castlereagh Country region has poor surface water resources and relies heavily on access to groundwater for farming production and drinking water for town population, alike. The quality of groundwater is assessed as relatively good throughout the region, and recent drilling projects have identified potential sources of deeper aquifer groundwater that may be suitable for irrigation enterprises.
- A drought resilience index approach which used a selection of independent drought indicators for exposure, sensitivity, and adaptive capacity determined the Gilgandra LGA to be marginally more drought resilient than the Warrumbungle LGA.
- The drought resilience index approach identified farming land quality and groundwater resources as key strengths in terms of drought resilience in the Castlereagh Country region. These are aspects to maintain and build on for a successful response to future drought in the region.
- Weaker areas in terms of drought resilience are current and future drought exposure, the projected impacts of climate change on the frequency, duration, and severity of future drought events, and relatively high unemployment levels. These are the aspects of vulnerability to drought in the region that need to be prioritised to improve resilience.

4 Introduction

The Future Drought Fund is an Australian Government initiative to help Australian farmers and regional communities become more prepared for, and resilient to, the impacts of drought[1].

The $5 billion fund invests $100 million a year in projects that seek to achieve meaningful and measurable improvements in:

- Planning for future droughts by farmers, agribusinesses, communities and regions.
- The uptake of farming practices and technologies that support continued productivity during times of drought, and faster recovery coming out of drought.
- The ability of community leaders, networks and organisations to assist in drought resilience planning and decision-making and to participate in a range of community resilience activities.

The RDRP program was established under the Future Drought Fund in 2021-22, and focuses on developing regional drought resilience plans, based on sound resilience planning principles and practices. These plans identify priority actions to build resilience to drought in agriculture and allied industries across different regions. In New South Wales, the program will deliver plans to three pilot regions within its foundation round. A further nine regions comprise the extension round, including the Castlereagh Country region which is the focus of this report.

4.1 Conceptual framework for drought resilience assessments

Regional drought resilience assessments are an important part of building the evidence base underpinning the plans. Resilience refers the ability of a system to absorb a disturbance and reorganise so as to maintain the existing functions, structure and feedbacks[2]. Resilience (and conversely vulnerability) encompasses a variety of concepts and elements including *exposure* to a hazard, *sensitivity* or susceptibility to harm as a result of exposure to the hazard and the *adaptive capacity* to cope and respond effectively to the hazard. Responding to drought at a local level requires a holistic approach that considers resilience in the context of complex economic, social and environmental/ecological systems. Figure 1 summarises the different components of a drought resilience assessment.

[1] Department of Agriculture, Fisheries and Forest Future Drought Fund https://www.agriculture.gov.au/agriculture-land/farm-food-drought/drought/future-drought-fund

[2] Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. (2004). *Resilience, adaptability and transformability in social–ecological systems.* Ecology and Society 9(2): 5.

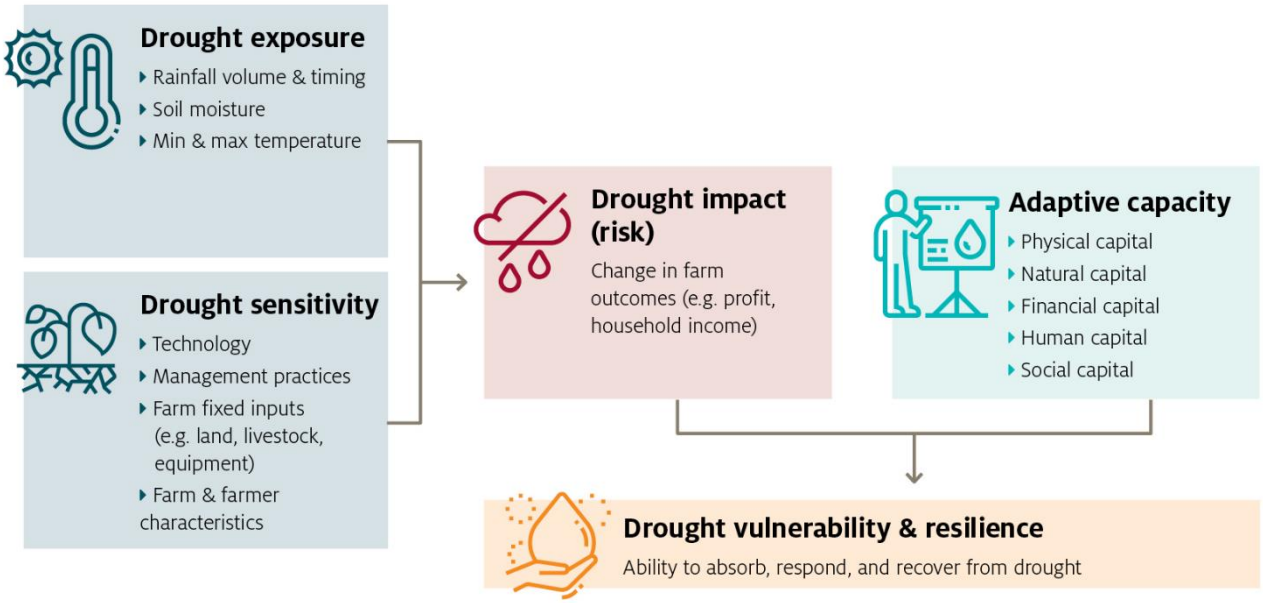

Figure 1: Conceptual framework for drought resilience (vulnerability) assessments.[3]

4.2 Stakeholder Engagement

Stakeholder engagement for the Castlereagh Country RDRP commenced in November 2023 and has continued throughout the drafting of the drought resilience assessment. The PCG decided to delay the community engagement component of stakeholder engagement as the winter crop harvest was one of the earliest in living memory, particularly in the Gilgandra Shire. The local community generally find it difficult to engage with projects seeking community feedback when they occur during the busy winter crop harvest period and the local Councils are mindful of undertaking engagement activities in this period as it generally results in poor attendance and leads to criticism for undertaking activities when many people are unable to attend.

The community, particularly those in the eastern part of the Warrumbungle Shire are currently experiencing a high level of consultation fatigue. This could be attributed to the major infrastructure projects in various stages of development, most notably renewable energy projects in the Central West Orana Renewable Energy Zone (REZ). Whilst difficult to quantify the impact on the level of engagement, the issue of engagement fatigue was raised during drop-in sessions and one-on-one engagements.

The Stakeholder Engagement Plan and the Stakeholder Engagement Report will be included as supporting documents to the Castlereagh Country RDRP.

4.2.1 Stakeholder engagement process

The Stakeholder Engagement Plan was developed and implemented in a partnership between Projence as the consultant and Gilgandra Shire Council, as the Project Manager for the Council Consortium.

Gilgandra Shire Council developed marketing collateral that was distributed through the following channels to advertise the opportunities for community engagement in the development of the plan:

- Posters to key traffic business and locations across the region
- Advertisement in local and community newspapers supported by supplied media release and story

[3] Department of Agriculture Fisheries and Forestry ABARES, Accessed 17 January 2024, <https://www.agriculture.gov.au/abares/research-topics/climate/drought/resilience>

- Posts to Gilgandra Shire Council and Warrumbungle Shire Council social media platforms
- Gilgandra Shire Council LGA mailout
- Email to Gilgandra Shire Council distribution list.

The Stakeholder Engagement Plan focused on four key actions to facilitate community feedback and input into the plan:

- Online survey
- Key theme community workshops
- Community drop-in sessions
- One-on-one key stakeholder engagement.

The online survey opened for community response on 13 November 2023 and remained open for the duration of the plan drafting. The survey data were extracted for analysis on 16 January 2024. The survey design focused on facilitating open ended response with five of the 16 questions allowing for unlimited text responses. In total, 105 surveys were completed with 70.8% of respondents identifying they were from the Gilgandra LGA and 29.2% of respondents identifying they were from the Warrumbungle LGA.

Stakeholder workshops and drop-in sessions were held between 27-29 November 2023 across the two Shires. The engagement method was adapted by the PCG to suit local needs, with Warrumbungle Shire Council's preference for community drop-in sessions in each of their towns (Coonabarabran, Baradine, Coolah, Dunedoo, Binnaway and Mendooran) and Gilgandra Shire Council preferring targeted issues-based workshops with the following themes:

- Agriculture
- Business and Economy
- Health and Wellbeing
- Community Organisations / Social and Support Services.

Council staff workshops were offered to both Gilgandra and Warrumbungle Shire Councils, but only the Gilgandra Shire Council workshop was requested.

Due to low participation and registration at issues-based stakeholder workshops, two were cancelled and the remaining two adjusted to make best use of the time in each location. This resulted in a more generic discussion on the issues rather than the focused workshops as per the Stakeholder Engagement Plan. Reasons for the low participation may include:

- Consultation fatigue, particularly in Warrumbungle Shire, which currently has a significant number of renewable energy projects proposed, and for which proponents have been undertaking community consultation. Council has also undertaken various stakeholder and community consultation activities recently in most of its towns and it tends to be the same stakeholders being invited to attend multiple consultation activities.
- Relatively short notice for stakeholders with flyers and invitations going out on 13 November, giving only two weeks of notice. The timelines for the Castlereagh Country RDRP are tight, and it was difficult to undertake an extensive advertising campaign and to make contact with key stakeholders prior to events.
- The region is not currently in drought and levels of concern are typically low regarding preparation for future droughts. Furthermore, engagement with stakeholders revealed a reluctance to discuss drought impacts at a time when conditions are favourable.

The revised consultation schedule is outlined below:

Monday 13 November

- Online survey went live and invitations were published to attend workshops and drop-in sessions

Monday 27 November

- Drop-in session at Baradine had no attendees, so the engagement strategy was revised to include direct approaches to available nearby community members, resulting in interviews with Michael Ross, Acting CEO Baradine Local Aboriginal Land Council, Ted Hayman, Chair of the Baradine and District Progress Association and Kate Olsen and Rita Enke of NSW National Parks and Wildlife Service.
- Workshop held for community organisations and social support services in Warrumbungle Shire Council Chambers attracted only one in-person participant and two attending online.

Tuesday 28 November

- Drop-in session at Dunedoo had no attendees, so the engagement strategy was revised to include direct approaches to available nearby community members, resulting in interviews with Louise Johnson (formerly Director Community Services at Warrumbungle Shire Council) who provided a list of key opinion leaders from Dunedoo that will be followed up with one-on-one interviews.
- Gilgandra Shire Council staff workshop was held at Gilgandra Council Chambers with 10 participants.
- Combined Health/Wellbeing and Agriculture stakeholder workshop was held at Gilgandra Coo-ee Heritage Centre where 10 people attended face to face and one online.

At each workshop, participants were encouraged to share what they were comfortable to share and were reminded that speaking about drought may trigger painful memories and emotions. Projence has a strong ongoing partnership with Lifeline and provided contact numbers for anyone who needed assistance as a result of workshop discussions. Associate Professor Anthony Kiem, Drought Technical Lead, provided a summary presentation on the history of drought and climate model projections for future rainfall, temperature and drought conditions as a stimulus for participants.

The online survey questions were used as the basis for workshop activities, where participants were asked to respond to the following questions:

- Discuss what worked to get your community through the last drought and why?
- What partially worked but would be more effective with additional resources or a different approach?
- What was missing or did not work at all?
- What things did you personally do to get you through the last drought that might be helpful for others to know about?
- How drought resilient do you believe your community is and what are your top three recommendations for how this resilience could be strengthened?

One-on-one key stakeholder engagement sessions (done via phone call, Microsoft Teams meeting and/or in-person interviews) were offered for people that could not attend the workshops and drop-in sessions, or felt they would like to discuss issues in more depth than filling out the survey. Only two one-on-one interviews were requested. Feedback from these interviews has been included in the wider stakeholder feedback.

Efforts have been made to hold discussions with local, State and Federal government and key agency sectors. This has proven to be difficult with timing and availability of key personnel limiting the engagement to this point.

4.3 Desktop Review

A desktop review is a critical component of any Drought Resilience Assessment process. The desktop review involves identifying, summarising, and interpreting what is already known about the impacts of drought, and also resilience to drought. The desktop review serves to identify what data are available for understanding and managing past, current, and future droughts and where the gaps in our knowledge are with respect to improving drought resilience. The desktop review followed the RDRP conceptual framework, investigating aspects of exposure, sensitivity, impact and adaptive capacity and the ways in which each of these relate to and inform drought resilience in the Castlereagh Country region.

The desktop review used a combination of data from a range of sources (e.g. previous drought impact/resilience reports, Regional Economic Development Strategies, the Australian Bureau of Statistics, ABARES, Geoscience Australia, industry groups and NSW Government) to review the key social, economic, and environment characteristics of the Gilgandra and Warrumbungle LGAs to inform understanding of drought impacts and drought resilience in the Castlereagh Country region. This included:

- Assessment of existing drought/water management strategies and policy to provide an understanding of current thinking and strategic direction related to improving drought resilience.
- Analysis of the current economy in the Castlereagh Functional Economic Region (FER), including strengths and weakness.
- Identification and analysis of competitive advantages, disadvantages, and opportunities the Castlereagh Country region has in relation to improving drought resilience.
- Identification of existing gaps that need to be addressed for the successful implementation of a RDRP (e.g. identification of industry sectors that should be targeted for assistance or encouraged to locate to the region).
- Summary of the socioeconomic profile of the Castlereagh Country region and benchmarking with adjoining LGAs, the broader FER, and/or other relevant regions.
- Assessment of key demographic and community characteristics such as household formation and expenditure, population forecasts and age structures, workforce participation and youth engagement, labour force skills/characteristics.
- Assessment of key industries to identify those industries that support local employment, contribute to Gross Regional Product, local expenditure, and regional exports.
- High level spatial assessment of employment precincts/locations across the study area. A focus on types of employment and function and intent of precincts.
- Analysis of the Visitor Economy to explore the key industry sectors that have the greatest exposure and propensity to support local tourism activity.

A significant focus of the desktop review is the assessment of the impacts of previous droughts and strengths/weaknesses of drought management visions/plans/options that existed at the time. This includes, but is not limited to:

- Review of local impact of State and Federal programs implemented during past droughts.
- Review of local media stories that point to informal or unique local activities undertaken during past drought events.
- Council Reports, correspondence and other documentation that points to the specific local issues experienced during past droughts in the Castlereagh region.
- An overview of who is active in the region with respect to drought, identifying their respective roles and the relationships between them.
- An overview of existing and past drought resilience policies and plans (from local to State/Federal government level).

5 Background Information

5.1 RDRP program

During the foundation period 2021-22, the RDRP program saw 23 regions across Australia announced as the first to develop plans. In 2022, the program was extended through to 2025 to allow participation of additional regions (Figure 2), including the Castlereagh Country region (combined area of the adjacent Warrumbungle and Gilgandra LGAs).

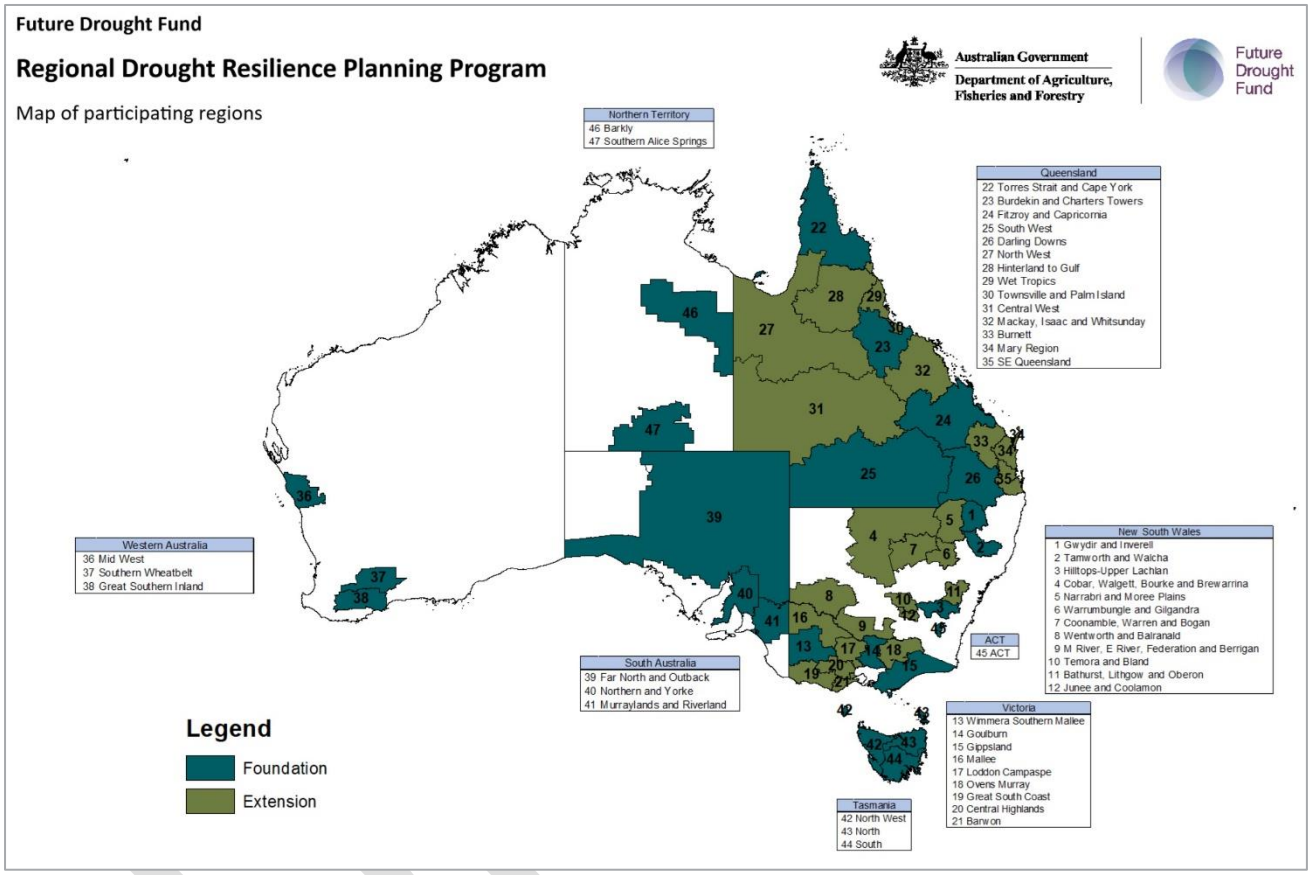

Figure 2: Regional Drought Resilience Planning program participating regions through to 2025.[4]

5.2 Castlereagh Country Region

The Castlereagh Country region (Figure 3) covers an area of 17,203 km^2 and consists of adjoining LGAs administered by Warrumbungle Shire Council (12,371 km^2) and Gilgandra Shire Council (4,832 km^2). The region is located on Traditional Owners land of the Wiradjuri, Kamilaroi and Wailwan nations. Warrumbungle LGA incorporates catchment areas of the Castlereagh River, Macquarie River and Namoi River, and Gilgandra LGA incorporates catchment areas of the Castlereagh River and Macquarie River.

<<The following figure is in draft form and will be updated according to mark ups shown for final issue of the report.>>

[4] Department of Agriculture, Fisheries and Forestry. Regional Drought Resilience Planning, Accessed 15 January 2024. <https://www.agriculture.gov.au/agriculture-land/farm-food-drought/drought/future-drought-fund/regional-drought-resilience-planning>

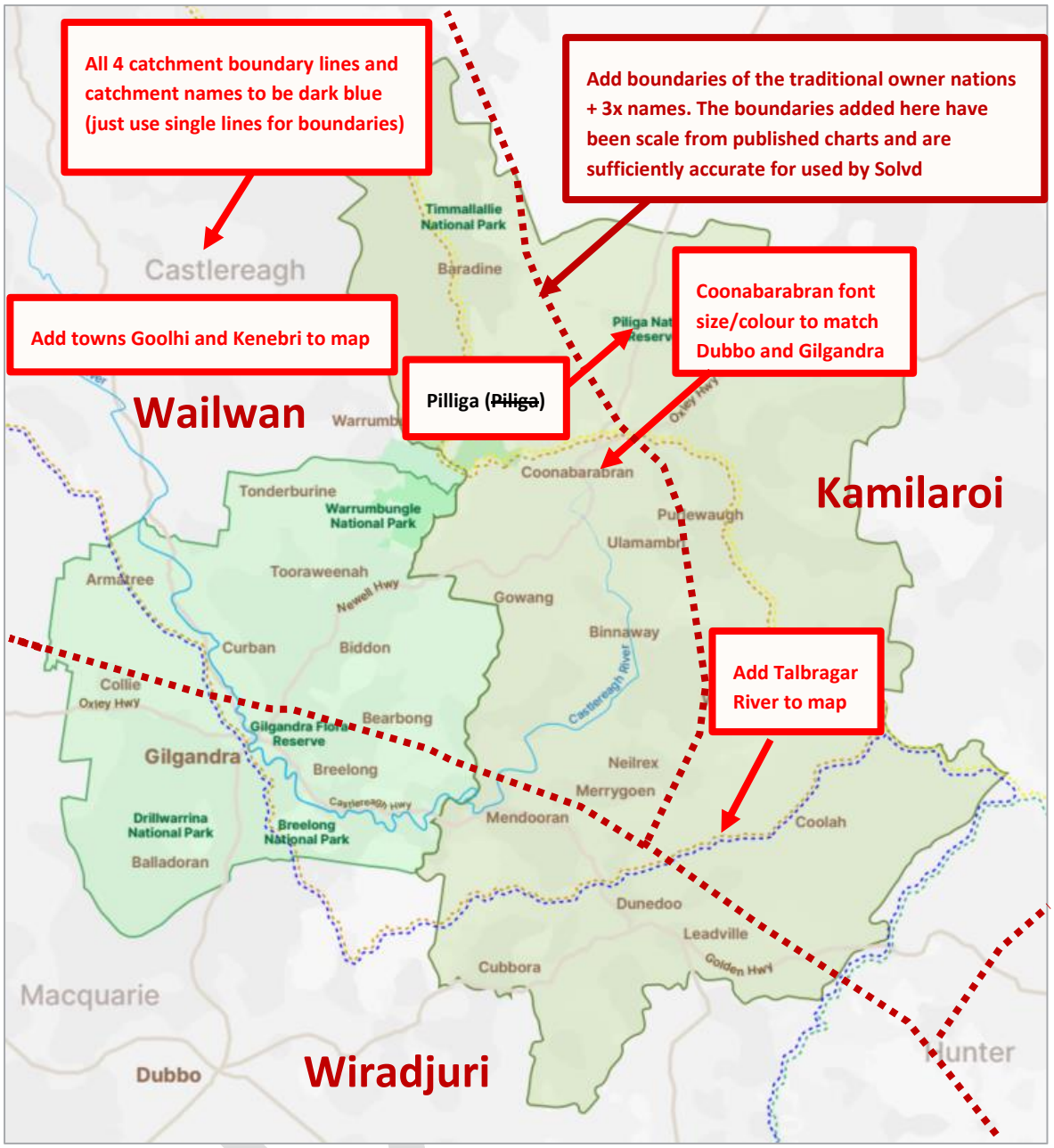

Figure 3: Regional scope of the Castlereagh Country Regional Drought Resilience Plan, including Aboriginal traditional owner nations[5] and river catchments.

The NSW Department of Primary Industries (DPI) is undertaking a mapping program across NSW to assist State and local government, other organisations and industries to recognise and value State Significant Agricultural Land[6] (SSAL). Only a small proportion of rural land in NSW is suitable for high levels of agricultural production or otherwise contributes to NSW's agricultural prosperity. This land is a finite resource with significant importance to agriculture and cannot be replaced if lost. The biophysical attributes of SSAL represent

[5] This map is based on published map resources and is just one representation of Aboriginal Australia. It indicates only the general location of larger groupings of people which may include smaller groups such as clans, dialects or individual languages in a group. Boundaries are not intended to be exact.

[6] NSW Department of Primary Industries, NSW Preliminary Draft State Significant Agricultural Land Map, Accessed 29 January 2024, <https://nswdpi.mysocialpinpoint.com/ssal/map#/>

the most capable, fertile and productive agricultural lands in the state, and support a variety of agricultural industries operating successfully. Mapping of preliminary draft SSAL for the Castlereagh Country region (Figure 4) has resulted in 31% coverage of the Gilgandra LGA and 26% coverage of the Warrumbungle LGA.

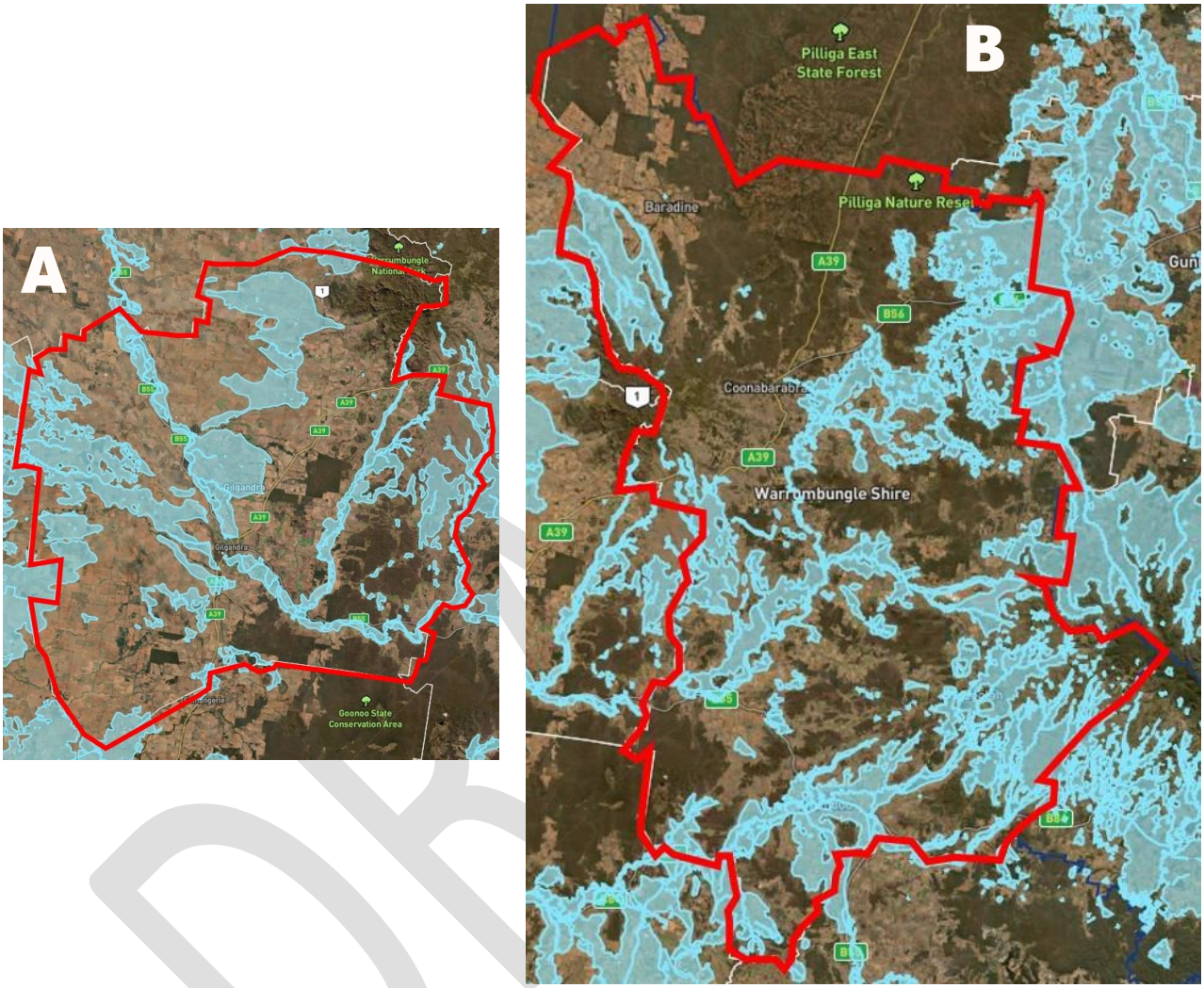

Figure 4: State Significant Agricultural Land (SSAL) mapping[6] (blue areas) for (A) Gilgandra LGA and (B) Warrumbungle LGA.

5.3 Demographic Summary

5.3.1 Population characteristics and distribution

The population of the Castlereagh Country region was 13,520 at the 2021 Census, with 9,225 (68%) living in the Warrumbungle Shire and 4,295 (32%) living in the Gilgandra Shire (Table 1). Each LGA has a population density below one person/km^2 (Figure 5), which ranks them towards the lower end of New South Wales regions by population density, and which is substantially low than the overall NSW population density of 10.2 persons/km^2.

The Castlereagh Country region median population age of 48 years is significantly higher than the New South Wales median age of 39 years and indicates an ageing population. Population age distribution of the Warrumbungle and Gilgandra LGAs (Figure 6) reveals a relatively low proportion of people in the 15-29 years and 30-44 years brackets when compared to the whole of New South Wales. This observation suggests that many working age people gravitate away from the region, most likely towards larger population centres.

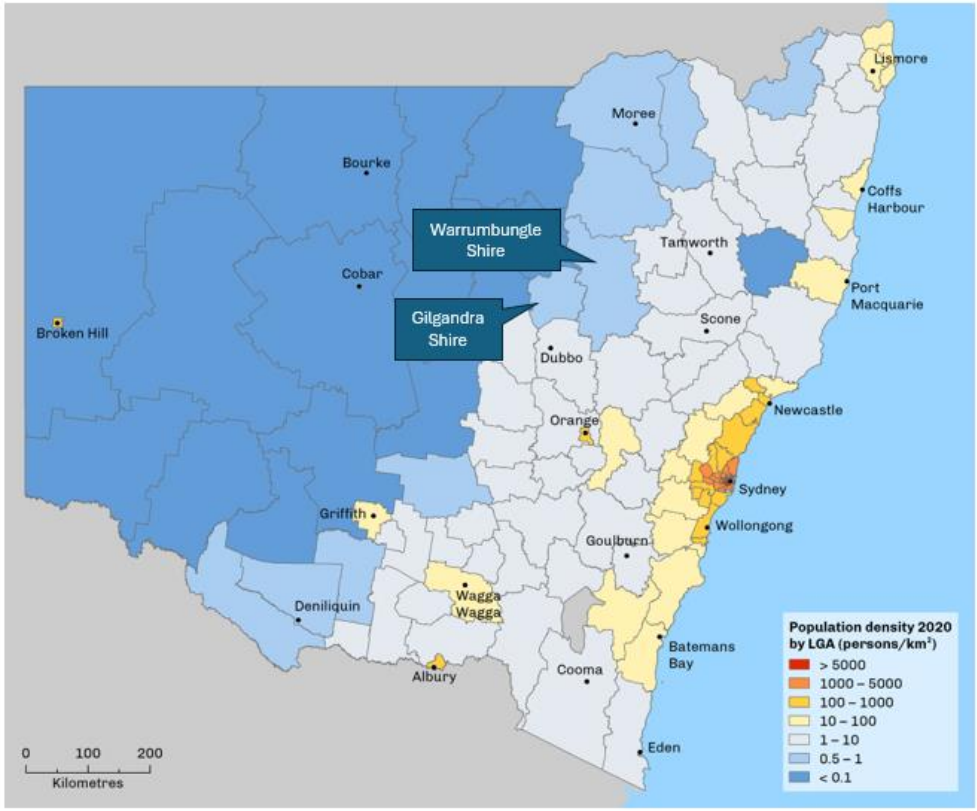

Figure 5: Population densities of NSW regions.[7]

Observed Census data between 2016-2021[14,15,16,17] shows a mean annual rate of population decline of -0.6% in the Warrumbungle LGA, but for the Gilgandra LGA the mean annual population growth rate increased by +0.1%. The NSW Department of Planning, Housing and Infrastructure (DPHI) population projections[8] suggest that population will reduce by approximately -19% in the period 2021 to 2041 across the Castlereagh Country region. Population is also projected to age marginally, which is consistent with broader, general population trends. The most significant projected change is a 4.6% increase in the 75+ years age group. It is noted the observed Census data do not appear to support the severity of the DPHI projections, highlighted by the projection that population would decline by more than 20% in the Gilgandra Shire when the 2016-2021 period resulted in a minor population increase.

[7] NSW Environment Protection Authority. NSW State of the Environment webpages. Accessed 29 January 2024.
< https://www.soe.epa.nsw.gov.au/all-themes/drivers/population>
[8] NSW Department of Planning, Housing and Infrastructure. Population projections webpages (various access dates).
< https://www.planningportal.nsw.gov.au/populations>

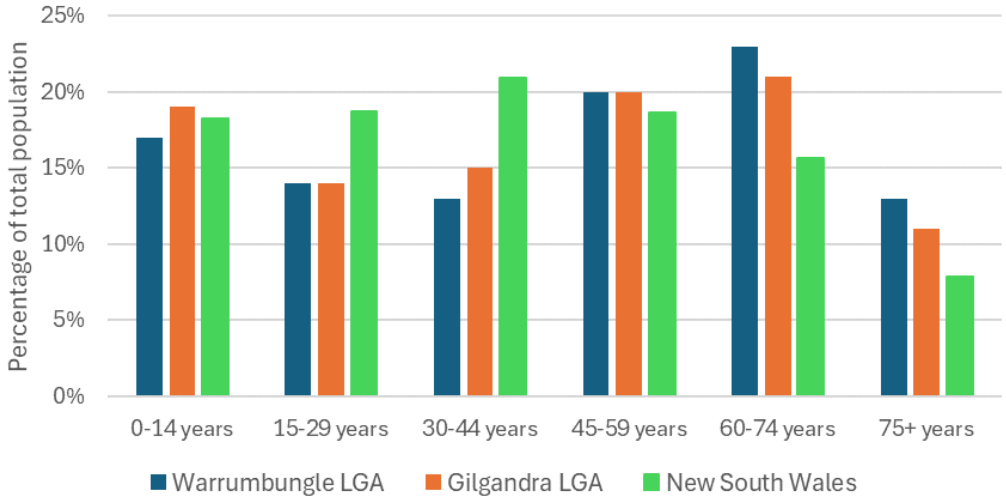

Figure 6: Population age distribution of the Warrumbungle and Gilgandra LGAs compared to the whole of New South Wales at the 2021 Census.[14,15]

Approximately 69% of Gilgandra Shire population lives in the Gilgandra township. Approximately 86% of the Warrumbungle Shire population lives in the six townships of Coonabarabran, Baradine, Binnaway, Coolah, Dunedoo and Mendooran. The concentration of the Castlereagh Country region's population in townships demonstrates the importance of resilience planning which not only considers drought impacts on farmers, but also on the higher portion of community members residing in the more densely populated urban areas. This observation has been reinforced by stakeholder engagement in Castlereagh Country, which repeatedly emphasised the role of the region's urban centres in providing opportunities and settings for all community members to benefit from drought related pressures.

Castlereagh Country also has relatively large proportions of Aboriginal and/or Torres Strait Islander people. Some of these peoples may hold specific knowledge on the lands of the Gamilaraay, Weilwan, and Wiradjuri nations, and on traditional practices in respect of these. Traditional knowledge may contribute to understanding the long-term patterns and indicators of developing drought stresses.

On average, the communities display some measures of disadvantage compared to other parts of the state. The averaged median weekly household income for Castlereagh Country ($1,109) is approximately one-quarter lower than the ABS 'Rest of NSW'[9] measure of $1,434 per week. The two LGAs also place in the lower 30% of all LGAs using the Socio-Economic Indexes for Areas (SEIFA) Index of Relative Social Advantage and Disadvantage (IRSAD). It is noted however, that a lower measure of socioeconomic status (SES) is not atypical for regional areas. For example, the median weekly household income for Greater Sydney was $2,077, which is approximately one-third above the state median. Further, the Australian Institute of Health and Welfare (AIHW) reported that people living in rural and remote areas also generally have lower incomes but pay higher prices for goods and services[10]. In 2019–20, Australians living outside capital cities had, on average, 15% less household income per week compared with those living in capital cities, and 22% less mean household net worth[11].

Other factors such as education and health access and outcomes may also be sources of disadvantage in the region. For example, data show that people living in rural and remote areas have higher rates of hospitalisations, deaths, injury and also have poorer access to,

[9] The balance of NSW with 'Greater Sydney' excluded. Rest of NSW does include other large cities including Newcastle – Lake Macquarie and Wollongong (ABS 2021 Census).
<https://www.abs.gov.au/census/find-census-data/quickstats/2021/1RNSW >.
[10] National Rural Health Alliance (NHRA) (2014). Income inequality experienced by the people of rural and remote Australia.
<https://www.ruralhealth.org.au/sites/default/files/documents/nrha-policy-document/submissions/sub-income-inequality-inquiry-15-oct-2014.pdf>.
[11] Australian Bureau of Statistics. Household Income and Wealth. Accessed 25 January 2023. <https://www.abs.gov.au/>.

and use of, primary health care services, than people living in major cities[12]. This includes access to mental health services, regarding which the National Rural Health Alliance (NHRA) found that access to mental health and wellbeing services and support in rural Australia may also be inhibited by the following additional influences[13]:

- Attitudinal factors – such as beliefs about usefulness and privacy concerns
- Cost – including the services, any travel and the cost of other work foregone
- Digital factors – including access to technology, useability and speed of connectivity.

Table 1: Demographic profile of Castlereagh Country.

Topic	Warrumbungle LGA	Gilgandra LGA	Castlereagh Country Region
Land area (km^2)	12,372	4,832	17,204
Population (2021 Census)[14,15]	9,225	4,295	13,520
Population density (people/km^2)	0.7	0.9	0.8
Observed Mean Annual Population Growth Rate (2016-2021)[14,15,16,17]	-0.6%	+0.1%	-0.4%
Predicted Population Growth (2021-2041)[18]	-17.6%	-21.9%	-19.0%
Predicted Annual Population Growth Rate (2021-2041)[18]	-0.9%	-1.1%	-1.0%
Median age[14,15]	50	46	49
0-14 years[14,15]	17%	19%	18%
15-29 years	14%	14%	14%
30-44 years	13%	15%	13%
45-59 years	20%	20%	20%

[12] Australian Institute of Health and Welfare. Rural and remote health, web article (last updated 11 September 2023). Accessed 30 January 2024. < https://www.aihw.gov.au/reports/rural-remote-australians/rural-and-remote-health>.
[13] National Rural Health Alliance. Fact Sheet. Mental Health in Rural and Remote Australia. July 2021. Accessed 30 January 2024. <https://www.ruralhealth.org.au/factsheets/thumbs>.
[14] Australian Bureau of Statistics. Warrumbungle Shire 2021 Census - All persons QuickStats. <https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA18020>
[15] Australian Bureau of Statistics. Gilgandra Shire 2021 Census - All persons QuickStats. <https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA12950>
[16] Australian Bureau of Statistics. Warrumbungle Shire 2016 Census - All persons QuickStats. <https://www.abs.gov.au/census/find-census-data/quickstats/2016/LGA18020>
[17] Australian Bureau of Statistics. Gilgandra Shire 2016 Census - All persons QuickStats. <https://www.abs.gov.au/census/find-census-data/quickstats/2016/LGA12950>
[18] NSW Department of Planning, Housing and Infrastructure. Population Projections website. Accessed 1 February 2024. < https://www.planning.nsw.gov.au/research-and-demography/population-projections >

Topic	Warrumbungle LGA	Gilgandra LGA	Castlereagh Country Region
60-74 years	23%	21%	22%
75+ years	13%	11%	13%
Aboriginal and/or Torres Strait Islander peoples (% of population)[14,15]	10.7%	14.5%	11.9%
People of Australian Aboriginal descent (% of population)	9.8%	13.1%	10.8%
Median household income (2021 Census) [$/week]	$1,068	$1,149	$1,109
SEIFA IRSAD (score/decile)[19]	914/3	913/3	N/A
Value of Agriculture (2020/21 [$m])[20]	187.9	176.3	364.2
Gross Regional Product 2020 [$m][21]	494.4	257.9	752.3
Agriculture value (% of GRP)	38.0	68.4	48.4
Total employment[24,25]	3,123	1,524	4,647
Agriculture employment[20]	811	433	1,244
Unemployment (% of total)[22,23]	2.8%	3.0%	2.8%
Agriculture businesses	473	278	751
Land area used for agricultural production (%)	70	87	75

[19] Australian Bureau of Statistics. Socioeconomic Indexes for Areas (SEIFA) Released 27/4/2023. Accessed 1 February 2024 <https://www.abs.gov.au/statistics/people/people-and-communities/socio-economic-indexes-areas-seifa-australia/latest-release >
[20] Department of Primary Industries, AgTrack - Agricultural and Land Use Dashboard, Accessed 18 January 2024, <https://www.dpi.nsw.gov.au/agriculture/lup/agriculture-data-for-planning/dashboard>
[21] NSW DPE (2022). Central West and Orana Regional Plan 2041, <https://www.planning.nsw.gov.au/sites/default/files/2023-03/central-west-and-orana-regional-plan-2041.pdf>
[22] Jobs and Skills Australia. Small Area Labour Markets (SALM) – Warrumbungle Shire - September 2023. Accessed 29 February 2024, <https://app.remplan.com.au/warrumbungle/economy/trends/unemployment?state=1BMxFb!6qZMIZkeEIEleb8UlRpy8Sziwfy53sLfJf0feUmf1gk>
[23] Jobs and Skills Australia. Small Area Labour Markets (SALM) – Gilgandra Shire - September 2023. Accessed 29 February 2024, <https://app.remplan.com.au/gilgandra/economy/trends/unemployment?state=BQ3Bcj!XJZrFXExKhX5V8rF3xnx1tPFmIZ8dfJI8IbImSnIwzM>

5.3.2 Regional economic contribution of agriculture

In terms of economic contribution, agriculture is the single largest industry in the region by a substantial margin, measured either by employment (Figure 7) or contribution to regional output (Figure 8) data sourced from REMPLAN[24,25].

Agricultural production is also the predominant land use at 70% in the Warrumbungle LGA and 87% in the Gilgandra LGA (Table 1). The distribution of categorised agricultural land uses within the Warrumbungle LGA is provided in Figure 9 and within the Gilgandra LGA in Figure 10.

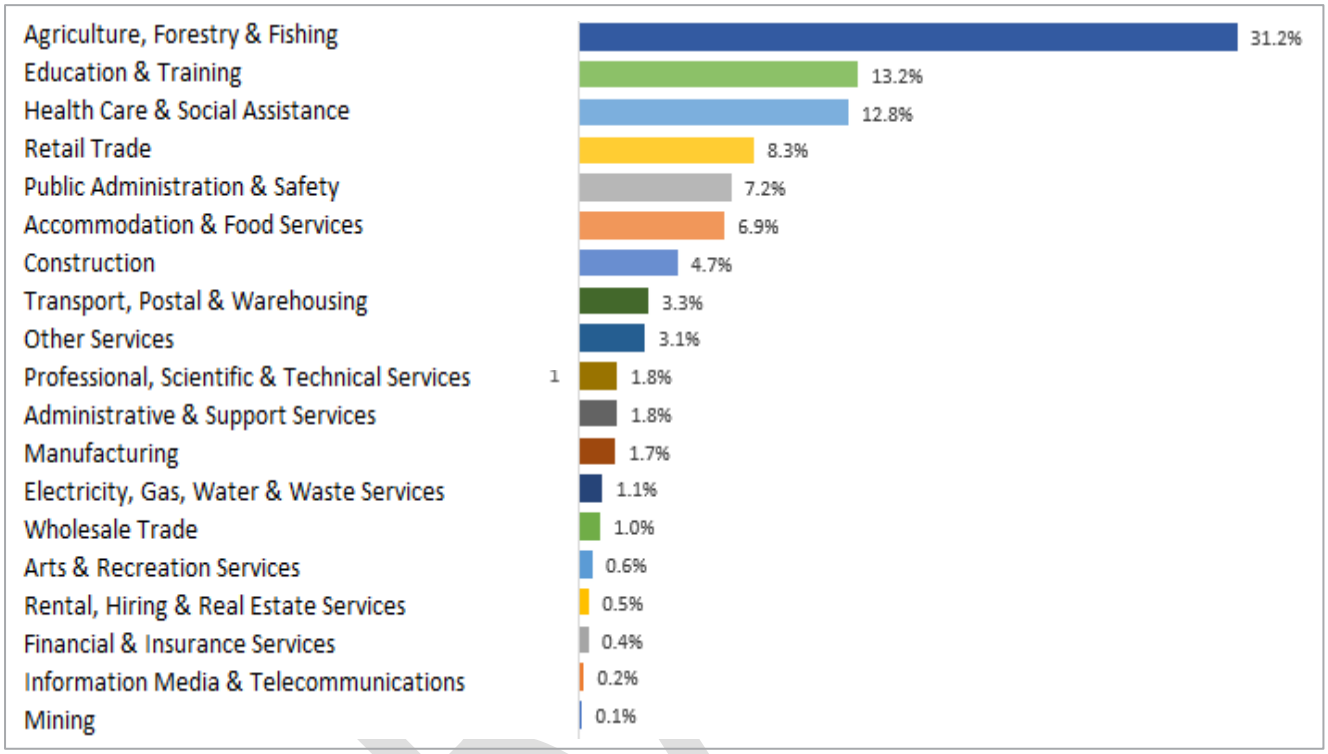

Figure 7: Castlereagh Country region employment by industry.[26]

[24] REMPLAN. Gilgandra Shire Economy Profile. Accessed 22 January 2024
< https://app.remplan.com.au/gilgandra/economy/summary?state=koGRHb3omF0rkXLTk9DB6Jc0IzIzQ5 >
[25] REMPLAN. Warrumbungle Shire Economy Profile. Accessed 22 January 2024
< https://app.remplan.com.au/warrumbungle/economy/summary?state=pr1AFQDyu0Y6dOS2jvw2EHAfWfEyL >
[26] Australian Bureau of Statistics. Census of Population and Housing: Census dictionary. Industry of employment (INDP). Released 15/10/2021. Accessed 22 January 2024.
<https://www.abs.gov.au/census/guide-census-data/census-dictionary/2021/variables-topic/income-and-work/industry-employment-indp >

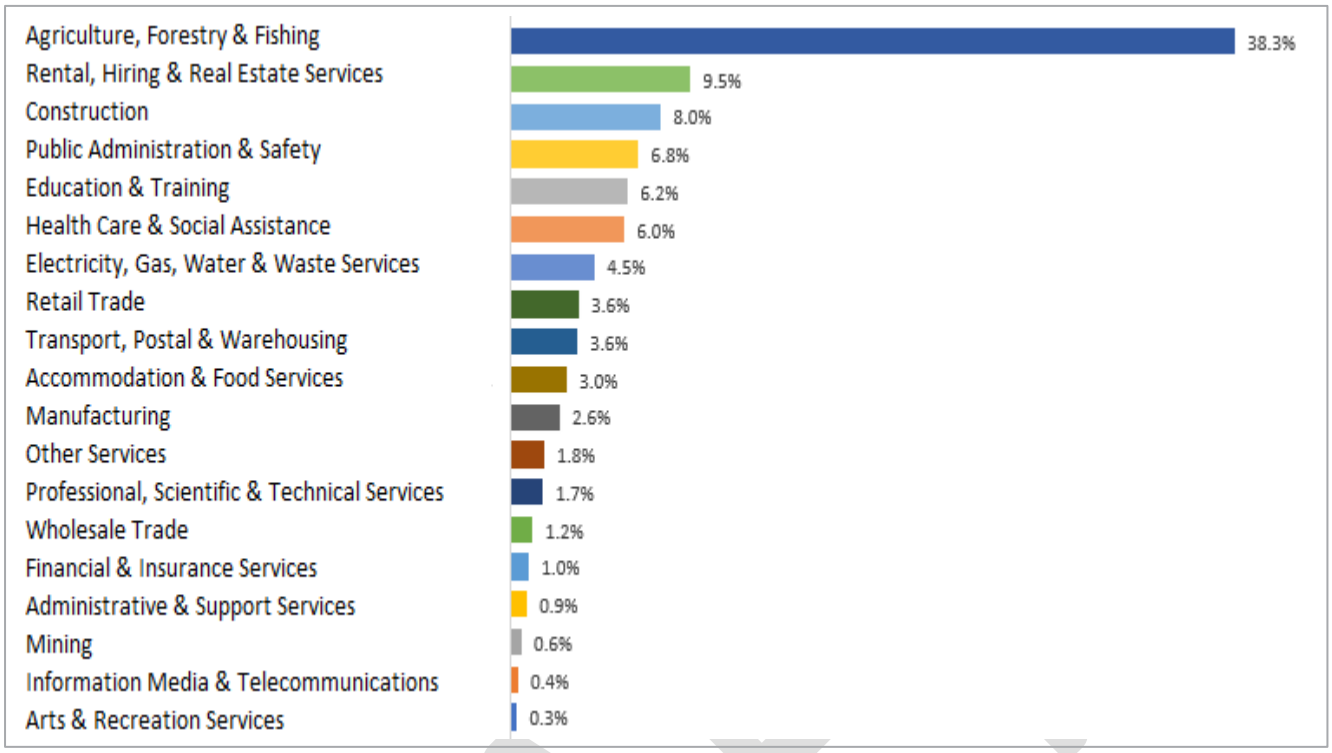

Figure 8: Castlereagh Country region economic output by industry.[24,25]

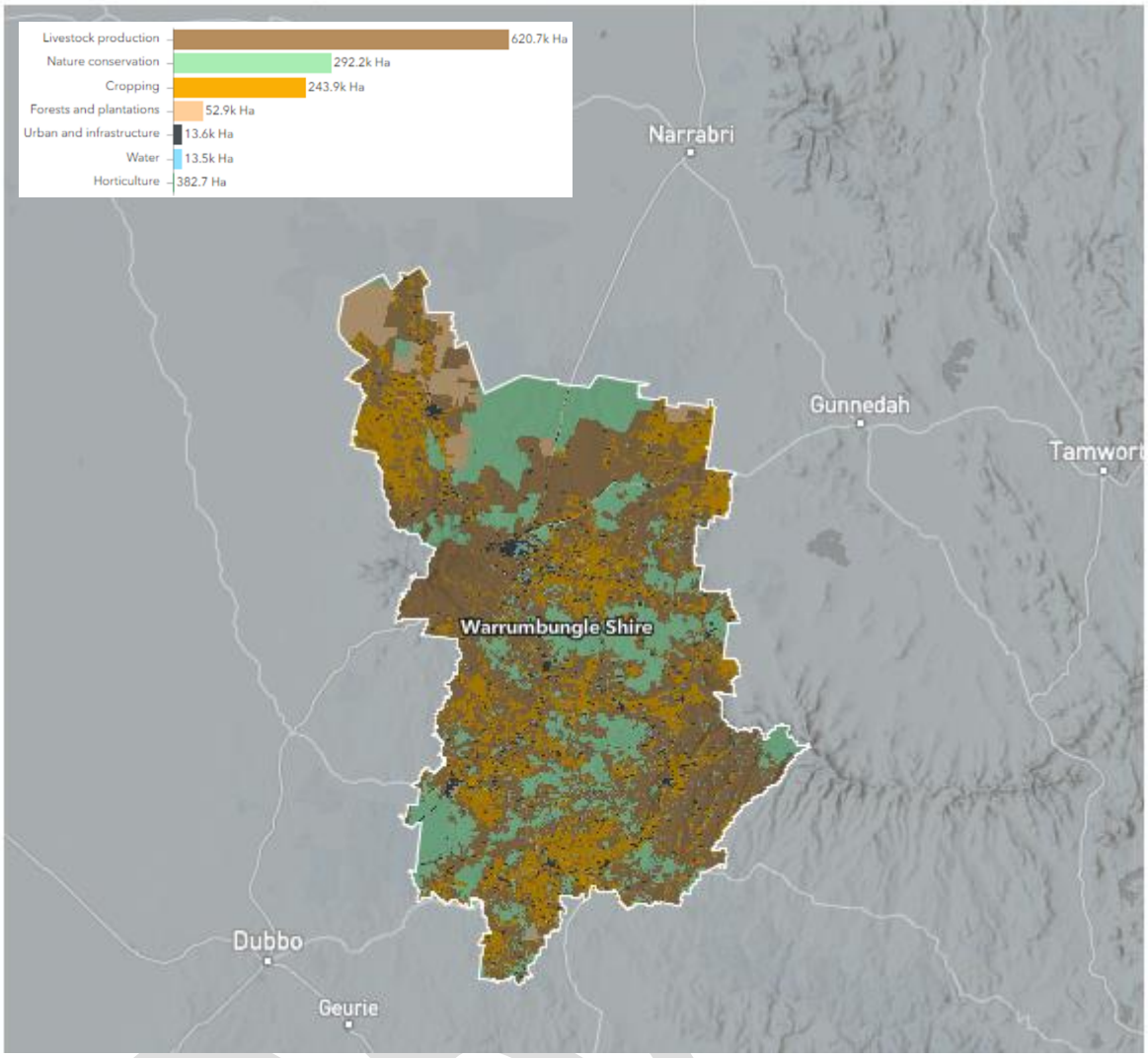

Figure 9: Warrumbungle LGA distribution of broad land use categories.[20]

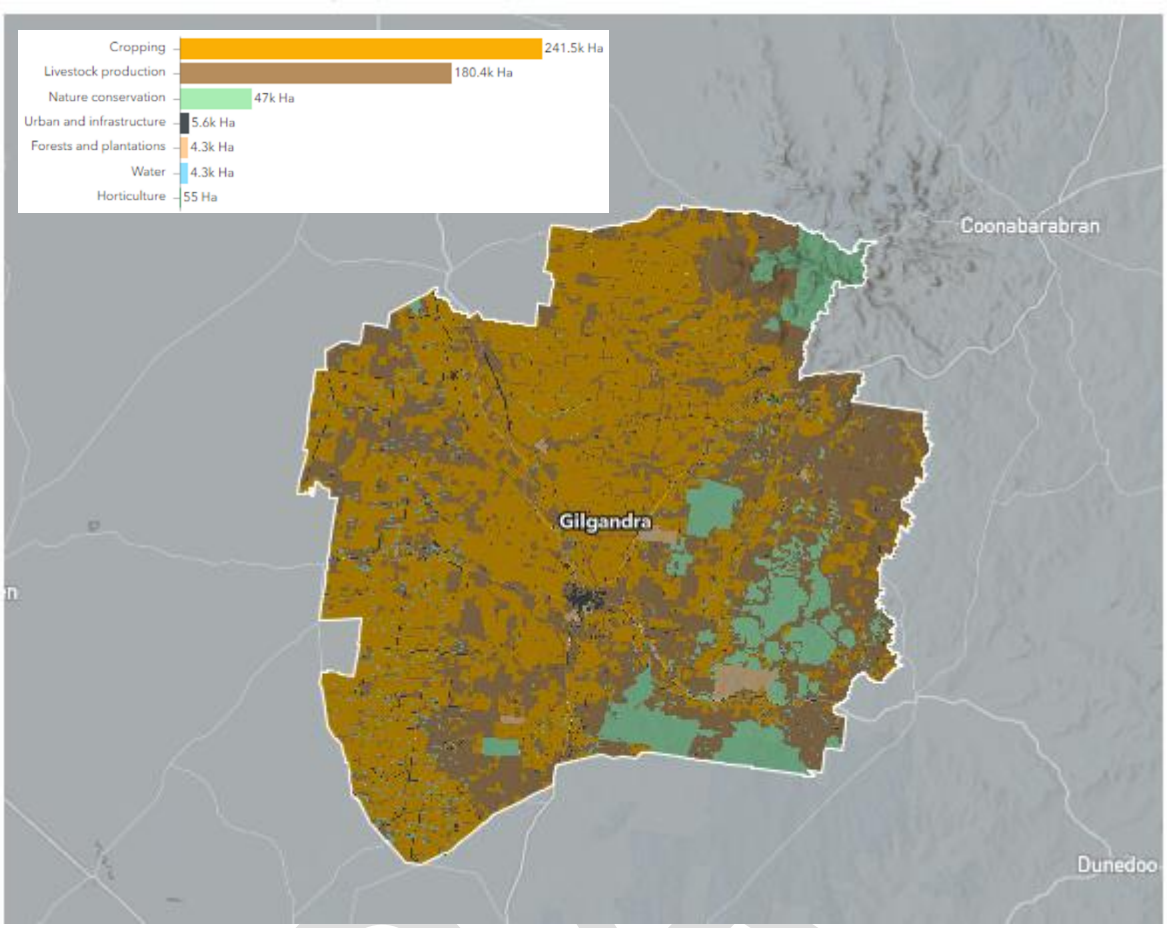

Figure 10: Gilgandra LGA distribution of broad land use categories.[20]

Wheat for grain is the largest output and cattle and calves the second largest by value for Gilgandra Shire, while the reverse is true for Warrumbungle Shire (Table 2). Cattle and calves are produced for meat, but also generate other byproducts.

Table 2: Summary of largest agricultural outputs.[14,15]

Index category	Warrumbungle LGA	Gilgandra LGA	Castlereagh Country Region
Cattle and calves ($M)	16.7	72.2	88.9
Wheat ($M)	84.2	30.3	114.5
Combined value ($M)	100.9	102.5	203.4
Combined % of all agricultural production	57%	55%	56%

Considering the predominance of the agriculture industries in the context of the older regional age profile, it is reasonable to conclude that there is significant knowledge and experience within the community. This observation was supported during stakeholder engagement where many community members indicated that resilience planning would likely benefit from accessing and disseminating this store of knowledge to maximise general resilience across the region. Like primary producers, experienced business owners and service provider managers and their staff also have accumulated knowledge of the impacts of drought on their businesses, and how their businesses can contribute to alleviating these effects.

5.3.3 Built environment

The two largest settlements in the Castlereagh Country region are Coonabarabran and Gilgandra. The role of these two towns as the administrative centres for the respective Gilgandra and Warrumbungle Councils places them at the centre of drought resilience planning and implementation as they will remain the primary locations that community regularly gravitate towards to address their needs.

These towns also have government primary and high schools, and primary Catholic schools. There is a broader distribution of other services across the Castlereagh Country region. For example, each of the smaller settlements has a central K-12 government school.

Binnaway and Mendooran are the only settlements that do not have a dedicated NSW Health facility, although the main health facility for all towns and settlements is Dubbo Base Hospital, which is some 60 km south of Gilgandra (Figure 3). Retail and other services are distributed across the towns, although these are at scale for their respective locations.

A common topic during stakeholder engagement was acknowledgement that use of public facilities for gatherings or other individual/family recreational use, for example public pools and community halls, provides much-needed mental health benefit during droughts. As many of these facilities are under Council control, their preparedness for responses or interventions might be readily achievable.

The Castlereagh Regional Economic Development Strategy – 2023 Update reported a tightening housing market since 2018, with residential vacancy rates in the region having dropped from 2.4% in January 2018 to a low of just 0.3% in March-May 2021, but having rebounded to 1.5% in August 2022.

Residential building approvals have remained consistently low, with either one or no approvals recorded in the data for most months in 2020 and 2021. There is no evident increase in-line with increased demand for housing. As vacancy rates remain below the levels of a healthy market, a focus will be required on increasing growth in housing supply to enable regional economic and population growth. Recent actions to activate the Gilgandra Aero Park development, with plans for 10 properties to be developed initially for use by Inland Rail staff working on the upcoming Narromine to Narrabri (N2N) project to, plus at least an additional 12 lots being prepared for sale on the open market will provide some boost to local housing supply in the region.[27]

5.3.4 Infrastructure

The region is serviced by an establish road and highway network providing for freight connectivity in all general directions (Figure 3).

The Telstra mobile coverage network offer 4G services across the region depending upon spatial availability (Figure 11). The proportion of total area in the Warrumbungle Shire which has 4G mobile phone coverage is 64%, while total area in the Gilgandra Shire is 78%.

[27] Gilgandra Shire Council (2022), Housing project with ARTC Inland Rail + design and construct EOI, Media Release, <https://www.gilgandra.nsw.gov.au/News/Media-Releases/Inland-Rail-Housing>

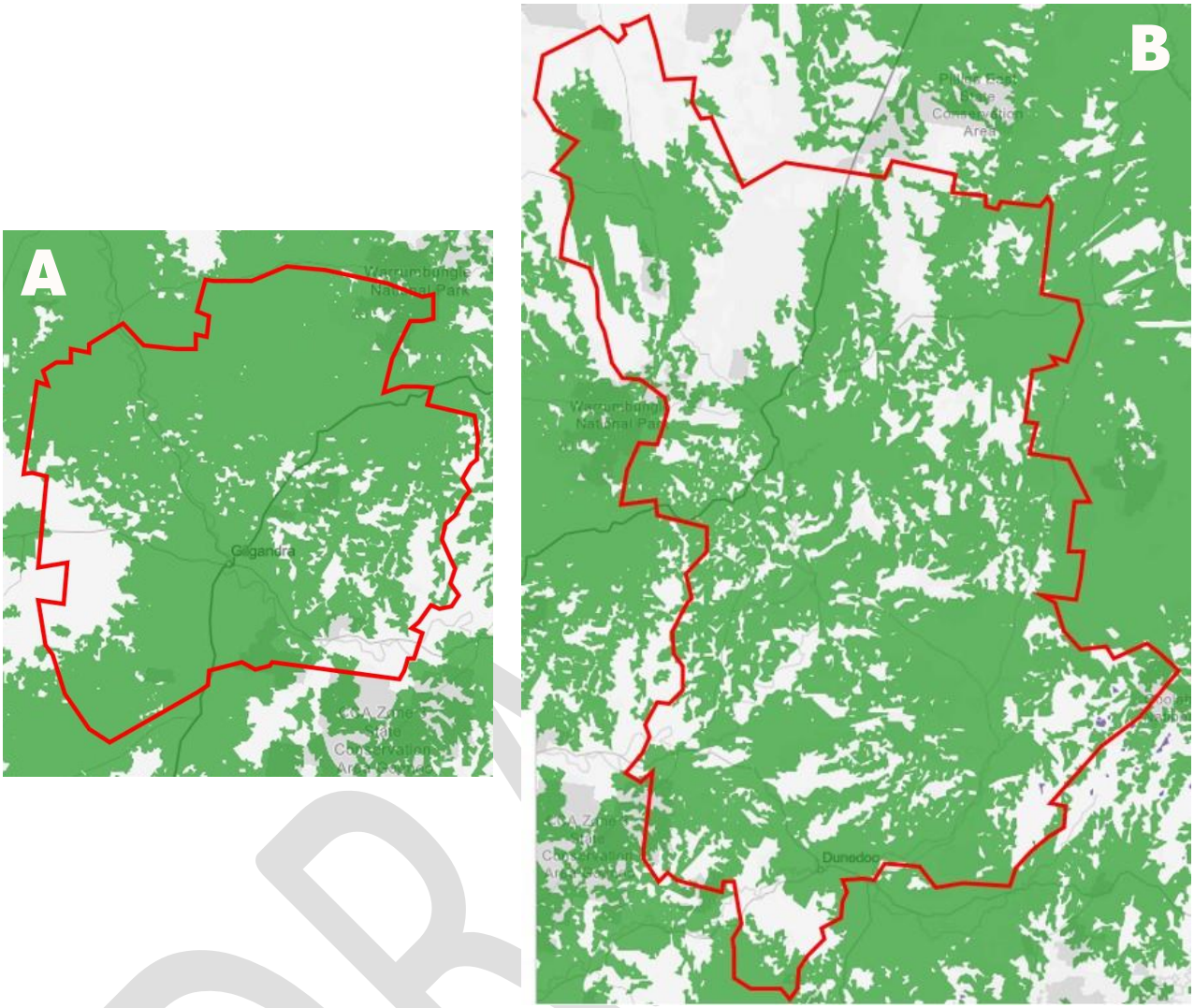

Figure 11: Telstra 4G coverage maps[28] (green areas) for (A) Gilgandra LGA and (B) Warrumbungle LGA.

5.4 Water Resources

5.4.1 Surface water and licensing

Castlereagh River and Talbragar River are the main surface water features of the Castlereagh Country region. The 1,140 ML capacity Timor Dam located at headwaters of the Castlereagh River catchment has the sole purpose of water supply to Coonabarabran. Both rivers are otherwise considered to be unregulated, meaning they have no major flow control storages to regulate flow releases for downstream surface water access. The Castlereagh River has seven gauging stations, including at Binnaway where the hydrographic record (Figure 12) is characteristic of highly variable flow in response to intermittent rain-fed inflows, and extended periods of low to no flow where the sandy beds of the rivers are often dry. A similar flow regime exists for the ungauged Talbragar River.

[28] Telstra. Our coverage maps. Accessed 29 January 2024. <https://www.telstra.com.au/coverage-networks/our-coverage>

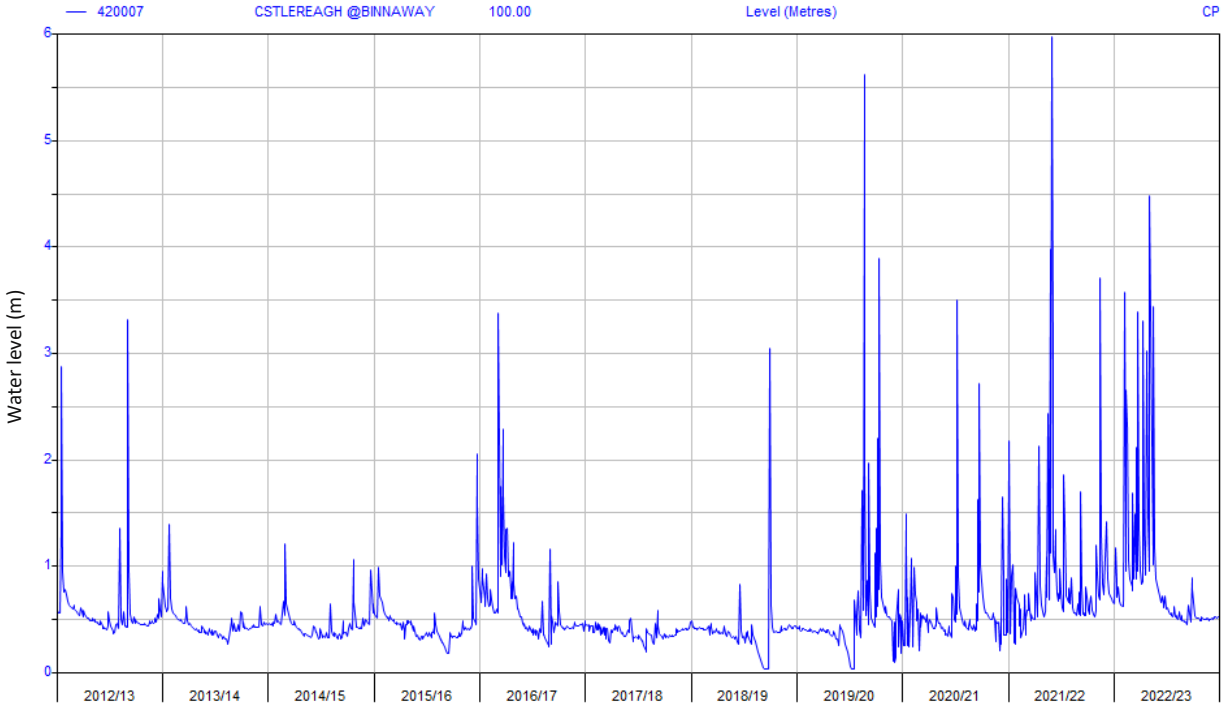

Figure 12: Historical water level gauging of Castlereagh River at Binnaway (site 420007).[29]

Castlereagh River water is licensed for access under the Water Sharing Plan for the Castlereagh Unregulated River Water Sources 2011[30] with varying quantities of unit shares held across private and water utility holders for water extraction (a unit share is equivalent to 1 ML when the Available Water Determination (AWD) for that water source is declared at 100%).

The Binnaway to Gilgandra Water Source (Figure 13) is accessed by Gilgandra Shire Council as the local water utility to service the Binnaway and Mendooran townships. During the past 10 years (mid-2013 to mid-2023) with AWDs consistently at 100%, the available 175 unit shares for utility water access have been used seven of 10 years to extract up to 98 ML/year. Private landholders hold a large 8,253 unit shares of unregulated river water, but during only three of past 10 years has pumped extraction occurred, and then only up to a maximum of 77 ML/year.

During the same period, the Castlereagh River Gilgandra to Coonamble Water Source has been accessed opportunistically in response large flow events. The available 1,559 unit shares held by Gilgandra Shire Council as the local water utility have been used during three the past 10 years (mid-2013 to mid-2023) to extract up to 120 ML/year. Gilgandra LGA private landholders hold a significant 3,190 unit shares of unregulated river water, but during only two years has pumped extraction occurred, and to a maximum of 660 ML/year.

The other two water sources in the water sharing plan are Castlereagh River above Binnaway and Tooraweenah to Coonamble Tributaries. Despite the existence of unit shares held across private and utility licences, no water has been extracted from the river system during the past 10 years.

With regard to information on available licensed water extraction activity, it is inferred that the regional river system does not represent a consistently reliable agricultural water source, but is beneficial for drinking water supply into the Binnaway and Mendooran townships.

[29] WaterNSW. Continuous water monitoring network. Accessed 18 January 2024. https://realtimedata.waternsw.com.au/water.stm
[30] NSW Government. Information about water sharing plans for the Macquarie-Castlereagh region. Accessed 18 January 2024. https://water.dpie.nsw.gov.au/plans-and-programs/water-sharing-plans/status/macquariecastlereagh-region

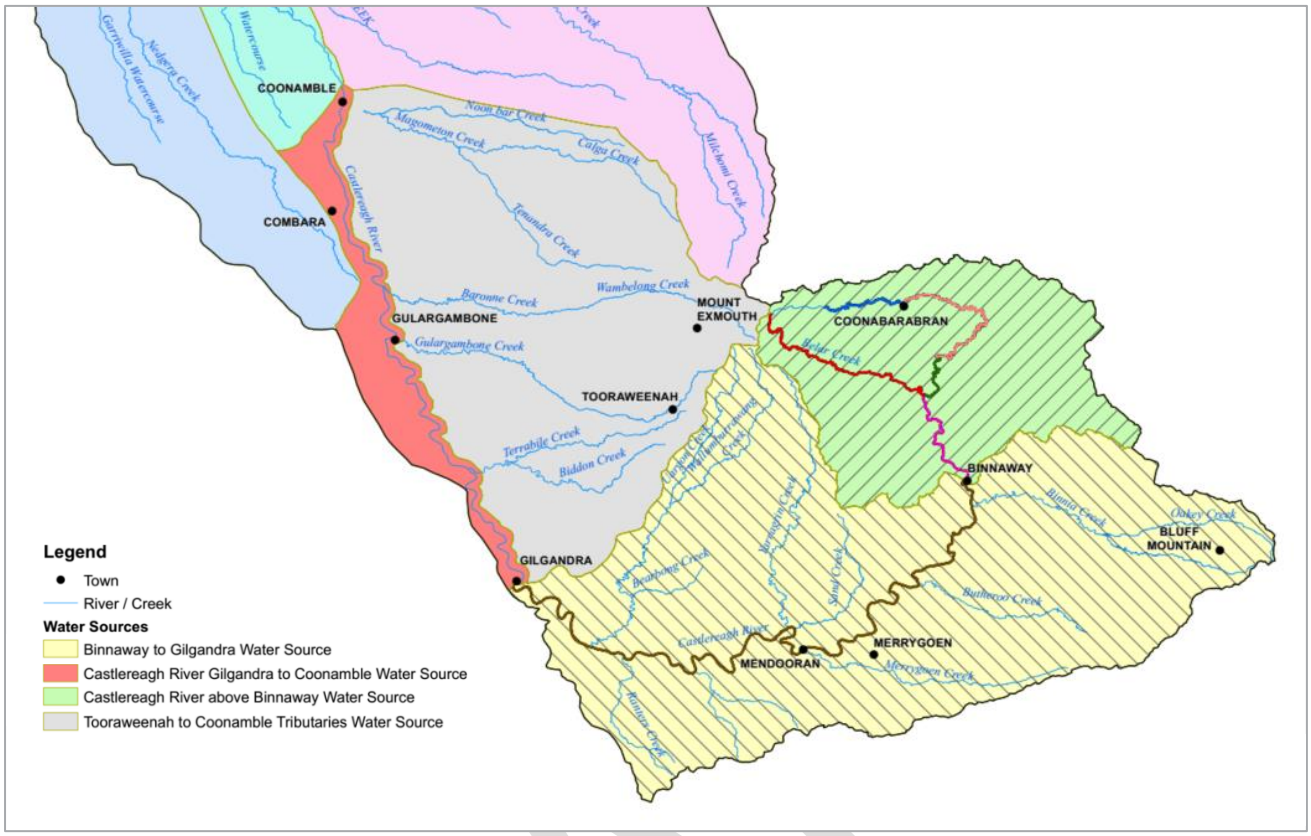

Figure 13: Map extract of the Water Sharing Plan for the Castlereagh Unregulated River Water Sources 2011.[31]

5.4.2 Hydrogeology and groundwater quality

Warrumbungle Shire

The Warrumbungle Shire is underlain by five major groundwater basins and aquifers, providing variable quantities and quality of groundwater. To the south of the shire near Dunedoo, the Lachlan Fold Belt provides domestic supplies in rural areas of variable quality. Parts of the south region are underlain by the Sydney Basin Permian Triassic Sandstones, which are often of low yield and brackish in water quality, with suitability only for stock drinking water.

The Talbragar River alluvial aquifer (Figure 14) is the sole area of the Warrumbungle Shire to provide good quality groundwater with high yield production bore rates of up to 120 L/s per second for the purpose of irrigation. This productive portion of this aquifer is located within the alluvial flats within approximately 10 km of the Dunedoo township.

[31] NSW Government. Plan Map Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources 2020. Accessed 23 January 2024. https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/540066/plan-map-wsp-macquarie-castlereagh-groundwater-sources-2020-WSP049_V1.pdf

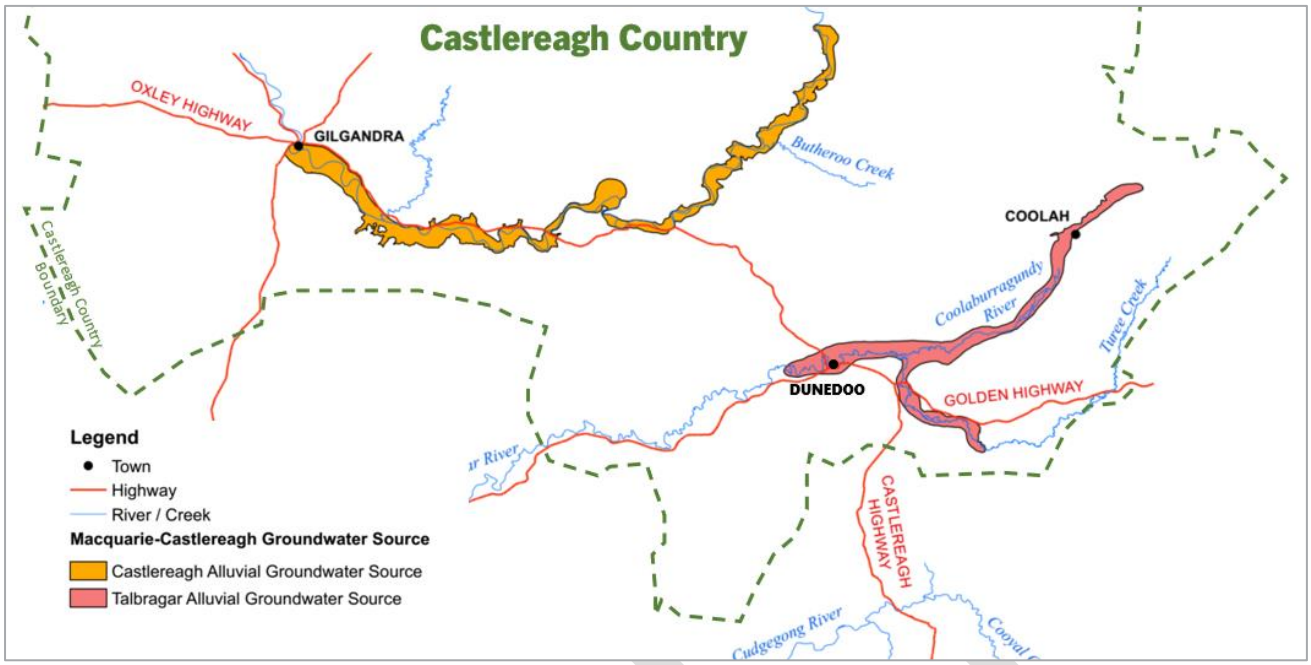

Figure 14: Map extract of the Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources 2020 annotated with Castlereagh Country boundary.[32]

The majority of the Warrumbungle Shire is underlain by the Cretaceous and Jurassic Great Artesian Basin intake beds. In many areas landholders access the shallow beds, which are typically low yielding and potentially brackish. Higher yielding and good quality groundwater is potentially available within the Great Artesian Basin intake beds at deeper depths, but cost to establish boreholes to several hundreds of metres is often a prohibitive hurdle for agricultural enterprises wishing to increase drought resilience.

A large portion of the Warrumbungle Shire is also underlain by the Permian and Triassic Gunnedah Basin, which was laid down under a marine environment, and subsequently its widespread aquifers tend to be saline or brackish and offer lower yields from sandstone aquifer interspersed between the thick shale beds. Selected areas to the east of Coonabarabran and towards Purlewaugh, have Gunnedah Basin formations at surface or near surface and is the only accessible aquifer in these areas.

Of the 3,212 groundwater bore records contained in the Australian Groundwater Explorer[33] across the Warrumbungle LGA (Figure 15), 302 bores have been subject to groundwater salinity testing at some point in time since bore construction. Assessing the highest salinity test result concentration at each bore against borehole depth (Figure 16) indicates 80% of groundwater exhibits salinity levels below 2,640 µS/cm. There exists a relatively small number of bores with salinity levels above 5,000 micro µS/cm, which are likely to be accessing groundwater from early Jurassic Garawilla Volcanics, the Gunnedah Basin or Lachlan Fold Belt or Sydney Basin rocks to the south of Warrumbungle Shire. Overall, groundwater bore depths are relatively shallow with a very high proportion of bores drilled to less than 100 metres below surface.

[32] NSW Government. Plan Map Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources 2020. Accessed 23 January 2024. <https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/540066/plan-map-wsp-macquarie-castlereagh-groundwater-sources-2020-WSP049_V1.pdf>

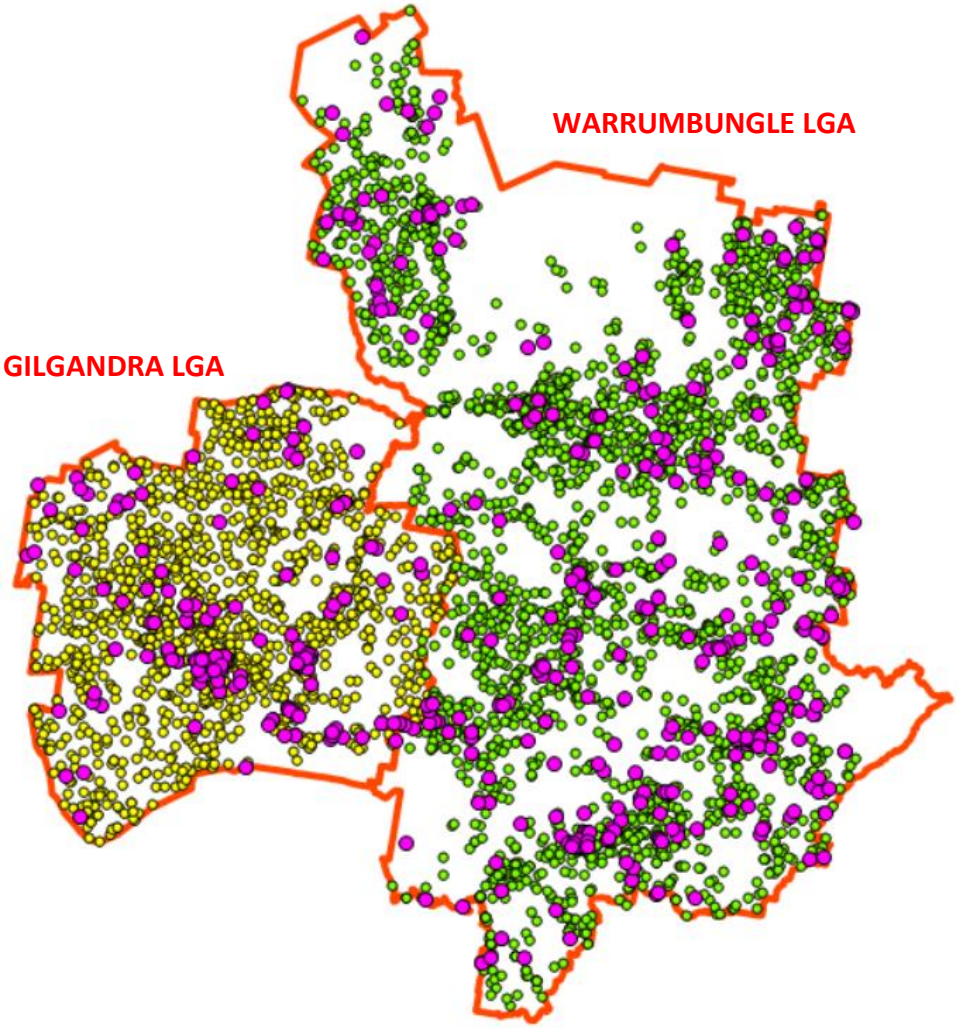

Figure 15: Distribution of bore records in the Australian Groundwater Explorer for Castlereagh Country, with records containing salinity measurement data indicated in purple.[33]

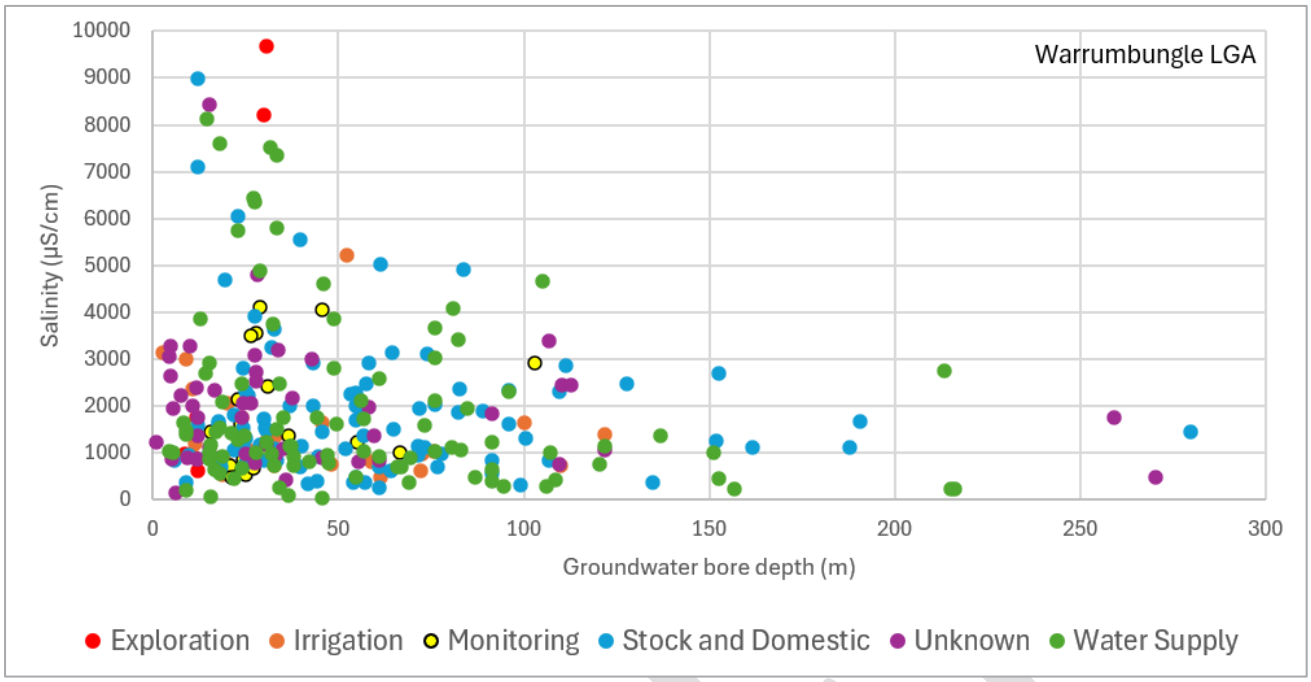

Figure 16: Maximum historical groundwater salinity measurements and borehole depths within the Warrumbungle LGA.[33]

Gilgandra Shire

The entire Gilgandra Shire is underlain by Cretaceous and Jurassic Great Artesian Basin intake beds, providing reliable and good quality groundwater. The majority of landholders access the shallow low yielding aquifers at depths around 40-100 metres.

In the northern half of the shire, the Great Artesian Basin sandstone beds dip to the north west and bore drilling depths typically extend to 150-250 metres. This generally provides higher yielding and better quality groundwater which rises to near surface under sub artesian pressures.

Recent drilling by the Gilgandra Shire Council has discovered that deeper Pilliga Sandstone occurs further to the south east, at areas near Curban and also further north east of the Tonderbrine area. The yields are relatively high and of excellent quality, and potential exists for small scale irrigation if regulatory approvals can be obtained.

There are also areas across the southern and central parts of the shire where Tertiary shallow aquifers exist above the Great Artesian Basin intake beds which provide limited yield under basic landholder rights.

The area north east of Gilgandra and the Castlereagh Highway is underlain by another sedimentary basin within the Gunnedah Basin. The Permian Triassic age material lies below the Great Artesian Basin intake beds. Relatively few groundwater bores have been drilled into this deep material and the extent of the aquifer is not well known. It is most likely yields will be low and of brackish quality.

Of the 1,764 groundwater bore records contained in the Australian Groundwater Explorer[33] across the Gilgandra LGA (Figure 15), 146 bores have been subject to groundwater salinity testing at some point in time since bore construction. Assessing the highest salinity test result concentration at each bore against borehole depth (Figure 17) indicates 80% of groundwater exhibits salinity levels below 1,650 µS/cm. Bores with salinity levels above 5,000 micro µS/cm are rare, which indicates high quality groundwater extends across the Gilgandra Shire.

Overall, groundwater bore depths are relatively shallow with a high proportion of bores drilled to less than 100 metres below surface.

[33] Australian Bureau of Meteorology. Australian Groundwater Explorer. Accessed 25 January 2024. <www.bom.gov.au/water/groundwater/explorer>

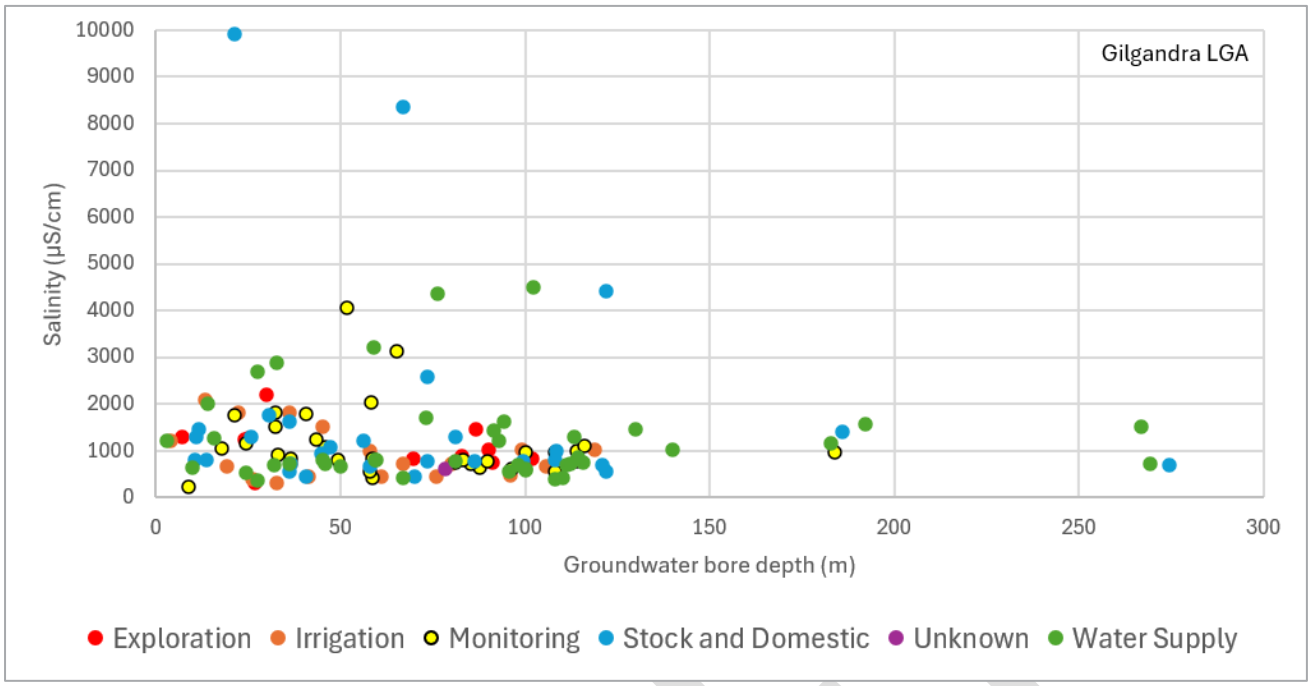

Figure 17: Maximum historical groundwater salinity measurements and borehole depths within the Gilgandra LGA.[33]

5.4.3 Groundwater licensing and usage

River surface waters are highly connected to shallow underlying alluvial aquifers along the main catchment riverbeds. These aquifers are an important source of groundwater and access to unit shares is licensed under the Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources 2020[34].

Agriculture in the region is primarily rain-fed, with limited irrigation restricted to land adjacent to shallow alluvial groundwater, which can be accessed in accordance with the water sharing plan. Groundwater extraction for irrigation is limited to share components held by private licensed users, and this translates to a potential maximum usage of 583 ML/year in the Castlereagh Alluvial Groundwater Source east of Gilgandra (Figure 14) and 5,355 ML/year in the Talbragar Alluvial Groundwater Source between Dunedoo and Coolah. The local water utility also supplies potable water to Dunedoo from its 650 unit shares in the Talbragar Alluvial Groundwater Source. Assessment of usage data[35] across 2013 to 2023 indicate no groundwater has been extracted for irrigation from the Castlereagh alluvium, which is supported by a complete lack of irrigation infrastructure. An average of 1,903 ML/year has been extracted for crop irrigation from the Talbragar alluvium in the vicinity of Dunedoo and the local water utility has extracted an average of 170 ML/year. Warrumbungle Shire Council publishes water level data for the alluvium (Figure 18) which evidences cyclical water table drawdown, likely in response to licensed groundwater extraction for irrigation purposes.

[34] NSW Government. Information about water sharing plans for the Macquarie-Castlereagh region. Accessed 18 January 2024. https://water.dpie.nsw.gov.au/plans-and-programs/water-sharing-plans/status/macquariecastlereagh-region
[35] WaterNSW. NSW Water Register. Accessed 18 January 2024. https://waterregister.waternsw.com.au/water-register-frame#

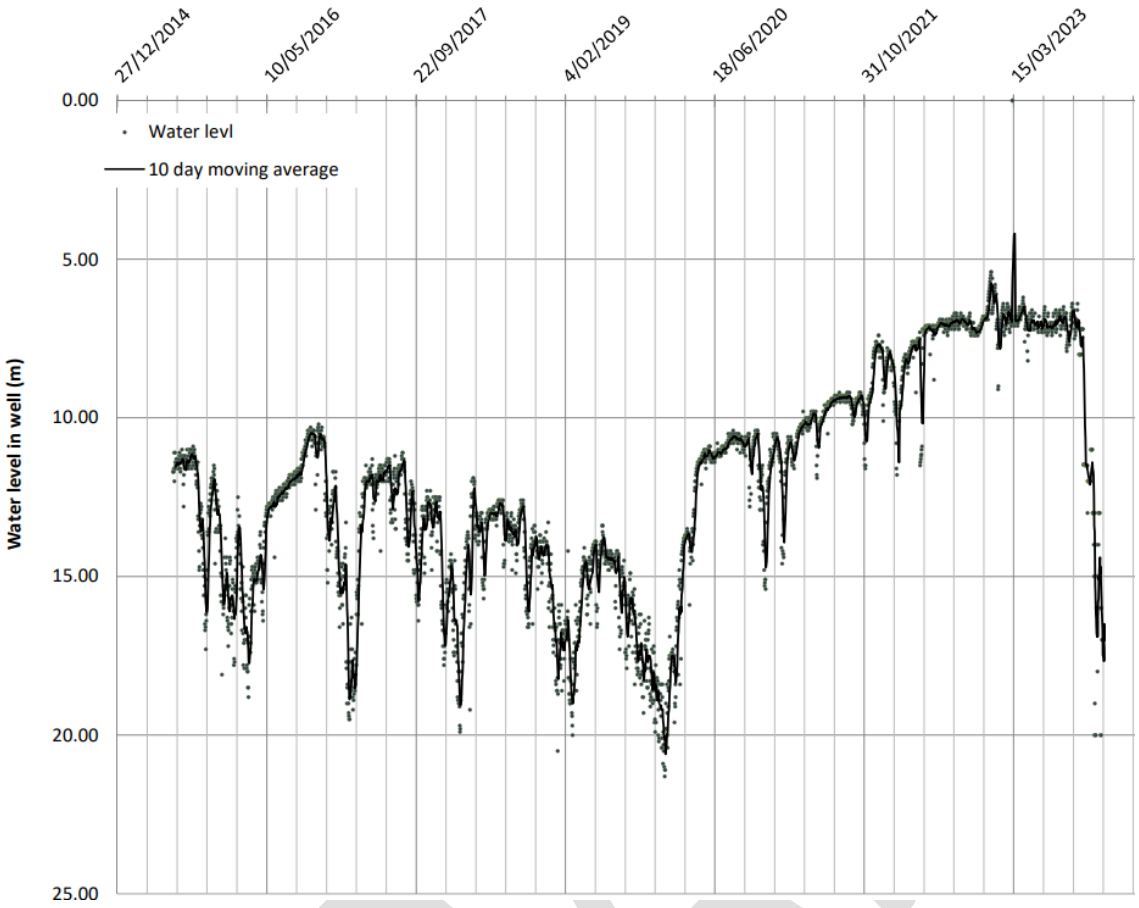

Figure 18: Historical water level data in the Talbragar Alluvial Groundwater Source which is relied upon for potable water supply to Dunedoo.[36]

The recent drilling by the Gilgandra Shire Council into the Pilliga Sandstone near Curban and north east of the Tonderbrine area accesses the Southern Recharge Groundwater Source, for which licensing is administered under the Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2020 (Figure 19). More than 24.6 GL of unit shares exists in the Southern Recharge Groundwater Source access water access licences. Assessment of usage data[37] across 2013 to 2023 indicates licensed annual average usage is marginally above 2.2 GL/year (9% of licensed water), indicating scope exists for development of groundwater bores in this region for irrigation purposes. This assertion is supported by consideration of overall water source extraction, which can include Basic Landholder Rights (BLR) as a major component. The sustainability of each water source in New South Wales is managed by Department of Climate Change, Energy, the Environment and Water (DCCEEW) and is actively monitored[40] for over extraction against the long-term average annual extraction limit (LTAAEL). Extraction volumes per water source are estimated from BLR estimates, water meter readings and the WaterNSW online water accounting system (iWAS)[38]. The total yearly extraction volumes for the Southern Recharge Groundwater Source (Figure 20) are consistently observed to be less than half of the LTAAEL.

[36] Warrumbungle Shire Council, Dunedoo Bore Water Levels, Accessed 28 January 2024, https://www.warrumbungle.nsw.gov.au/resident-services/warrumbungle-water-sewer/water-update-information/water-update-information

[37] WaterNSW. NSW Water Register. Accessed 18 January 2024. https://waterregister.waternsw.com.au/water-register-frame#

[38] WaterNSW. Online water accounting system (iWAS). Accessed 6 February 2024. <https://www.waternsw.com.au/customer-services/ordering-and-trading/ordering-water>

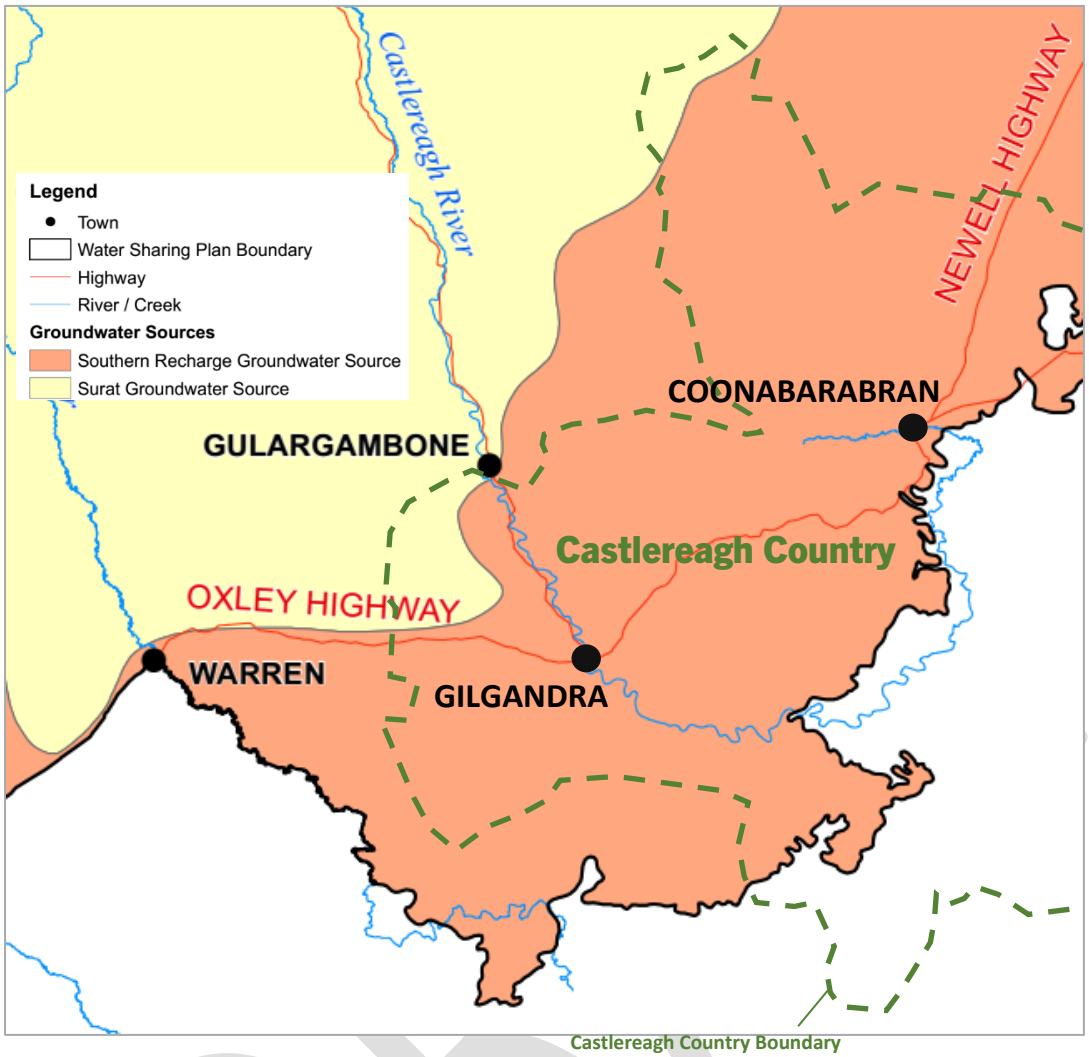

Figure 19: Map extract of the Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2020[39] annotated with Castlereagh Country region boundary.

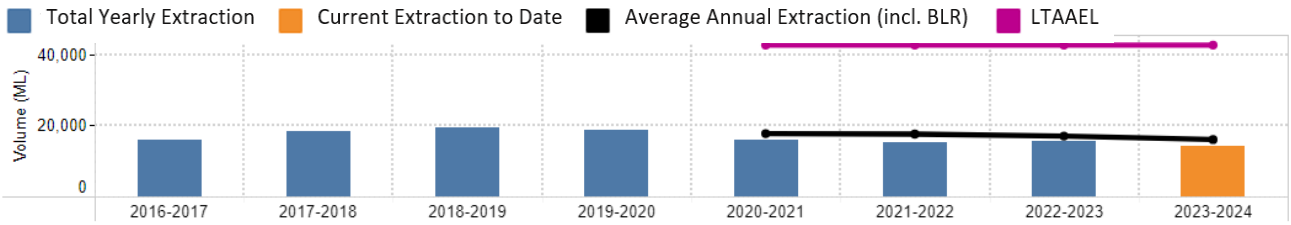

Figure 20 Monitoring of actual groundwater extraction against LTAAEL for the Southern Recharge Groundwater Source during full water years commencing 2016 to 2022 and part water year commencing 2023.[40]

[39] NSW Government. Plan Map Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2020. Accessed 23 January 2024. <https://water.nsw.gov.au/__data/assets/pdf_file/0010/539731/plan-map-wsp-gab-groundwater-sources-2020-WSP040_V2.pdf>

[40] NSW Department of Climate Change, Energy, the Environment and Water. Tracking groundwater extraction against extraction limits. Accessed 6 February 2024. <https://water.dpie.nsw.gov.au/allocations-availability/extraction-limits/tracking-groundwater>

Regarding town water supply, all the major towns and villages in the Warrumbungle LGA (Table 3) and Gilgandra LGA (

Table 4) are either fully or partially dependent on groundwater. In the Gilgandra Shire, groundwater is a critical resource for many parts of the shire due to the intermittent nature of surface water flows and low rainfall for extended periods. The Gilgandra township has a long history of groundwater reliance and was colloquially known as 'town of windmills' in the 1900s. Currently, Gilgandra Shire Council holds the largest licensed allotment of unit shares of any water utility in the Great Artesian Basin[41].

Since 2022, Warrumbungle Shire Council as the local water utility, has shored up groundwater supply resources by drilling additional backup bores and Council is currently in the process of securing sufficient water access licences to meet town water demand requirements. This project was complemented by a new 8 km pipeline connecting Nandi Creek, Homeleigh Drive and Bart Bok bores to the town water treatment plant.

Table 3: Groundwater extraction infrastructure and the aquifers targeted by Warrumbungle Shire Council for town water supplies within the LGA.

Town	Groundwater extraction infrastructure	Aquifer targeted for water supply
Baradine	2 bores	Access Pilliga Sandstone aquifer at depths over 200 metres
Binnaway	Castlereagh River well, 1 back-up bore	Access water in shallow wells on the Castlereagh River and deep Great Artesian Basin aquifer
Bugaldie	1 bore	Access shallow Great Artesian Basin aquifer
Coolah	2 bores at the town wells, 1 back-up bore in town	Access both shallow aquifer near Coolaburragundy River and a deep bore accessing Pilliga Sandstone
Coonabarabran	12 bores	Access both shallow and deep Great Artesian Basin aquifer
Dunedoo	2 bores	Access the shallow alluvial aquifer of the Talbragar River
Kenebri	1 bore	Access shallow Great Artesian Basin aquifer
Mendooran	Castlereagh River well, 2 back-up bores	Access water in shallow well on the Castlereagh River and shallow Great Artesian Basin aquifer
Merrygoen (not potable)	Castlereagh River well	Access water in shallow wells on the Castlereagh River

[41] Frontier Economics, 2016, Economic output of groundwater dependent sectors in the Great Artesian Basin, A report commissioned by the Australian Government and Great Artesian Basin jurisdictions based on advice from the Great Artesian Basin Coordinating Committee, August 2016.

Table 4: Groundwater extraction infrastructure and the aquifers targeted by Gilgandra Shire Council for town water supplies within the LGA.

Town	Groundwater extraction infrastructure	Aquifer targeted for water supply
Gilgandra	6 bores	Gilgandra town water supply bores are drilled to depths of up to 110 metres at locations west and south of the town, accessing a combined 120 L/s of good quality Great Artesian Basin groundwater
Tooraweenah	2 bores	Tooraweenah water supply bores are drilled to depths of up to 155 metres at locations within the township, accessing a combined 6.5 L/s of good quality Great Artesian Basin groundwater

5.5 Assessing Drought Impacts and Drought Resilience

The World Economic Forum estimates that drought costs $US6-8 billion per year globally due to losses in agriculture and related businesses alone – this does not include non-agricultural economic costs or harder to define and measure non-economic costs (e.g. impacts on mental health and well-being, changes to community/culture, environmental damage etc.)[42,43]. The environmental and socioeconomic impacts of drought are particularly severe in Australia, even though droughts are a natural and recurrent feature, because the large spatial and temporal hydroclimatic variability that exists[44,45,46] was not properly taken into account when agriculture and water storage/supply infrastructure and systems were designed[47,48]. For example, prolonged dry conditions associated with the ~1997–2010 Millennium drought[49,50,51,52,53] triggered water restrictions in major cities and heavily reduced (in some cases to zero) irrigation allocations across the Murray-Darling Basin, the largest agriculture region in Australia, resulting in major environmental and socioeconomic impacts[54,55,56].

[42] Below R, Grover-Kopec E, Dilley M (2007) Documenting drought-related disasters: a global reassessment. J Environ Dev 16:328–344.
[43] Botterill LC, Cockfield G (eds) (2013) Drought, Risk management, and policy: Decision-making under uncertainty. Drought and water crises. CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, Florida, USA 33487–2742.
[44] Murphy BF, Timbal B (2008) A review of recent climate variability and climate change in southeastern Australia. Int J Climatol 28:859–879
[45] Risbey JS, Pook MJ,McIntosh PC,WheelerMC, Hendon HH (2009) On the remote drivers of rainfall variability in Australia. Mon Weather Rev 137:3233–3253.
[46] Gallant AJE, Kiem AS, Verdon-Kidd DC, Stone RC, Karoly DJ (2012) Understanding hydroclimate processes in the Murray-Darling Basin for natural resources management. Hydrol Earth Syst Sci 16:2049–2068.
[47] Williams J (2003) Can we myth-proof Australia? Australas Sci 24:40–42.
[48] McKernan M (2005) Drought: The Red Marauder. Allen & Unwin, Crows Nest.
[49] Murphy BF, Timbal B (2008) A review of recent climate variability and climate change in southeastern Australia. Int J Climatol 28:859–879
[50] Verdon-Kidd DC, Kiem AS (2009) Nature and causes of protracted droughts in Southeast Australia - comparison between the federation, WWII and big dry droughts. Geophys Res Lett 36:L22707.
[51] Kiem AS, Verdon-Kidd DC (2010) Towards understanding hydroclimatic change in Victoria, Australia – preliminary insights into the "Big dry". Hydrol Earth Syst Sci 14:433–445, www.hydrol-earth-syst-sci.net/414/433/2010/
[52] Gallant AJE, Kiem AS, Verdon-Kidd DC, Stone RC, Karoly DJ (2012) Understanding hydroclimate processes in the Murray-Darling Basin for natural resources management. Hydrol Earth Syst Sci 16:2049–2068.
[53] van Dijk AIJM, Beck HE, Crosbie RS, de Jeu RAM, Liu YY, Podger GM, Timbal B, Viney NR (2013) The millennium drought in Southeast Australia (2001–2009): natural and human causes and implications for water resources, ecosystems, economy and society. Water Resour Res 49:1–18.
[54] Kiem AS (2013) Drought and water policy in Australia: challenges for the future illustrated by the issues associated with water trading and climate change adaptation in the Murray-Darling Basin. Glob Environ Chang 23:1615–1626.
[55] Kiem AS, Austin EK (2013) Drought and the future of rural communities: opportunities and challenges for climate change adaptation in regional Victoria, Australia. Glob Environ Chang 23:1307–1316.
[56] van Dijk AIJM, Beck HE, Crosbie RS, de Jeu RAM, Liu YY, Podger GM, Timbal B, Viney NR (2013) The millennium drought in Southeast Australia (2001–2009): natural and human causes and implications for water resources, ecosystems, economy and society. Water Resour Res 49:1–18

The simplest definition of drought is a deficit of water compared with normal conditions. However, droughts are more than just a lack of rainfall and have a wide-range of cascading impacts that may be caused or exacerbated by different factors (Figure 21). Five commonly used drought categories or types are:

- Meteorological drought: extent and severity of drought in terms of deficits in precipitation from average conditions, possibly combined with increased potential evapotranspiration.
- Soil moisture (or agricultural) drought: deficit of soil moisture (mostly in the root zone), emphasising availability of soil moisture to support vegetation growth (usually crop or pasture growth, meaning the terms soil moisture drought and agricultural drought are often used interchangeably).
- Ecological drought: prolonged and widespread deficit in soil moisture, or biologically available water, that imposes multiple stresses in terrestrial and aquatic ecosystems.
- Hydrological or water resources drought: departure in surface or sub-surface water supplies from average conditions.
- Socioeconomic drought: the impacts of one or more of the other types of drought on humans, communities and/or the economy, defined based on social expectations, perceptions and other measures (e.g. employment levels, income and debt levels, mental and physical health).

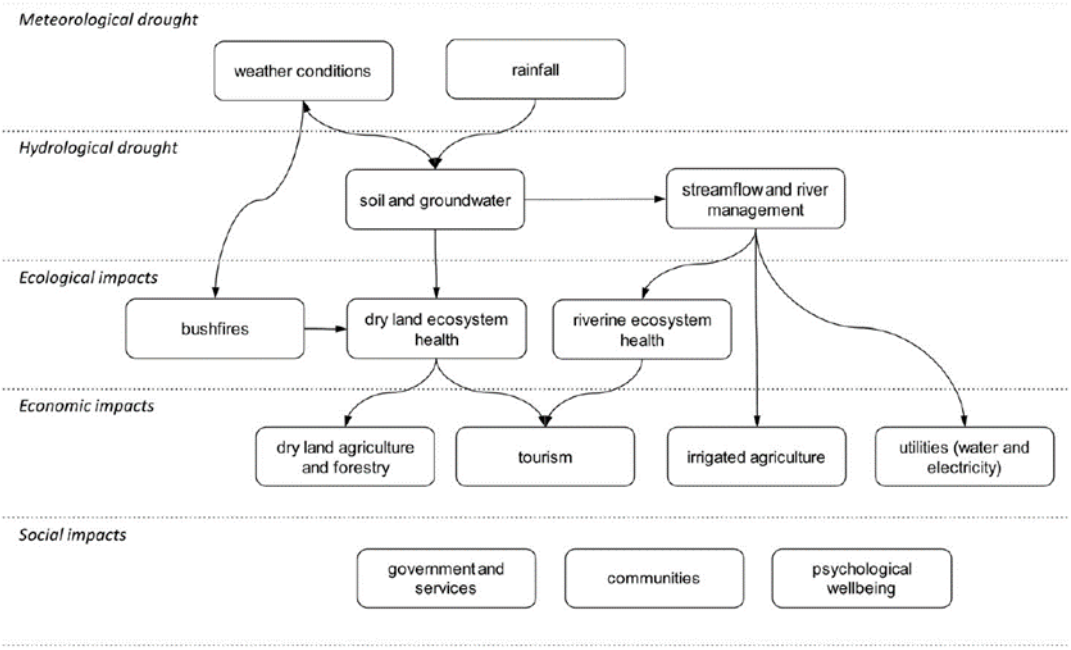

Figure 21: Drought propagation from meteorological drought (i.e. lack of rainfall) through the hydrological cycle and associated environmental, economic, and social impacts.[53]

5.5.1 Assessing Drought Impacts

Due to the multifaceted nature of drought, assessing drought impacts requires a triple-bottom-line approach (i.e. environmental impacts, economic impacts, social impacts).

Environmental impacts of drought include lower water levels in reservoirs, lakes and dams, as well as reduced streamflow in rivers. This decrease in available water can also lead to groundwater depletion, shrinking wetlands, and lower water quality (e.g. the concentration of salts and other contaminants can increase). Lower rainfall associated with droughts also results in lower soil moisture levels and a reduced ability for soils to support crops, an increased amount of dust due to dryness/erosion, and a greater chance of wildfires due to drier vegetation. Wildlife habitat may also become degraded because poor soil quality and inadequate water may affect plant growth, and there may not be enough drinking water for animals. There may also be stress placed on endangered species and a loss of biodiversity in drought-affected areas.

Economic impacts of drought occur at the individual, household/farm, regional, state, national and international level. For example, in

2008, during the Millennium Drought, tourism to the Murray River region dropped severely and this caused an estimated $70 million loss to the region's tourism industry. Drought also has huge impacts on Australia's agriculture industry, causing:

- damage to farmable land, including erosion and loss of topsoil
- reduced food and fibre production leading to shortages in supply
- fewer jobs – between 2007 and 2008, drought conditions caused the loss of 6000 agriculture jobs in the southern Murray–Darling Basin
- flow-on impacts to related industries such as manufacturing, transport, tourism, and retail
- flow-on impacts to consumers through price increases and shortages
- reduced income from exports.

Broadacre farming dominates land use in the Castlereagh Country region. Broadacre farmers in Australia are financially impacted by drought and variability in commodity prices[41]. As seen in Figure 22, the most profitable years for farmers tend to be those with high rainfall and favourable prices, such as 2016–17, while the least profitable tend to be drought years with unfavourable prices, such as 2006–07.

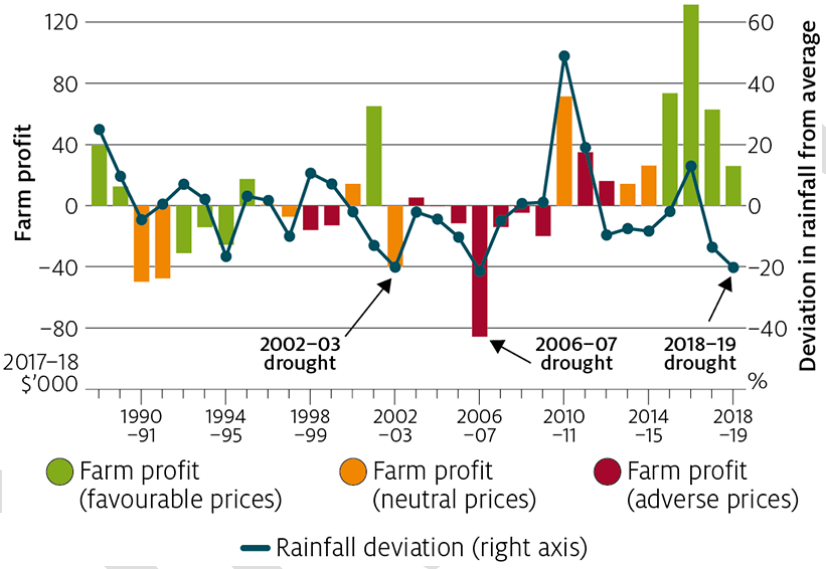

Figure 22: Annual average broadacre farm profit relative to rainfall and commodity prices (farm terms-of-trade), 1988–89 to 2018–19.[57] Farm business profit is calculated at market prices for all inputs and outputs, including unpaid family labour, as well as changes in the value of stocks (including inventory and livestock). Years classified as 'favourable prices' (100–65 percentile), 'neutral prices' (65–35 percentile) and 'unfavourable prices' (35–0 percentile) based on ABARES farmers terms-of-trade index. Rainfall is average for broadacre farms for the financial year.

Social impacts of drought can be both direct and indirect. For farmers and others living or running businesses in rural/regional areas, drought affects income, wellbeing and lifestyle. The social impacts of drought can include permanent loss of services in regional areas, loss of employment opportunities, negative physical health impacts (e.g. increased asthma associated with increased frequency of bushfire and dust storms), negative mental health impacts (e.g. during drought the risk of suicide increases by up to 15% for rural

[57] Hughes, N., Galeano, D., Hattfield-Dodds, S 2019, The effects of drought and climate variability on Australian farms, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0. <http://doi.org/10.25814/5de84714f6e08>.

makes aged 30-49 years), and financial hardship. Drought exacerbates the existing personal and professional burdens of regional communities such as poor health, isolation and limited access to services and infrastructure[58,59].

5.5.2 Assessing Drought Resilience

Resilience is the capacity of communities, environments and economies to cope with a hazardous event or disturbance, while maintaining their essential functions and structure. As shown in Figure 1, drought resilience means the ability to adapt, reorganise or transform when a drought occurs to maintain (or improve) environmental, economic, and social conditions even if the drought frequency, duration, or intensity is different to what has occurred historically. Drought resilience is strongly influenced by regional characteristics including wealth, infrastructure, policies and plans, the level of community cohesion and the extent to which regional economies depend directly on agriculture and/or water[60,61,62].

The Future Drought Fund Monitoring Evaluation and Learning (MEL) Framework, outlines the rationale, scope and approach for monitoring and evaluating the Future Drought Fund, including setting a range of high-level indicators to monitor drought resilience[3]. These indicators are shown in Table 5, categorised under the strategic priorities of the Future Drought Fund:

- Economic resilience for an innovative and profitable agricultural sector
- Environmental resilience for sustainable and improved functioning of farming landscapes
- Social resilience for resourceful and adaptable communities.

[58] Kiem AS, Austin EK (2013) Drought and the future of rural communities: opportunities and challenges for climate change adaptation in regional Victoria, Australia. Glob Environ Chang 23:1307–1316.
[59] Austin, E.K., Handley, T., Kiem, A.S., Rich, J.L., Lewin, T.J., Askland, H.H., Askarimarnani, S.S., Perkins, D.A. and Kelly, B.J. (2018), Drought-related stress among farmers: findings from the Australian Rural Mental Health Study. Medical Journal of Australia, 209: 159-165.
[60] Adams P., M. Horridge, J. Madden, G. Wittwer. 2002. Drought, regions and the Australian economy between 2001-02 and 2004-05. Centre of Policy Studies, Monash University
[61] Wanders N. 2016. Human impacts on droughts: how these hazards stopped being purely natural phenomena. Princeton University. Accessed 3 February 2022 <https://highwire.princeton.edu/2016/02/16/human-impacts-on-droughts-how-these-hazards-stopped-being-purely-natural-phenomena/>
[62] Department of Agriculture, Water and the Environment (DAWE). 2021. National Climate Resilience and Adaptation Strategy. Accessed 10 January 2022 <https://www.awe.gov.au/sites/default/files/documents/national-climate-resilience-and-adaptation-strategy.pdf>

Table 5: Framework mapping high-level indicators of drought resilience.[63]

Strategic priority	Thematic area	High-level indicators	How indicator informs progress towards resilience/ strategic priority
Economic resilience for an innovative and profitable agricultural sector	Macroeconomic	Rural Economies Sector performance	If rural economies are healthy with diverse and well-performing sectors and markets for trade, this will have flow on effects to businesses, individuals and systems in the agriculture sector, including though alternative income and business opportunities.
	Microeconomic	Farm financial diversification: • on-farm diversification of activity and income • off-farm income	This is about strategies, financial practices and decisions to minimise impact of drought. More diversification of farm and household income sources translates to less sensitivity to drought, and resources to draw on and manage through seasonal downturns. Diversifying income may include carbon farming.
	Microeconomic	Farm business drought risk: • change in farm profit • change in household income	Tailored analysis of aggregate farm performance comparing drought versus normal years and controlling for non-climate factors, measures the sensitivity and exposure of broadacre farms to drought over time. This is also influenced by farms' financial and human capital, and shows how impact of drought on farm outcomes varies between sectors and regions.
	Management structures	Farm planning and management practice	This indicator covers: planning for farm risks, planning for drought, drawing on planning to make business decisions, and confidence in achieving outcomes. These practices and management capacities are key elements in responding to adversity and taking action.

[63] DAWE 2020, Future Drought Fund Monitoring, Evaluation and Learning Framework, Department of Agriculture, Water and the Environment, Canberra, December 2020. <https://www.agriculture.gov.au/agriculture-land/farm-food-drought/drought/future-drought-fund/mel>

Strategic priority	Thematic area	High-level indicators	How indicator informs progress towards resilience/ strategic priority
	Economic productivity	Total Factor Productivity (climate adjusted) R&D investment and impact	Analysis of farm productivity, driven by technological progress, helps indicate progress of adoption of transformative approaches and technologies for improved financial resilience. Climate-adjusted estimates will isolate the effects of long-term technological change on productivity. Farm business expenditure (including through levies), and government investment in research and development supports capacity to innovate and adopt new approaches. Links to the Future Drought Fund Drought Resilience Research and Adoption Program for investment analysis, regional applicability and impacts.
Environmental resilience for sustainable and improved functioning of agricultural landscapes	Ecological management	Ecosystem Services Environmental stewardship uptake	Functioning ecosystems and the range of goods and services they provide underpins the health and productivity of agricultural landscapes and systems. Greater uptake of practices and value placed on (this aspect of) natural capital will contribute to adaptive capacity through income, and resource protection.
	Innovation	Carbon farming uptake Other innovation	Managing land for carbon sequestration is an example of innovation and re-thinking production that can provide income and protect natural capital stocks. Access to ideas, technology, and willingness to improvise and experiment supports adaptive capacity and transforming through change and taking opportunities.
	Landscape function	Groundcover (total vegetation cover) Soil health measures	Groundcover is a recognised biophysical process indicator that can suggest landscape health, function and soil condition. Important for drought resilience by enabling rain infiltration and protecting soil from erosion. Groundcover analysed at landscape level relative to suitable targets is a key natural capital measure to track preparedness and recovery from drought and linked environmental stresses.
	Agricultural production	NRM Practices and farming practices	Extent of specific on-farm NRM practices, for managing productivity and drought resilience. Sub-indicators here include improving soil water retention, more water efficient pastures, changed soil additives, increase fodder held, de-stocking early, or retaining groundcover. Higher levels of these will enable more efficient or productive use of the natural capital base, prior to and through drought.

Strategic priority	Thematic area	High-level indicators	How indicator informs progress towards resilience/ strategic priority
Social resilience for resourceful and adaptable communities	Demographic	Women, Indigenous, young people representation in agriculture Socio-economic status - Index of Education and Occupation Population change, migration Australian Natural Disaster (hazard) Resilience Index	Active participation of diverse groups of people within agriculture will enhance resilience through greater inclusion within communities, and more diverse ideas, skills, perspectives, and networks. Combining measures of educational attainment, employment and occupation participation indicates collective human capital in a community contributing to adaptive capacity and likely access to resources to respond to change (drought and other). Also indicates likelihood to share learnings. Population change can indicate desirability of area to live in, health and diversity of local economy. The Australian Natural Disaster Resilience Index applies across other thematic areas and could be applied to preparedness and response capacity to drought.
	Individual and social connectivity	Personal wellbeing Social capital Community human capital and partnerships	Levels of personal wellbeing (happiness and life satisfaction), and strength of bonding and bridging links within community such as through volunteer networks and sporting club participation, contribute to ability to respond to adversity individually and provide support to others, building resilience. Identification with shared norms and values increases trust and social capital. Effective local leadership and groups, community values and mutual trust are a key to solving problems and coordination when communities are faced with challenges.
	Economic	Financial Capital Economic Diversity Index	Personal and household income levels and financial wellbeing indicate extent of access to financial resources that the community can draw on to cope in the short-term and adapt to long-term adversity. An economic diversity index measures variety of employment sectors in a local economy relative to the Australian economy and is one of the most common and influential components of adaptive capacity metrics (human and financial capital). Areas that are more economically diverse are likely to be in a better position to respond to change than are less diverse areas.
	Structural factors	Community capital Services and infrastructure	Higher levels of confidence in leadership and governance capacity, safety, and access to local physical and support services contribute to adaptive capacity through the collective ability within a community to plan, connect and make decisions.

5.6 Institutional and Policy Context

Crisis management and financial assistance policies focused on drought response and recovery are commonly used around the world and have largely been assessed as ineffective. Drought relief packages have typically been viewed by recipients as belated or inadequate, unfairly distributed or difficult to access. Measures that promote self-reliance and preparedness are generally preferred by farmers, industry and government agencies alike. Globally, and in Australia, policies have shifted away from treating drought as an unexpected disaster and reacting to recover when a drought occurs towards developing early warning systems and implementing proactive risk management strategies that build resilience to drought.

States and territories have primary legislative and administrative responsibility for natural resources and agriculture. This includes:

- Land use
- Water management
- Drought response and planning.

The Commonwealth, states and territories also have several shared roles and responsibilities:

- Drought preparedness, response and recovery programs
- Capability building programs
- Tools and technologies
- Rural financial counselling services
- Health and wellbeing support
- Sharing relevant drought policy information
- Making available drought assistance information
- Contributing to the development of quality data
- Having input into drought policy and programs.

The Australian Government Drought Response, Resilience and Preparedness Plan assists farmers and rural communities prepare for, manage and recover from drought. The plan was released in November 2019 and focuses on three key areas:

- Immediate action for those in drought – comprising measures to support farmers and communities facing prolonged drought conditions.
- Support for wider communities affected by drought – recognising that many rural and regional communities depend on farmers for their livelihoods.
- Long-term resilience and preparedness – accepting that the next drought is inevitable and the importance of building capacity to withstand drought periods in the long-term.

There exists a large number national and local agencies in Australia involved in drought research, preparedness, response and recovery[64], and combined, they administer dozens[65] of drought resilience programs, including data platforms and on-ground assistance with drought planning, preparation, response and recovery.

[64] ACIL Allen. 2020. Drought resilience research, development, extension and adoption stocktake: gaps and opportunities for investment – Final Report.
[65] Department of Primary Industries and Regional Development. (2022) Drought Vulnerability Assessment for the Mid West region incorporating the City of Greater Geraldton and the Shires of Chapman Valley and Northampton.

5.6.1 Drought Policies, Plans and Priorities

The following documents were reviewed in the context of drought resilience:

- Central West and Orana Regional Plan 2041
- Castlereagh Regional Economic Development Strategy 2018-2022 - Incorporating Gilgandra Shire Council and Warrumbungle Shire Council
- Castlereagh Regional Economic Development Strategy – 2023 Update
- Country and Outback NSW Destination Management Plan 2022-2030
- Development Strategy Warrumbungle Shire Council – Drought Management Plan 2019
- Warrumbungle Shire Council Community Strategic Plan 2022/2037
- Warrumbungle Shire Economic Development & Tourism Strategy 2019-2023
- Baradine Community Action Plan
- Binnaway Community Action Plan
- Coolah Community Action Plan
- Coonabarabran Community Action Plan
- Dunedoo Community Action Plan
- Mendooran Community Action Plan
- Gilgandra Region Community Strategic Plan 2032
- Gilgandra Local Strategic Planning Statement 2020
- Gilgandra Activation Blueprint

Drought is frequently coupled with other natural disaster events such as floods, bushfires and more broadly a changing climate. The impacts of drought are typically dealt with at a broad level in most local plans because it is just one of many challenges communities face.

Existing plans, strategies and policies are referencing and identifying actions to address drought resilience. It is evident the Gilgandra and Warrumbungle communities have a range of existing projects and opportunities that, if implemented, may improve the community's resilience to drought impacts. These includes, diversifying the economy, supporting existing business, and increasing quality services and facilities to make the communities more attractive to locals and visitors. There is also broad acknowledgement of the need to improve the management of natural assets and the physical environment.

Water security is a common theme that exists across nearly every reviewed strategy and plan. Water security may involve water infrastructure, access to groundwater, improved surface water storage capacity in the Gilgandra and Warrumbungle LGAs or the legal licensing of access to available water resources (groundwater and surface water). The wide range of potential water security options presents an opportunity for the Drought Resilience Assessment to explore where vulnerability is greatest and to develop viable solutions.

6 Environmental, Economic and Social Drought Impacts

6.1 Defining Drought

As explained in Section 5.5, in simplest terms, drought is a deficit of water compared with normal conditions, but drought is more than just a lack of rainfall. In addition to the different types of droughts to consider, compared to other natural hazards droughts are unique in their timing with drought impacts usually only becoming apparent months or years after a drought has started developing (compared with minutes to days for other natural hazards) and once a drought is occurring it typically takes unusually wet conditions to return to normal circumstances. As a consequence, drought characteristics such as onset and duration are less clearly defined compared to other natural hazards which only persist while extraordinary meteorological conditions continue (i.e. rarely for more than a week).

To address these issues the NSW government developed the Enhanced Drought Information System (EDIS). The EDIS is a publicly available drought monitoring tool that monitors seasonal conditions across NSW. The EDIS was launched in March 2018 and is used across government and farming stakeholders to build drought risk awareness, emphasise drought preparedness, and improve confidence in drought monitoring and early warning. A key feature of the EDIS is the development of the Combined Drought Indicator (CDI). The CDI combines meteorological, hydrological, and agricultural definitions of drought (see Section 5.5) using indices for rainfall, soil, water, and plant growth. Table 6 shows the six drought phases defined by the EDIS using the CDI.

Table 6: Phases of drought.[66]

CDI PHASE	TECHNICAL DEFINITION	DESCRIPTION - TYPICAL FIELD CONDITIONS
Intense Drought	All three indicators (rainfall, soil water, plant growth) are below the 5th percentile	Ground cover is very low, soil moisture stores are exhausted and rainfall has been minimal over the past 6-12 months.
Drought	At least one indicator is below the 5th percentile	Conditions may be very dry, or agronomic production is tight (low soil moisture or plant growth). It is possible to be in Drought when there has been some modest growth, or a few falls of rain.
Drought Affected (intensifying)	At least one indicator is below the 30th percentile and the rainfall trend is negative over the past 90 days.	Conditions are deteriorating; production is beginning to get tighter. Ground cover may be modest, but growth is moderate to low for the time of year. When indicators are close to the Drought threshold drought conditions are severe.
Drought Affected (weakening)	At least one indicator is below the 30th percentile and the rainfall trend is positive over the past 90 days.	Production conditions are getting tighter, but there have been some falls of rain over the past month. It is rare to enter the Recovering phase from the Non-Drought category; Usually there is a quick (1-2 week) transition into Drought Affected or Drought. When indicators are close to the Drought threshold drought conditions are severe.
Recovering	All indicators are below the 50th percentile but above the 30th percentile	Production is occurring but would be considered 'below average'. Full production recovery may not have occurred if this area has experienced drought conditions over the past six months.
Non-drought	At least one indicator is above the 50th percentile	Production is not limited by climatic conditions.

Figure 23 shows the recent (February 2022 to present) drought status for the Castlereagh Country region indicated by the CDI and the associated phases of drought explained in Table 6.

[66] NSW Department of Primary Industries. Combined Drought Indicator, Accessed 26 January 2024. <https://edis.dpi.nsw.gov.au/cdi-drought-phases>

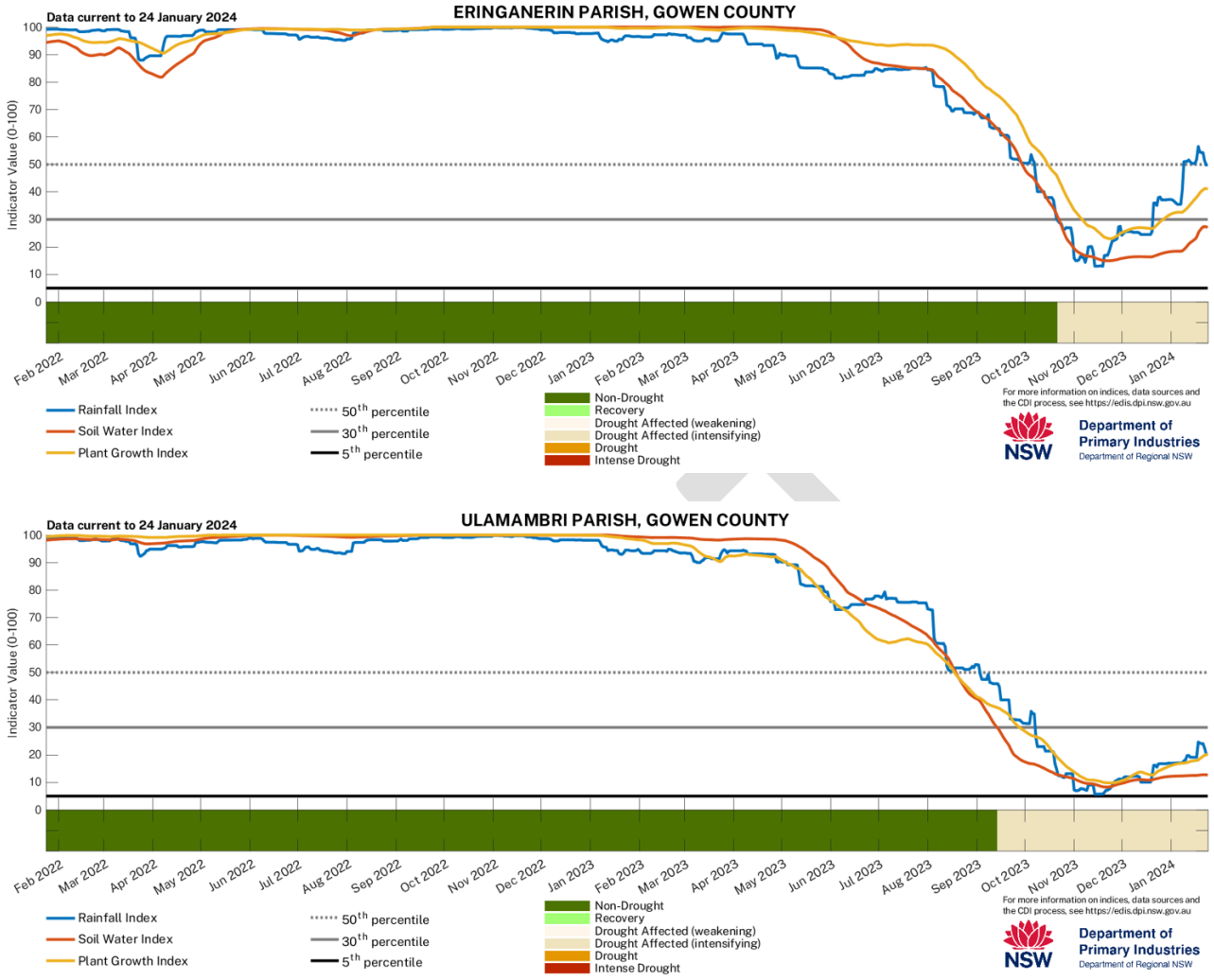

Figure 23: Recent (February 2022 to present) drought status for the Castlereagh County region indicated by the Combined Drought Indicator (CDI) for (top) Gilgandra (Eringanerin Parish) and (bottom) Coonabarabran (Ulamambri Parish).[67]

While the CDI and associated phases of drought is useful for drought monitoring and early warning in order to assess drought resilience more information is required about historical drought conditions (e.g. the CDI began in March 2018 and as such only one major drought experienced in the Castlereagh region is captured by the CDI (the 2017-2019 drought).

To overcome this limitation with the CDI, long-term historical rainfall, temperature, and potential evapotranspiration data was obtained from SILO[68] for the locations indicated in Table 7 (refer Figure 3) and used to calculate historical drought status for each growing season (April to October) from January 1900 to December 2023. The meteorological data from SILO was supplemented with monthly plant growth data available for both Gilgandra and Warrumbungle LGAs for 1890-2023 from Grains Research and Development Corporation (GRDC) Harvest Reports[69]. Drought status is based on the drought phase definitions shown in Table 6 (but with long-term SILO meteorological and GRDC plant growth data used instead of the CDI which is only available from March 2018). The representative locations shown in Table 7 were chosen to capture the spatial variability of hydroclimatic conditions (including

[67] NSW DPI. Seasonal Conditions Information Portal. Accessed 29 January 2024 <https://edis.spaceport.intersect.org.au/%2FDroughtHistory%2FParish>

[68] Queensland Department of Environment and Science (DES). SILO (Scientific Information for Land Owners) database of Australian climate data. Accessed 22 January 2024 <https://www.longpaddock.qld.gov.au/silo/>

[69] Grains Research and Development Corporation (GRDC) Harvest Reports, Accessed 25 January 2024. <https://nvt.grdc.com.au/harvest-reports>

drought impacts) across the Castlereagh region because it is not always the case that locations within the Castlereagh Country region are in drought (or not in drought) at the same time.

Table 7: Representative locations used to assess historical drought impacts across the Castlereagh Country region (refer to map in Figure 3).

LGA	Township location	Representative area	Latitude (degrees)	Longitude (degrees)
Warrumbungle	Kenebri	NW Warrumbungle LGA	-30.77	149.02
	Goolhi	NE Warrumbungle LGA	-31.00	149.76
	Coonabarabran	Central Warrumbungle LGA	-31.27	149.28
	Coolah	South Warrumbungle LGA	-31.83	149.72
Gilgandra	Armatree	NW Gilgandra LGA	-31.45	148.48
	Tonderburine	NE Gilgandra LGA	-31.34	148.73
	Gilgandra	Central Gilgandra LGA	-31.71	148.66
	Balladoran	South Gilgandra LGA	-31.86	148.64

6.2 Historical Drought

The Castlereagh region endured a severe and prolonged period of drought from 2018-2020 (Figure 24). Primary producers were heavily impacted, with many farmers suffering severe financial hardships, and forced into making difficult decisions related to reducing herd sizes or not planting crops.

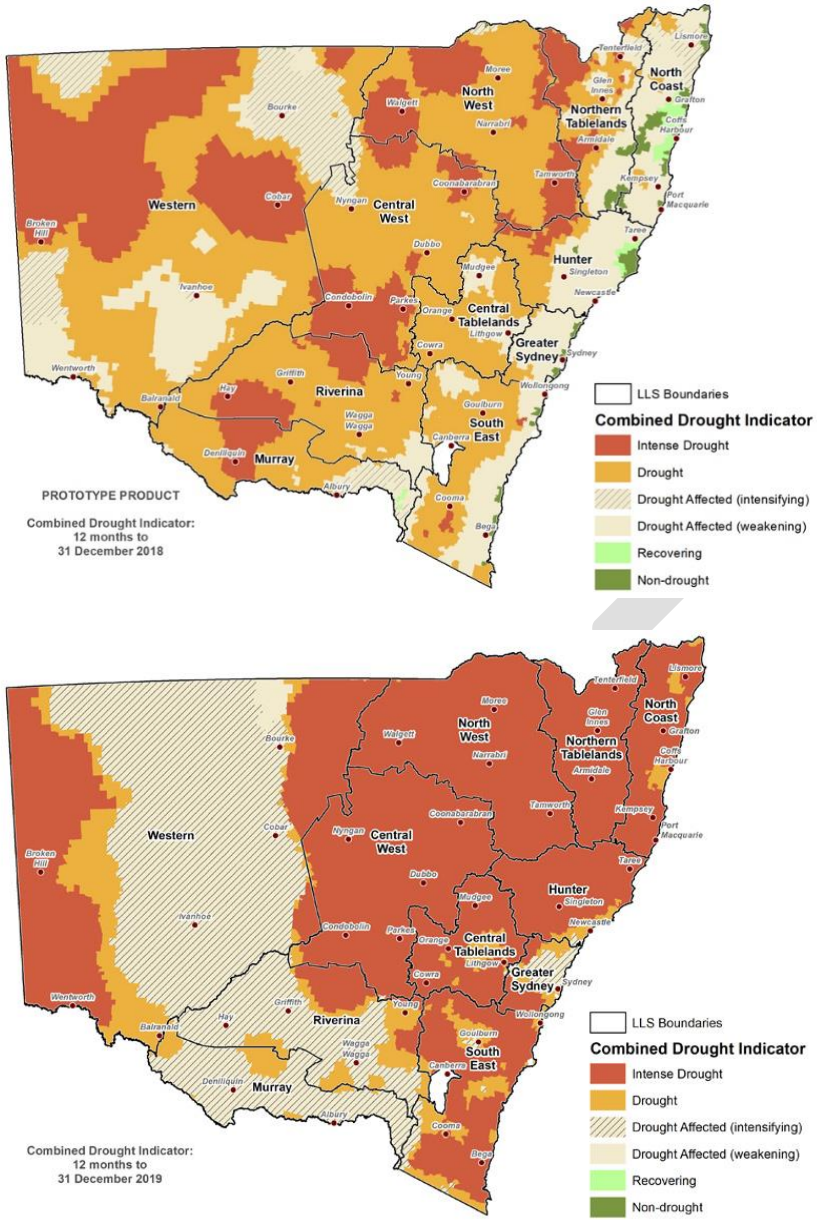

Figure 24: Combined Drought Indicator (CDI) for 12 months (top) to December 2018 and (bottom) to December 2019.[70,71]
While the impacts of the 2018-2020 drought were undoubtedly serious,
Figure 25 shows some recent (since 1980) droughts that have occurred in the Castlereagh Country region that had similar (or worse) impacts to the 2018-2020 drought (the most recent 2018-2020 drought is also included in

Figure 25 to enable comparison with earlier droughts). An important point to note is the spatial variation in how drought impacts (i.e. rainfall deficits) are experienced across the Castlereagh Country region – it is rare for the whole region to be experiencing the same level of drought, and sometimes (e.g. 2001-2004) parts of the region are in drought while others are not. This is consistent with anecdotal evidence obtained from engagement with local stakeholders who consistently highlighted the need for drought impact/resilience assessments to consider location-specific (i.e. at a sub-LGA) differences in the way drought is experienced across a

[70] Department of Primary Industries. NSW State Seasonal Update - December 2018, Accessed 24 January 2024. <https://www.dpi.nsw.gov.au/climate-landing/ssu/december-2018>
[71] Department of Primary Industries. NSW State Seasonal Update - December 2019, Accessed 24 January 2024. <https://www.dpi.nsw.gov.au/climate-landing/ssu/december-2019>

region.

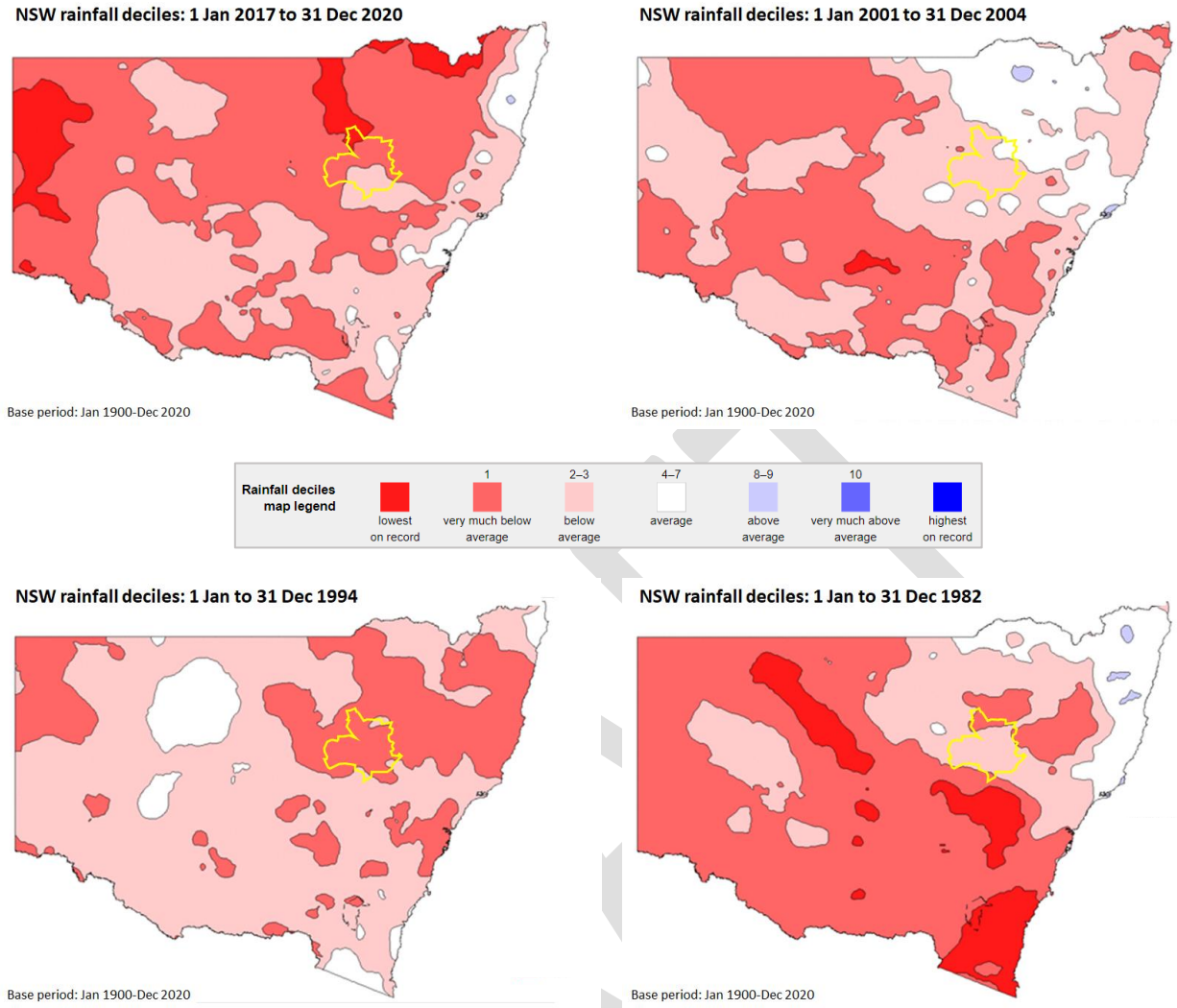

Figure 25: Periods since 1980 associated with drought in the Castlereagh Country region (yellow boundary).[72]

Drought status can be calculated based on growing season (April to October) meteorological data (from SILO) and plant growth data (from GRDC) – refer to Section 6.1 for further details. Based on long-term (1900-2023) historical drought status at representative locations across the Castlereagh Country region (Figure 26 and Figure 27), it is clear that drought has regularly occurred within the region. The number of droughts in recent decades (e.g. 2001-2020) is higher than in the previous two decades (i.e. 1981-2000) (Table 8), but whether this is due to natural decadal-scale climate variability or evidence that anthropogenic climate change is already increasing drought frequency in the Castlereagh region (or both) is currently unclear because drought dominated decades have occurred earlier in the 1900s (e.g. 1927-1946). Irrespective of the cause, increased drought frequency in recent decades has caused significant environmental, economic, and social impacts and needs to be considered and addressed when developing the Castlereagh Country RDRP.

[72] Bureau of Meteorology. 124 years of Australian rainfall. Accessed 28 January 2024. <http://www.bom.gov.au/climate/history/rainfall/>

Table 8: Number of growing seasons classed as Drought Affected, Drought, or Intense Drought during 1981-2000 compared with during 2001-2020.

LGA	Township location	Number of growing seasons classed as Drought Affected, Drought, or Intense Drought for 1981-2000	Number of growing seasons classed as Drought Affected, Drought, or Intense Drought for 2001-2020	Change (2001-2020 minus 1981-2000)
Warrumbungle	Kenebri	3	10	7
	Goolhi	4	11	7
	Coonabarabran	2	10	8
	Coolah	3	9	6
Gilgandra	Armatree	5	8	3
	Tonderburine	4	9	5
	Gilgandra	4	11	7
	Balladoran	5	8	3

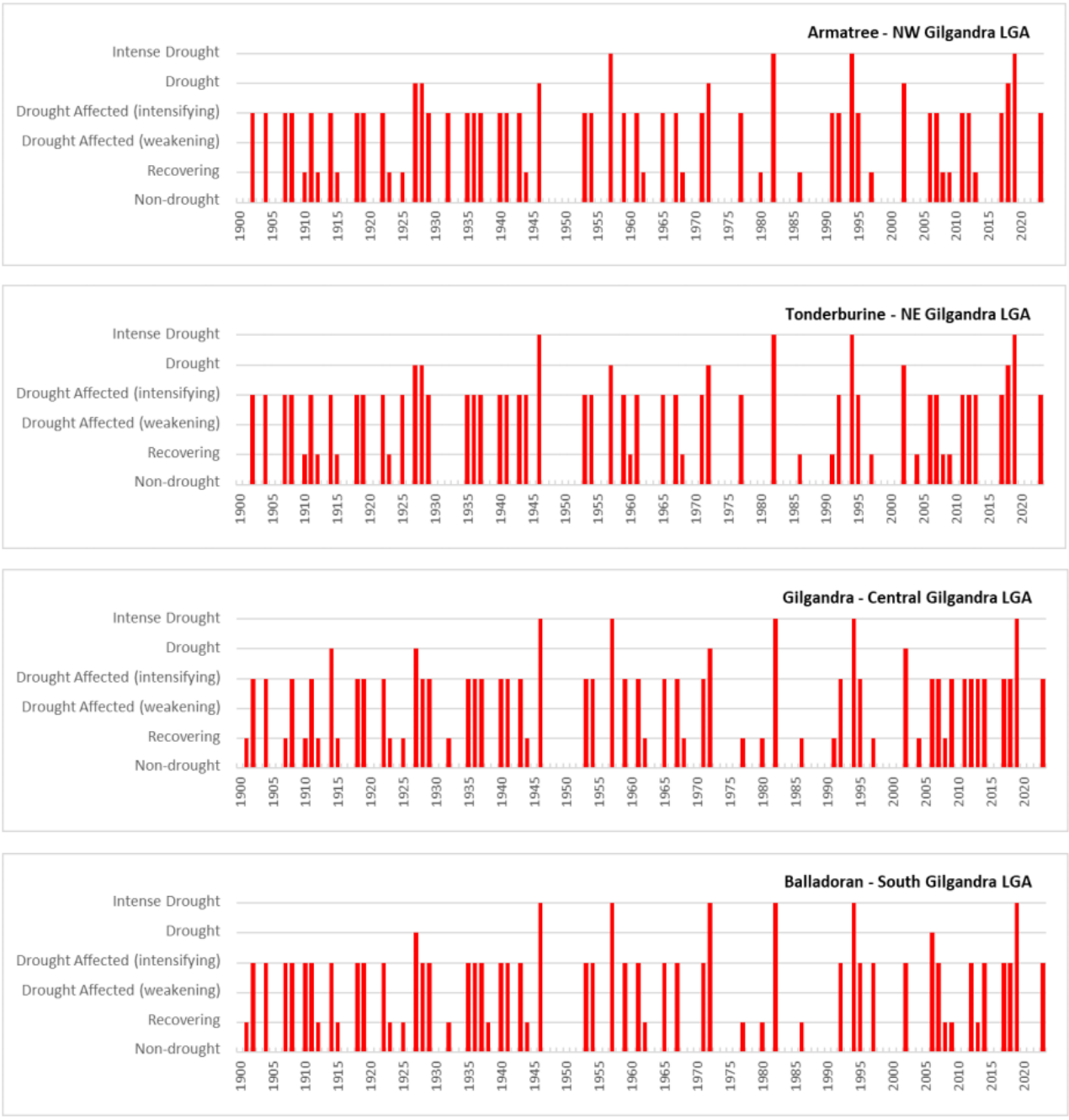

Figure 26: Historical (since 1900) drought phases (as defined in Table 6) at representative locations in the Gilgandra LGA (see Table 7 and map in Figure 3 for details on the representative locations).

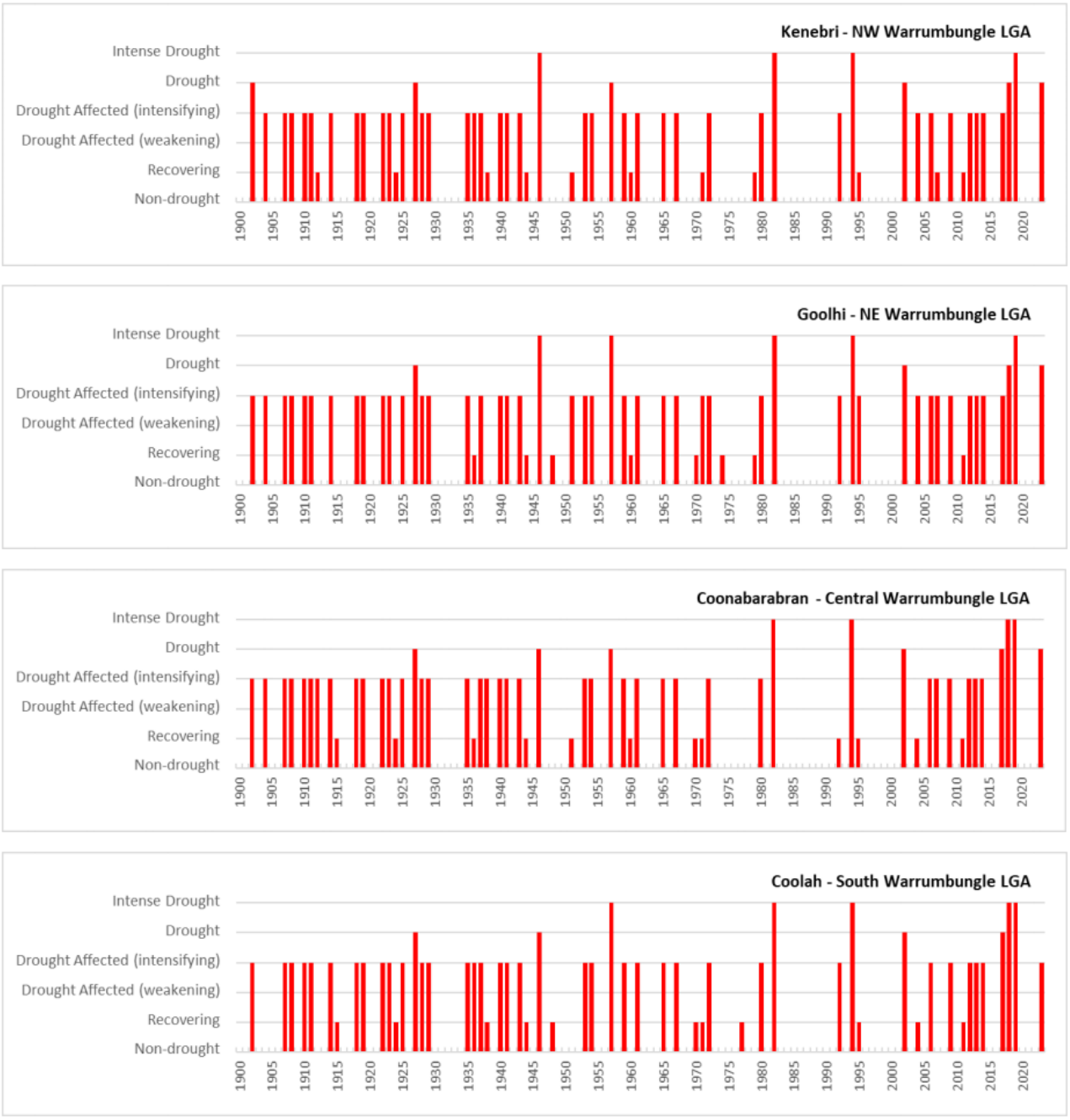

Figure 27: Historical (since 1900) drought phases (as defined in Table 6) at representative locations in the Warrumbungle LGA (see Table 7 and map in Figure 3 for details on the representative locations).

6.3 Future Drought

In the future, it is projected that drought will continue to be a regular occurrence in the Castlereagh Country region with possible increases in the frequency and severity of drought impacts. The best available climate modelling results project the following changes to drought-related-variables in the Castlereagh region:

- Average temperatures projected to increase in all seasons (very high confidence).
- Number of hot days and warm spells projected to increase (very high confidence).

- Average winter/spring rainfall projected to decrease (high confidence).
- Changes in summer/autumn rainfall are possible but unclear and varies by location.
- Increased intensity of extreme rainfall events (high confidence).
- A harsher fire-weather climate in the future (high confidence).
- Fewer frosts are projected (high confidence).

Table 9 shows the change in the number of growing seasons associated with different drought phases when the projected impacts of climate change (as listed above) are applied to historical data to infer plausible future drought conditions for the Castlereagh Country region. At all locations the number of growing seasons not associated with drought is projected to decrease and the magnitude of drought is projected to increase (i.e. the number of Intense Droughts is projected to increases at every location and the number of Drought Affected years is projected to increases at six out of eight locations).

Table 9: Change in the number of growing seasons associated with different drought phases when the projected future (2030-2063) is compared with 1990-2023.

LGA	Township location	1. Non-drought	2. Recovering	3/4. Drought Affected	5. Drought	6. Intense Drought
Warrumbungle	Kenebri	-3	-1	4	-1	1
	Goolhi	-2	0	2	-2	2
	Coonabarabran	-2	-3	5	-1	1
	Coolah	-3	2	-1	1	1
Gilgandra	Armatree	-3	-1	2	0	2
	Tonderburine	-2	-2	4	-2	2
	Gilgandra	-1	-2	-1	3	1
	Balladoran	-3	-2	3	0	2

6.4 Impacts of Drought

6.4.1 Aboriginal Community Impacts of Drought

<<TBC when engagement completed>>

6.4.2 Economic Impacts of Drought

Economic impacts of drought emerging from the stakeholder engagement included:

- Extra costs associated with the need to stockpile grain, silage and hay in suitable storage facilities so as to preserve quality for use during drought.
- Costs (time) associated with establishing eligibility and preparing applications for drought assistance grants (or subsidies or loans) and, if grants are won, justifying/reporting how the grant money is spent. Delays in approving grant applications are also problematic as there were examples given of situations whereby the time the grant money was approved it was no longer financially viable to implement the desired drought resilience strategy.
- Demand for, and cost of, feed significantly increases during drought. Labour costs associated with "hand feeding" also significantly increases during drought.

- "Buy local" initiatives are very important, especially during droughts. Local businesses need to be supported and receiving donated goods that are sourced outside the local area (as is common during major droughts) has a negative effect on local economies.
- Challenges associated with accessing financial help (especially for people in lower socioeconomic brackets). Banks and legal services are no longer local and this causes barriers and negative economic impacts on individuals and the wider community.

The Warrumbungle and Gilgandra LGAs fall within the Far West NSW Region for which ABARES agricultural economic data is collated, and it is assumed findings based on Far West NSW Region data are applicable to Castlereagh Country. The economic impact of drought within the Far West NSW region (Figure 28) for recent droughts affecting the Castlereagh Country (2001-2004 and 2017-2020 in accordance with Figure 24) shows negative farm profits and peaks in farm labour. These impacts are especially true for years 2003 and 2019, when drought conditions had been experienced for at least 18 consecutive prior months. This is consistent with the insights gained from the stakeholder engagement where people repeatedly told stories of how much extra work there is to do during drought (e.g. sourcing feed, hand feeding, selling (or slaughtering) livestock, doing work that would normally be done by contractors because there is no money available to pay contractors etc.).

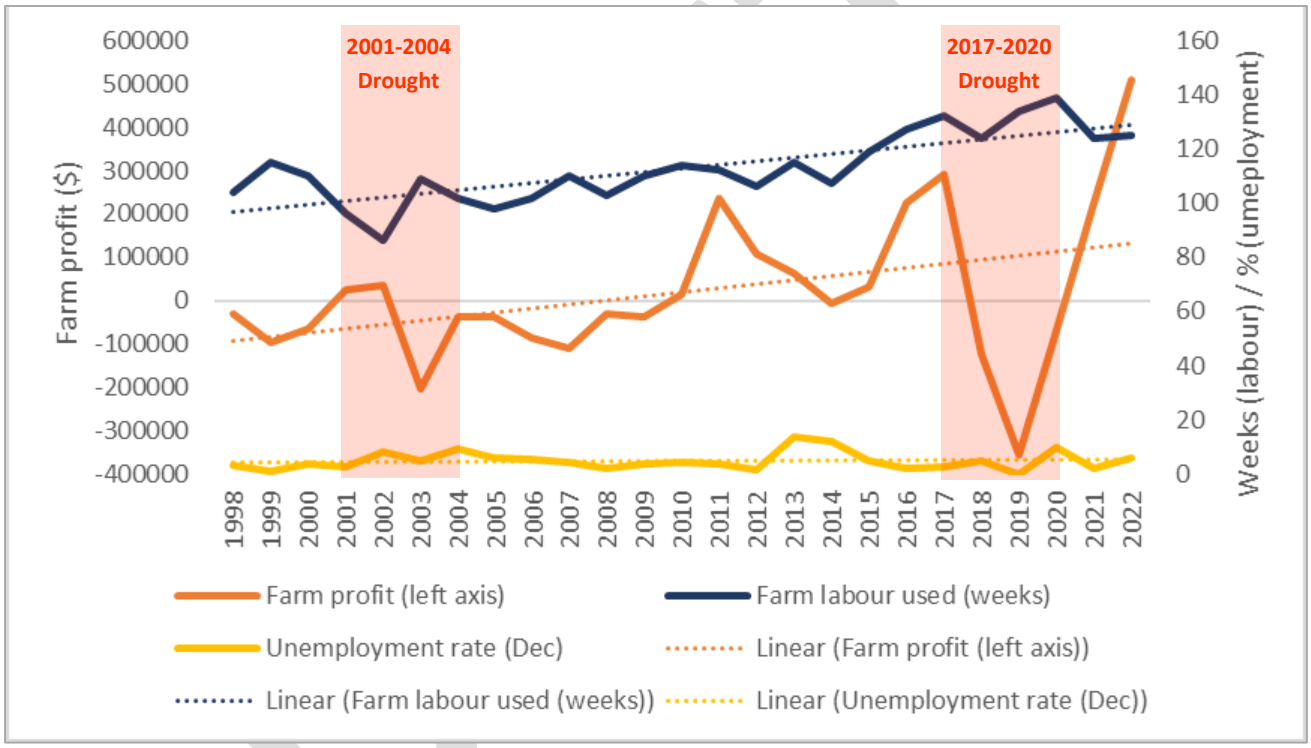

Figure 28: Economic activity measures for Far West NSW (1998-2022).[73] 'Farm labour used (weeks)' is estimated by the farm owner/manager and includes all work on the farm by the owner–manager, partners, family, hired permanent and casual workers and sharefarmers, but excludes work by contractors.

The economic impacts of drought across the Far West NSW region are further illustrated by comparison of farm profit with the gross value aggregated across NSW of the top five Castlereagh Region agricultural outputs of wheat, cattle/calves, sheep/lamb, wool, hay/silage (Figure 29). The decrease in farm profit that occurs during droughts also has an economic impact on the wider NSW region due to the substantial contribution the Castlereagh Country region makes to NSW production, meaning that a drought-related decrease in wheat, cattle/calves, sheep/lamb, wool, and hay/silage in the Castlereagh contributes in a negative NSW-wide economic impact.

[73] Department of Agriculture, Fisheries and Forestry – ABARES. Farm Data Portal, Accessed 24 January 2024. <https://www.agriculture.gov.au/abares/data/farm-data-portal>

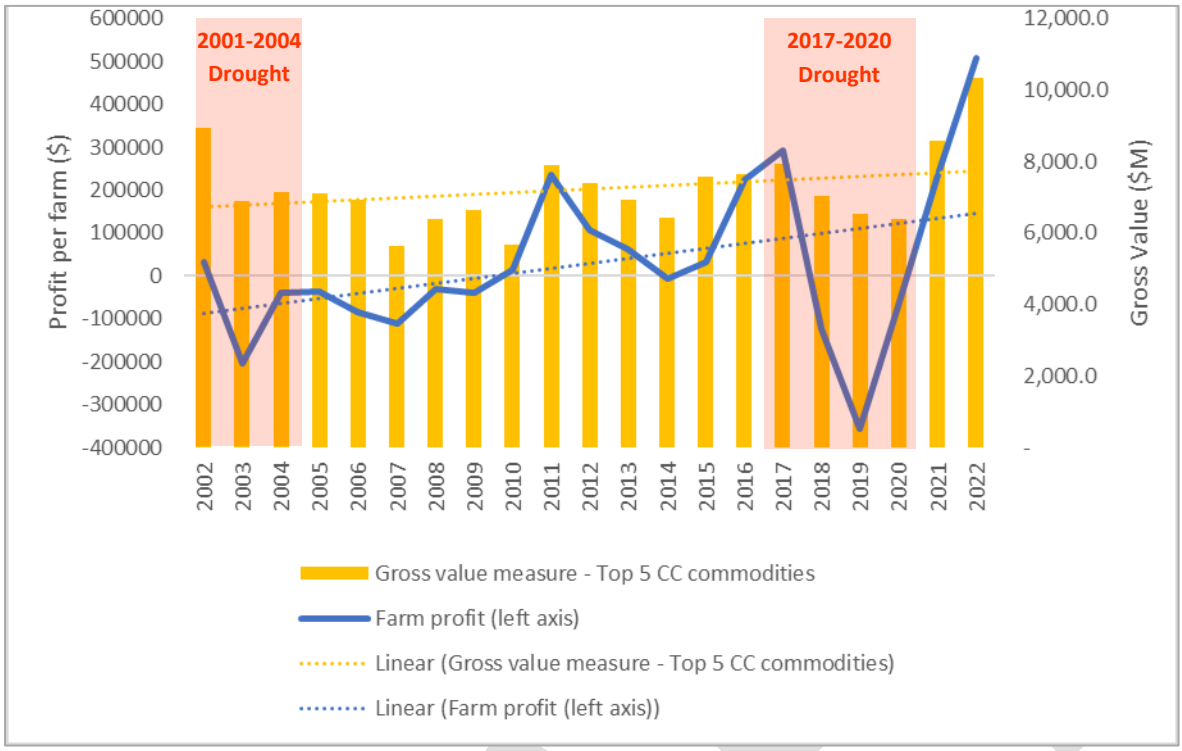

Figure 29: Farm profit for Far West NSW compared with gross value across NSW for the top five the top five Castlereagh Country (CC) outputs (wheat, cattle/calves, sheep/lamb, wool, hay/silage).[73]

6.4.3 Environmental Impacts of Drought

The environment impacts of drought can be widespread and long-lasting. Drought conditions can have a significant impact on natural resources, including irreversible damage to water quality, soil and vegetation, leading in turn to increased risk of fire and dust storms (and the associated loss of topsoil, soil nutrients, organic matter and soil carbon).

During the stakeholder engagement process, community members from the Castlereagh Country region stated that drought negatively affected soil health, water resources, and biodiversity. Several noted the soil erosion that occurred during the 2018-2020 drought and subsequent drought-breaking rain/floods. The increased risk of fire-related environmental impacts during drought was also raised several times.

Other environmental impacts of drought emerging from the stakeholder engagement included:

- The need for education programs about, for example, conservation/regenerative farming and/or growing water-resistant gardens so people can at least save their gardens during droughts and water restrictions. Need for some small areas of "green" to act as oases in drought (e.g. public pools, some public open space to be kept green so people have respite from the visual and psychological impacts of seeing drought everywhere they look).
- Water scarcity and restrictions during drought impact fire fighting efforts (e.g. Coolah experienced the overlap of fire leading into drought).
- Need to encourage and educate farmers to take greater responsibility for becoming more drought resilient (e.g. environmentally sustainable crops and livestock, environmentally sustainable livestock numbers, storage of grain and fodder during good times etc.).

Pilliga koalas are also at risk from drought impacts. Providing water troughs for livestock has increased feral populations that then prey on native wildlife. Koalas have a boom/bust population based on the weather and conditions, loss of water in the Pilliga is a serious threat because there is often a need to access this water for fire fighting in remote parts of the Castlereagh Country region.

6.4.4 Social Impacts of Drought

The social and economic impacts of drought on individuals, families and communities are complex and interrelated. During the stakeholder engagement process, community members not only identified drought specific challenges, but also recognised that these challenges may lead to indirect and sometimes cumulative impacts. A common example of indirect social impact raised by community members was the contributions of community based organisations and individuals during periods of adversity, which may lead to volunteer 'burnout', with the associated risks of mental and physical health impacts for these community workers. Similarly, relating to economic impacts, drought-related reductions in incomes and employment then affect other businesses 'in town' through reduced local spending with associated implications for business viability and levels of employment.

Stakeholder feedback was very clear on the damaging effects of drought, the need for communities to be well prepared when drought inevitably occurs, and to be able to collectively 'defend' their communities in these situations.

One of the strengths of rural communities in dealing with the effects of drought is shared experience and the mutual support that it engenders. These community features are characteristic building blocks of 'social capital'. Social capital is defined as 'the networks, institutions, relationships and social customs that determine the quality of social interactions'. Stakeholder feedback indicates that the Castlereagh Country region's communities do respond collectively during drought and other naturally occurring emergencies. Experience gained through these responses has created a store of ideas that the communities recognise can be used to improve drought resilience and better prepare for future drought events. These are both evidence of existing social capital, and means for increasing social capital and the function of the region's communities not only during drought, but as part of the ongoing life of the communities.

Stakeholder feedback identified what might be described as a 'resilience toolkit' that can be developed for preparing for, and responding to drought. These tools are a means for addressing a range of financial, economic and social impacts, at individual, business and community levels. From the communities' perspectives, there are two common elements to maximising the effectiveness of each part of the toolkit: (i) information and (ii) communication.

Access to information is vital, for example, when this involves information-sharing on more resilient farming practices. It follows that having in place the appropriate infrastructure and opportunities to facilitate communication is equally important. As is the case with the effects of drought, the benefits of communication are also multi-faceted. For example, in addition to sharing practical information, fostering opportunities for people to communicate with each other, can also be beneficial in supporting better mental health outcomes. The Australian Institute of Health and Welfare (AIHW) reported[74] that:

'The mental health effects of drought appear to be complex and may vary by sex. From 2001–02 to 2007–08, people living in drought-affected areas in rural Australia had higher levels of distress than people living in urban areas[75]. A 2012 study[76] found an increased risk of suicide among males aged 30–49 living in rural areas of Australia during periods of drought between 1970 and 2007. Findings on the effects of drought on the mental health of women are mixed[77,78]'.

Improved communications infrastructure and connectivity can contribute to keeping people informed on community-based support and activities. It also facilitates better access to services such as the NSW Government funded Rural Adversity Mental Health Program (RAMHP), which directly assists people during drought and other periods of adversity, including the aftermath of drought. Each

[74] Australian Institute of Health and Welfare. Natural environment and health (web article). Accessed 2 January 2024. <https://www.aihw.gov.au/reports/australias-health/natural-environment-and-health>
[75] O'Brien LV, Berry HL, Coleman C and Hanigan IC (2014) 'Drought as a mental health exposure- external site opens in new window', Environmental Research, 131:181–187.
[76] Hanigan IC, Butler CD, Kokic PM and Hutchinson MF (2012) 'Suicide and drought in New South Wales, Australia, 1970–2007- external site opens in new window', Proceedings of the National Academy of Sciences of the United States of America, 109(35):13950–13955.
[77] Hanigan IC, Schirmer J and Niyonsenga T (2018), 'Drought and distress in southeastern Australia- external site opens in new window', EcoHealth,15(3):642–655.
[78] Powers JR, Dobson AJ, Berry HL, Graves AM, Hanigan IC and Loxton D (2015) 'Lack of association between drought and mental health in a cohort of 45–61 year old rural Australian women- external site opens in new window', Australian and New Zealand Journal of Public Health, 39(6):518–523.

recommended action within the RDRP should be approached with some emphasis on how improved communication opportunities can contribute to optimising the outcomes and for sharing the benefits as broadly as possible across the communities.

Other social impacts of drought emerging from the stakeholder engagement included:

- Mental health and wellbeing – need for continuity of care and ongoing mental health support services. Even once the drought breaks, cash flow continues to be a serious challenge for many farmers who can take years to recover with the need to rebuild stock numbers and replant crops. Mental health is still adversely affected for an extended period even once the drought officially breaks. Community events that allow people to come together during difficult times are very important to give people short term relief from the daily grind of feeding stock and dealing with the challenges of drought.
- Education programs are needed for mental health resilience even in good times so people are better equipped to deal with drought as it slowly creeps up on people.
- Volunteer fatigue and burn out are also very real issues during drought – need better support and training for volunteers to maintain resilience and strong mental health. Volunteer burnout and difficulties in managing donated goods were major concerns. There were challenges in coordinating aid distribution, leading to feelings of guilt or neglect when donations were declined.
- Coordination of mental health services – referral pathways – need better continuity of care.
- Charities did a lot of work distributing donations – however this needs to be done earlier and in a more targeted way – hard for farmers to ask for help.
- Increase in motor vehicle accidents due to dust, fatigue, and decrease in road repair/maintenance due to lack of financial/human resources during drought.
- Most vulnerable groups faced housing and subsidy issues, with inadequate support beyond the agriculture sector.
- Addressing increased suicide rates, reducing anxiety, and countering alarmist media language were identified as crucial areas.
- Community events as a means to escape worries typically decrease during drought or do not happen at all. There is a need to maintain/increase educational and fun activities to build community spirit. Succession planning events and dinners with speakers are beneficial.
- It was raised many times that mental health and wellbeing issues persist long after the drought has 'finished'. Drought-related anxieties are exacerbated by media hype and alarmist language. The impact on stock prices due to alarmist media is also not helpful. There are big concerns about access to mental health support and the fact that even if mental health support is available farmers are hesitant to access it due to pride.
- Local money card system facilitated by a trusted local identity for mental health support.
- Scams during drought/fire, including fake RFS cold calls and fake Go Fund Me.

6.4.5 Water Impacts of Drought

Water is an extremely valuable commodity in agricultural production. The Castlereagh Country region generates 38%[79] [80] of its gross value income from the agriculture sector, within which livestock production (43%) and dryland cereal grain cropping (41%) are the dominant revenue generating industries[20].

[79] REMPLAN. Gilgandra Shire Economy Profile. Accessed 29 January 2024,
< https://app.remplan.com.au/gilgandra/economy/summary?state=koGRHb3omF0rkXLTk9DB6Jc0IzIzQ5 >
[80] REMPLAN. Warrumbungle Shire Economy Profile. Accessed 29 January 2024,
< https://app.remplan.com.au/warrumbungle/economy/summary?state=pr1AFQDyu0Y6dOS2jvw2EHAfWfEyL >

During the stakeholder engagement process, the most frequently mentioned impact of drought identified by Castlereagh Country region community members related to impacts on water, including impacts on water infrastructure, water availability, and water quality. Improvements to water infrastructure were the most common responses to past drought, and related mostly to:

- Increased capacity for on-farm water capture, treatment and storage.
- Exploration of alternative water sources and infrastructure.
- Optimisation of groundwater bore locations and improved/optimised water access in general.
- The crucial need to continue water infrastructure maintenance during droughts so that when it does rain again, access to water is efficient so as to enable recovery from drought as quickly as possible.
- Cheaper and more comprehensive water supplies to support improved drought resilience in agriculture and allied industries in the region, particularly in the horticulture sector.
- Improved water infrastructure and water management strategies to enable people to stay cool during and to maintain "green" areas as oases to escape the dry, hot, dusty drought conditions (even when water restrictions are in place).

Security of water supply is a major issue for several locations within the Castlereagh region. Aging water infrastructure is in urgent need of upgrade across the Castlereagh region with recent (mid-late 2023 and during the 2018-2020 drought) hot/dry weather contributing to increased air conditioning pipe breaks and a series of hydrant and asbestos cement pipe breaks, interrupting water supply and creating the need for boiled water alerts. Groundwater bores that had previously been established and used during droughts before the 2018-2020 drought to supplement water supply, particularly for farmers and those on properties outside the reticulated water supply, have since failed or are no longer operational. These groundwater bores need to be reinstated at a minimum or more installed.

Other water-related impacts of drought emerging from the stakeholder engagement included:

- Widespread community concern about the water required for construction and operation of renewable energy facilities. The introduction of these renewable energy facilities to regional/rural areas like the Castlereagh Country region is associated with many positive outcomes for the community (e.g. diversification of income, increased training/employment opportunities, improved transport/communication infrastructure etc.) however these renewable energy facilities also require ongoing access to water and the community is wary of the impact this will have on local water supplies (especially during drought periods when there is already not enough water to meet demand). In short, security of water supply in and around existing or proposed renewable energy facilities is already a major issue, even in non-drought periods – drought exacerbates these issues and the competing demands for water resources needs to be addressed in the RDRP.
- Access to water is required to fight bushfires, and the frequency of bushfires tends to increase during drought periods. NSW National Parks and Wildlife Service has had difficulty getting access to water for fire fighting helicopters. It is not feasible/sensible to use potable water, so access is needed to dams or alternative water sources to protect environmental land.
- There was repeated mention of the need for increased water storage capacity across the Castlereagh Country region (both surface water storage and groundwater storage).
- There were repeated/prominent concerns about challenges associated with water availability and costs/practicalities associated with carting water during previous droughts.
- Limited availability to water (and the need to conserve whatever water there is for use on the farm) meant limited bathing facilities and there was some concern about the physical/mental health aspects of this as well as potential hygiene issues.
- Graziers expressed concerns about competing with other industries for groundwater, emphasizing the importance of reliable springs and off-grid power supply.

7 Drought Resilience Assessment

7.1 Drought Resilience Index

A drought resilience index has been developed for the Castlereagh Country region from readily available regional and national datasets. The drought resilience index can track temporal and spatial changes to drought resilience over time as datasets are updated and refined, and it is potentially applicable to any region across New South Wales.

The development and analysis of the drought resilience index draws on an established RDRP drought vulnerability assessment framework previously applied to Western Australian conditions[81]. While the Western Australian study was a drought vulnerability assessment, a similar approach can be used in this Drought Resilience Assessment because the inputs are the same and resilience is essentially the converse of vulnerability (i.e. high vulnerability is similar to low resilience and vice versa). This drought vulnerability (or resilience) assessment framework is attractive as it draws on learnings from Australia and around the world to ensure that attention is paid to important aspects of drought vulnerability (or resilience) in an affected region.

The analysis recognises overall drought resilience as the outcome of interacting *exposure*, *sensitivity*, and *adaptive capacity* parameters. A selection of independent indicators within each category have been identified to serve as proxies for exposure (Section 7.1.1), sensitivity (Section 7.1.2) and adaptive capacity (Section 7.1.3). Each indicator was scored using a 1-5 sliding scale where: 1 represents the most desirable condition (low risk/high resilience) and 5 represents the least desirable condition (high risk/low resilience). To enhance the utility of the approach, all data used for determining scores for each indicator were drawn entirely from publicly available datasets. Scores represent the average for a sub-region, which was set at LGA scale for this assessment.

[81] Department of Primary Industries and Regional Development. (2022) Drought Vulnerability Assessment for the Mid West region incorporating the City of Greater Geraldton and the Shires of Chapman Valley and Northampton. <https://www.mwdc.wa.gov.au/f.ashx/RegionalDroughtResiliencePlan/RDRP_DVA_MidWest_Final_Draft.pdf>

7.1.1 Drought Exposure

Indicator 1 - Current drought exposure	
Current drought exposure is determined based on the drought phase definitions shown in Table 6 (but with long-term (1900-2023) SILO meteorological and GRDC plant growth data used instead of the CDI which is only available from March 2018).	
Sliding scale 1 – low drought exposure 5 – high drought exposure	1. All growing seasons since 1990 classed as Non-Drought 2. More than 5% of growing seasons since 1990 classed as being in any Drought Phase 3. More than 5% of growing seasons since 1990 classed as Drought Affected, Drought, or Intense Drought 4. More than 5% of growing seasons since 1990 classed as Drought or Intense Drought 5. More than 5% of growing seasons since 1990 classed as Intense Drought
Drought resilience implication	Drought resilience is a function of drought risk and drought adaptive capacity. Drought risk (impact) is a function of exposure and sensitivity to drought. Therefore it is necessary to assess *current* drought exposure to quantify drought risk and drought resilience.
Score – Warrumbungle LGA	18/34 (53%) growing seasons since 1990 classed as Non-Drought 10/34 (30%) growing seasons since 1990 classed as Drought Affected or Recovering from drought 3/34 (9%) growing seasons since 1990 classed as Drought 3/34 (9%) growing seasons since 1990 classed as Intense Drought Final score for current drought exposure in Warrumbungle LGA = 5
Score – Gilgandra LGA	17/34 (50%) growing seasons since 1990 classed as Non-Drought 13/34 (38%) growing seasons since 1990 classed as Drought Affected or Recovering from drought 2/34 (6%) growing seasons since 1990 classed as Drought 2/34 (6%) growing seasons since 1990 classed as Intense Drought Final score for current drought exposure in Gilgandra LGA = 5
Supporting description	Current drought exposure has the highest (i.e. worst) possible ranking across both Warrumbungle and Gilgandra LGAs.

Indicator 2 - Future drought exposure	
Future drought exposure is determined based on the future drought phases (as per Table 6) obtained when the projected impacts of climate change (as listed in Section 6.3) are applied to historical data (i.e. the same data used to determine Indicator 1) to infer plausible future drought conditions for the Castlereagh Country region.	
Sliding scale 1 – low drought exposure 5 – high drought exposure	1. All growing seasons 2030-2063 classed as Non-Drought 2. More than 5% of growing seasons 2030-2063 classed as being in any Drought Phase 3. More than 5% of growing seasons 2030-2063 classed as Drought Affected, Drought, or Intense Drought 4. More than 5% of growing seasons 2030-2063 classed as Drought or Intense Drought 5. More than 5% of growing seasons 2030-2063 classed as Intense Drought
Drought resilience implication	Drought resilience is a function of drought risk and drought adaptive capacity. Drought risk (impact) is a function of exposure and sensitivity to drought. Therefore it is necessary to assess *future* drought exposure to quantify drought risk and drought resilience.
Score – Warrumbungle LGA	16/34 (47%) 2030-2063 growing seasons classed as Non-Drought 12/34 (35%) 2030-2063 growing seasons classed as Drought Affected or Recovering from drought 2/34 (6%) 2030-2063 growing seasons classed as Drought 4/34 (12%) 2030-2063 growing seasons classed as Intense Drought Final score for future drought exposure in Warrumbungle LGA = 5
Score – Gilgandra LGA	14/34 (41%) 2030-2063 growing seasons classed as Non-Drought 14/34 (41%) 2030-2063 growing seasons classed as Drought Affected or Recovering from drought 2/34 (6%) 2030-2063 growing seasons classed as Drought 4/34 (12%) 2030-2063 growing seasons classed as Intense Drought Final score for future drought exposure in Gilgandra LGA = 5
Supporting description	Future drought exposure has the highest (i.e. worst) possible ranking across both Warrumbungle and Gilgandra LGAs.

Indicator 3 - Change in drought frequency	
Change in drought frequency is determined by comparing the number of growing seasons classed as Drought Affected, Drought, or Intense Drought during 1981-2000 versus 2021-2020.	
Sliding scale 1 – low change in drought frequency 5 – high change drought frequency	1. Three or four fewer droughts 2. One or two fewer droughts 3. Equal number of droughts 4. One or two more droughts 5. Three or four more droughts
Drought resilience implication	Drought resilience is a function of drought risk and drought adaptive capacity. Drought risk (impact) is a function of exposure and sensitivity to drought. Therefore it is necessary to assess *changes* to drought exposure to quantify drought risk and drought resilience.
Score – Warrumbungle LGA	3 growing seasons classed as Drought Affected, Drought, or Intense Drought for 1981-2000. 10 growing seasons classed as Drought Affected, Drought, or Intense Drought for 2001-2020. Final score for change in drought frequency in Warrumbungle LGA = 5
Score – Gilgandra LGA	5 growing seasons classed as Drought Affected, Drought, or Intense Drought for 1981-2000. 9 growing seasons classed as Drought Affected, Drought, or Intense Drought for 2001-2020. Final score for change in drought frequency in Gilgandra LGA = 5
Supporting description	Current drought frequency has the highest (i.e. worst) possible ranking across both Warrumbungle and Gilgandra LGAs.

7.1.2 Drought Sensitivity

Indicator 4 - Area classified as State Significant Agricultural Land	
The data show areas identified as State Significant Agricultural Land (SSAL) as identified by draft SSAL mapping.	
Sliding scale 1 – low sensitivity 5 – high sensitivity	1. Very high proportion of area mapped as SSAL (>40%) 2. High proportion of area mapped as SSAL (30-40%) 3. Moderate proportion of area mapped as SSAL (20-30%) 4. Low proportion of area mapped as SSAL (10-20%) 5. Very low proportion of area mapped as SSAL (<10%)
Drought resilience implication	SSAL mapping shows both land under irrigation practices and land with certain beneficial biophysical attributes for agriculture. SSAL land likely has greater capacity to withstand impacts of drought on agricultural practices compared to land not mapped as SSAL.
Score – Warrumbungle LGA	3
Score – Gilgandra LGA	2
Supporting description	A moderate proportion of total land in the Warrumbungle Shire is mapped as SSAL (26%) and a high proportion of total land in the Gilgandra Shire is mapped as SSAL (31%) (Figure 4).

Indicator 5 - Percentage employment in agriculture	
The data show the percentage of total employed people who are employed in farming and allied industries according to the Australian Census 2021 records of characteristics of employed persons.	
Sliding scale 1 – low sensitivity 5 – high sensitivity	1. Very few people employed in agriculture (<10%) 2. Few people employed in agriculture (10-20%) 3. Some people employed in agriculture (20-30%) 4. Many people employed in agriculture (30-40%) 5. Very many people employed in agriculture (>40%)
Drought resilience implication	Livelihoods that depend directly on dryland agriculture are more sensitive to negative impacts from drought.
Score – Warrumbungle LGA	3
Score – Gilgandra LGA	3
Supporting description	Employment rate in agriculture is relatively moderate for rural areas at 26.0% for Warrumbungle LGA and 28.4% for Gilgandra LGA.[19,20,22]

7.1.3 Drought Adaptive Capacity

Indicator 6 – Percentage of people unemployed	
The data show the percentage of people who are unemployed according to the Australian Census 2021 records of total labour force status.	
Sliding scale 1 – high adaptive capacity 5 – low adaptive capacity	1. Very low unemployment (0-2%) 2. Low unemployment (>2-3%) 3. Moderate unemployment (>3-4%) 4. High unemployment (>4-5%) 5. Very high unemployment (>5%)
Drought resilience implication	Unemployment is an indicator for financial stress and dependency. Unemployment can exacerbate pre-existing, or introduce new, social or economic disadvantages which decreases adaptive capacity and increases the risk of adverse impacts from drought.
Score – Warrumbungle LGA	2
Score – Gilgandra LGA	2
Supporting description	Unemployment rate is low at 2.8% for Warrumbungle LGA and 3.0% for Gilgandra LGA.[22,23]

Indicator 7 – Telecommunications access	
The data show the percentage of land area which has Telstra 4G mobile phone coverage according to published Telstra coverage data.	
Sliding scale 1 – high adaptive capacity 5 – low adaptive capacity	1. Very high proportion of area has 4G mobile phone coverage (>90%) 2. High proportion of area has 4G mobile phone coverage (85-90%) 3. Moderate proportion of area has 4G mobile phone coverage (80-85%) 4. Low proportion of area has 4G mobile phone coverage (75-80%) 5. Very low proportion of area has 4G mobile phone coverage (<75%)
Drought resilience implication	Mobile phone coverage is considered an indicator of overall connectivity to services available over internet and voice protocols. Incomplete connectivity can reduce adaptive capacity (and increase adverse impacts from drought) by reducing ability to communicate to fellow community members and limiting access to knowledge regarding available assistance services.
Score – Warrumbungle LGA	5
Score – Gilgandra LGA	4
Supporting description	A very low proportion of total area in the Warrumbungle Shire has 4G mobile phone coverage (64%) and a low proportion of total area in the Gilgandra Shire has 4G mobile phone coverage (78%) (Figure 11).

Indicator 8 – Groundwater quality	
The data shows the likely groundwater salinity concentration.	
Sliding scale 1 – high adaptive capacity 5 – low adaptive capacity	1. <938 Electrical Conductivity in µS/cm* (potable drinking[82]) 2. 938-1,600 Electrical Conductivity in µS/cm (no burden to livestock for drinking[83]) 3. 1,600-6,300 Electrical Conductivity in µS/cm (no adverse effects to beef cattle[83]) 4. 6,300-7,880 Electrical Conductivity in µS/cm (no adverse effects to beef sheep[83]) 5. >7,800 Electrical Conductivity in µS/cm (adverse effects on main livestock types)
Drought resilience implication	Given that surface water resources are typically not viable, groundwater resources are heavily relied upon during drought conditions. Irrigation is a minor use for groundwater, making human and livestock drinking water quality requirements the key risk levels of importance.
Score – Warrumbungle LGA	3
Score – Gilgandra LGA	2
Supporting description	Groundwater in the Warrumbungle LGA is generally good quality (2,640 µS/cm – 80th percentile value) and in the Gilgandra LGA is generally high quality (1,145 µS/cm – 80th percentile value).

*1 dS/m = 1000 EC (or µS/cm) = approximately 640 mg/L (or ppm)[84]

[82] National Health and Medical Research Council (Australia), (issuing body.) & National Resource Management Ministerial Council (Australia) (2011). *Australian Drinking Water Guidelines 6: National Water Quality Management Strategy* (Version 3.4 Updated October 2017). National Health and Medical Research Council, Canberra, ACT

[83] NSW Department of Primary Industries (2014), Water for livestock: interpreting water quality tests, April 2014, Primefact 533, Second edition.

[84] NSW Department of Primary Industries (2017), Salinity tolerance in irrigated crops, December 2016 Primefact 1345, Second edition.

Indicator 9 – Land and soil capability	
The data show limiting (or worst) capability of land and soil attributes to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources as defined by Land and Soil Capability Mapping for NSW[85,86].	
Sliding scale 1 – highest adaptive capacity 5 – lowest adaptive capacity	1. 50-70% of area high to very high capability 2. >70% of area moderate to very high capability 3. 50-70% of area moderate to very high capability 4. 50-70% of area low to very low capability 5. >70% of area low to very low capability
Drought resilience implication	Highly capable land and soil has greater capacity to become productive for agricultural purposes post-drought than compared to low capability land and soil.
Score – Warrumbungle LGA	4
Score – Gilgandra LGA	2
Supporting description	Warrumbungle LGA contains 57.6% of land with low to very low capability and 74.5% of the in the Gilgandra LGA has moderate to very high capability.

7.2 Assessing Drought Resilience Using the Drought Resilience Index

The nine individual drought resilience indicator values are summarised in Table 10. By averaging the individual drought resilience indicator values for each LGA, a representative resilience of 4.2 was determined for the Warrumbungle LGA and 3.8 for the Gilgandra LGA. The nine individual drought resilience indicator values are also plotted for Warrumbungle LGA (Figure 30) and Gilgandra LGA (Figure 31) to better visual the strengths or weaknesses of each LGA zone with respect to drought resilience. It is noted that more desirable indicator values are clustered towards to the centre of the plot.

Aspects of strength in terms of drought resilience in the Castlereagh Country region are identified in farming land quality and groundwater resources. These are areas to maintain and build on for a successful response to future drought in the region.

Weaker areas in terms of drought resilience are current and future drought exposure, the expected impacts of climate change on the frequency of future drought events, and relatively high unemployment levels. These are the aspects of vulnerability to drought in the region that need to be prioritised to improve resilience. If these can be improved, or better understood, planned for and dealt with, the region will be in a better position to respond effectively to drought.

The resilience index value determination process can be repeated when new information becomes available, for example when data are published for a more recent Australian Census. This process progression permits the temporal tracking of drought resilience over time using a subjective evaluation tool.

[85] Department of Planning, Industry and Environment, 2021, Accessed 25 January 2024. Land and Soil Capability Mapping for NSW, Version 4.5, NSW Department of Planning, Industry and Environment, Parramatta. <https://datasets.seed.nsw.gov.au/dataset/land-and-soil-capability-mapping-for-nsw4bc12>

[86] NSW Office of Environment and Heritage. 2012. The land and soil capability assessment scheme - Second approximation. <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Land-and-soil/land-soil-capability-assessment-scheme-120394.pdf >.

The subjectivity of the sliding scale divisions used for each individual resilience indicator warrant further investigation. For example, 'Indicator 8 – Groundwater quality' is, in part, based on published findings of the impact on production of livestock caused by salinity content in livestock drinking water. The utility of 'Indicator 4 - Area classified as State Significant Agricultural Land' is based on the rational assumption that an area with a higher proportion of SSAL land (characterised by beneficial biophysical attributes for agriculture) would be better able to generate financial gain via agricultural production when compared to an area with a lower proportion of SSAL land. Whether this impact is linear in terms of SSAL land proportions, or whether a minimum threshold level exists, are issues that required further understanding and potential refinement of sliding scale divisions.

Table 10: Nine drought resilience indicators (covering drought exposure, sensitivity and adaptive capacity) used to assess drought resilience for the Castlereagh Country region LGAs.

Index category	Indicator	Warrumbungle LGA score	Gilgandra LGA score
Drought Exposure	1. Current drought exposure	5	5
	2. Future drought exposure	5	5
	3. Change in drought frequency	5	5
Drought Sensitivity	4. Area classified as State Significant Agricultural Land	3	2
	5. Percentage of people employed in farming and allied industries	3	4
Drought Adaptive Capacity	6. Percentage of people who are unemployed	2	2
	7. Telecommunications access	5	4
	8. Likely groundwater salinity	3	2
	9. Land and soil capability	4	2
AVERAGE INDEX VALUE		3.9	3.4

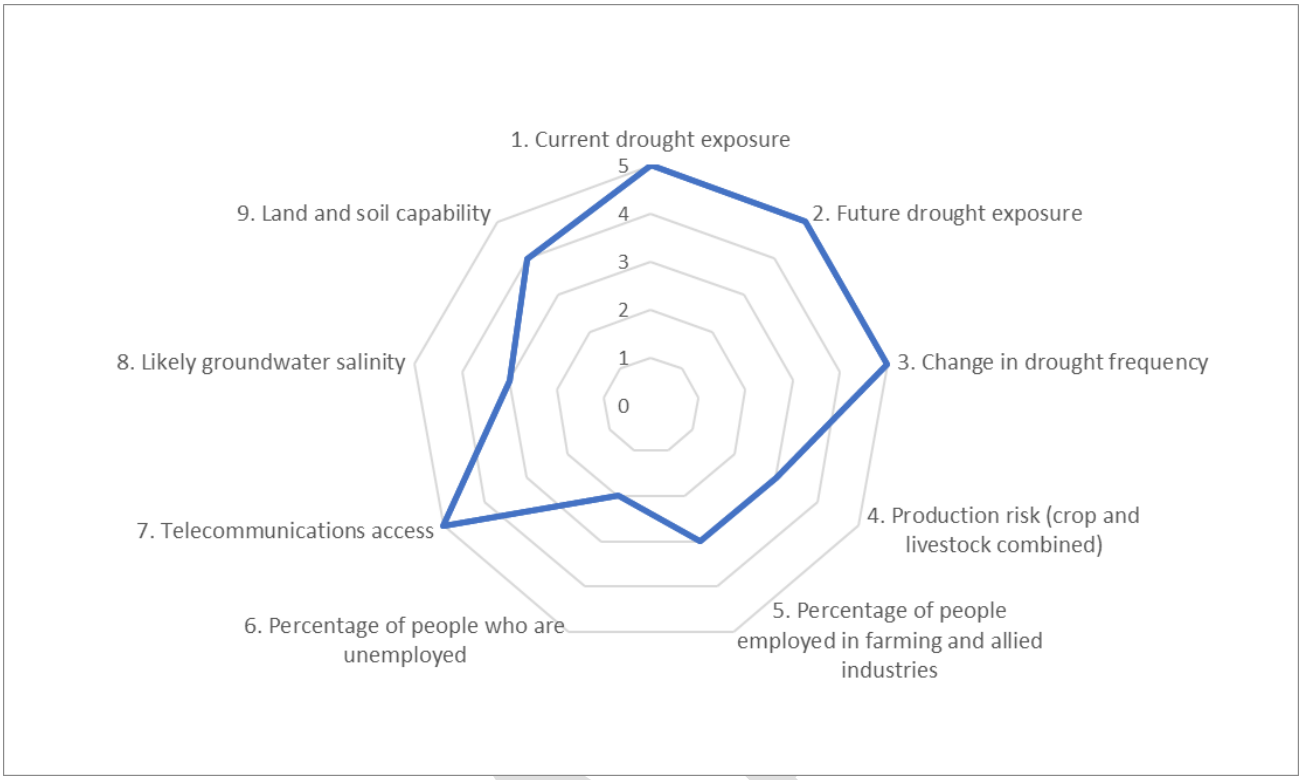

Figure 30: Radar plot of the nine drought resilience indicators (covering drought exposure, sensitivity and adaptive capacity) used to assess drought resilience for the Warrumbungle LGA.

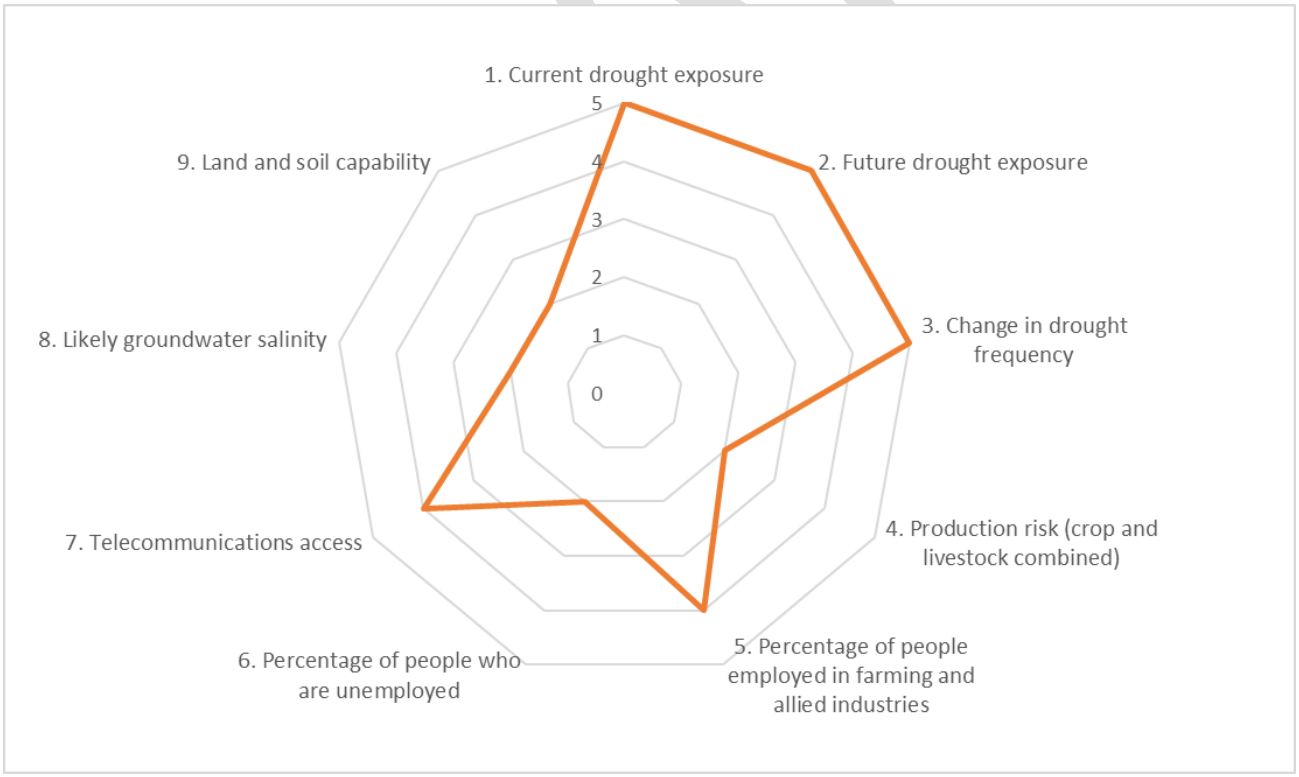

Figure 31: Radar plot of the nine drought resilience indicators (covering drought exposure, sensitivity and adaptive capacity) used to assess drought resilience for the Gilgandra LGA.

8 Conclusions and Next Steps

This Drought Resilience Assessment identifies priority actions for increasing resilience to the impacts of drought in the Castlereagh Country region. It provides analysis, guidance and recommendations to local decision makers and managers in the region regarding the historical and projected impacts of drought and identifies where resilience-building efforts should be concentrated. This Drought Resilience Assessment is an important step in building the evidence base for the Castlereagh Country RDRP.

The impacts of drought are complex, therefore, a multi-facetted drought resilience response is required which will ensure that regional communities are able to adapt to future drought. The worsening patterns of climate change to date, high levels of direct dependency on agriculture, and demonstrated willingness of the community to adapt to changing conditions make the Castlereagh Country region an excellent candidate for specific, targeted drought resilience action. Efforts should be made to reduce socio-economic vulnerabilities and increase institutional capacities. This is important as enhanced adaptive capacity (from individual to institutional levels) will result in an improvement in people's wellbeing, as well as an improved understanding of the natural resources of the region.

This Drought Resilience Assessment provides a significant step forward in understanding of the drought-related resilience characteristics in the Castlereagh Country region, however some further refinement is required in order for the identified priority actions to integrate well into regional planning processes. Climate and hydrological science advances continuously, especially in relation to how/where/when drought impacts are projected to change in the future, and it also may be necessary to update this analysis as climate assessments improve.

The main findings of this Drought Resilience Assessment are as follows:

- The Future Drought Fund provides Australia with a comprehensive program to build drought resilience in regional areas. There are many national and local agencies involved in drought preparedness, response and recovery and in delivering drought resilience programs. Improved communication around the support available to regional communities, and how to access that support, is required.
- Globally, and in Australia, policies have shifted away from treating drought as an unexpected disaster and reacting to recover when a drought occurs towards developing early warning systems and implementing proactive risk management strategies that build resilience to drought. Measures that promote self-reliance and preparedness against drought impacts are consider more desirable.
- Wheat for grain and cattle and sheep production are the primary economic outputs and dominant employers in the region, meaning economic dependence on agriculture is very high. Resilience building activities must focus on strengthening preparation and response capacity of the agriculture sector and allied industries to effectively deal with drought.
- In the future, it is projected that drought will continue to be a regular occurrence in the Castlereagh Country region with possible increases in the frequency and severity of drought impacts. There is high confidence in the best available climate modelling results which indicate average temperatures are projected to increase in all seasons, number of hot days and warm spells are projected to increase, and average winter/spring rainfall is projected to decrease.
- Assessment of historical drought impacts on economic commodities suggest drought is expected to continue to impact adversely on crop and livestock production in the region.
- Past droughts have far-reaching impacts on social well-being, causing younger people to move away and, in turn, reducing populations, access to skills and the availability of community services and support networks in the region.
- Nature conservation is the third highest land use of the Castlereagh Country region. This asset is unique for a rural area and provides an opportunity to enhance economic diversification via the visitor economy.
- The Castlereagh Country region has poor surface water resources and relies heavily on access to groundwater for farming production and drinking water for town population, alike. The quality of groundwater is assessed as relatively good throughout the region, and recent drilling projects have identified potential sources of deeper aquifer groundwater that may be suitable for irrigation enterprises.
- A drought resilience index approach which used a selection of independent drought indicators for exposure, sensitivity, and adaptive capacity determined the Gilgandra LGA to be marginally more drought resilient than the Warrumbungle LGA.
- The drought resilience index approach identified farming land quality and groundwater resources as key strengths in terms

of drought resilience in the Castlereagh Country region. These are aspects to maintain and build on for a successful response to future drought in the region.

- Weaker areas in terms of drought resilience are current and future drought exposure, the projected impacts of climate change on the frequency, duration, and severity of future drought events, and relatively high unemployment levels. These are the aspects of vulnerability to drought in the region that need to be prioritised to improve resilience.