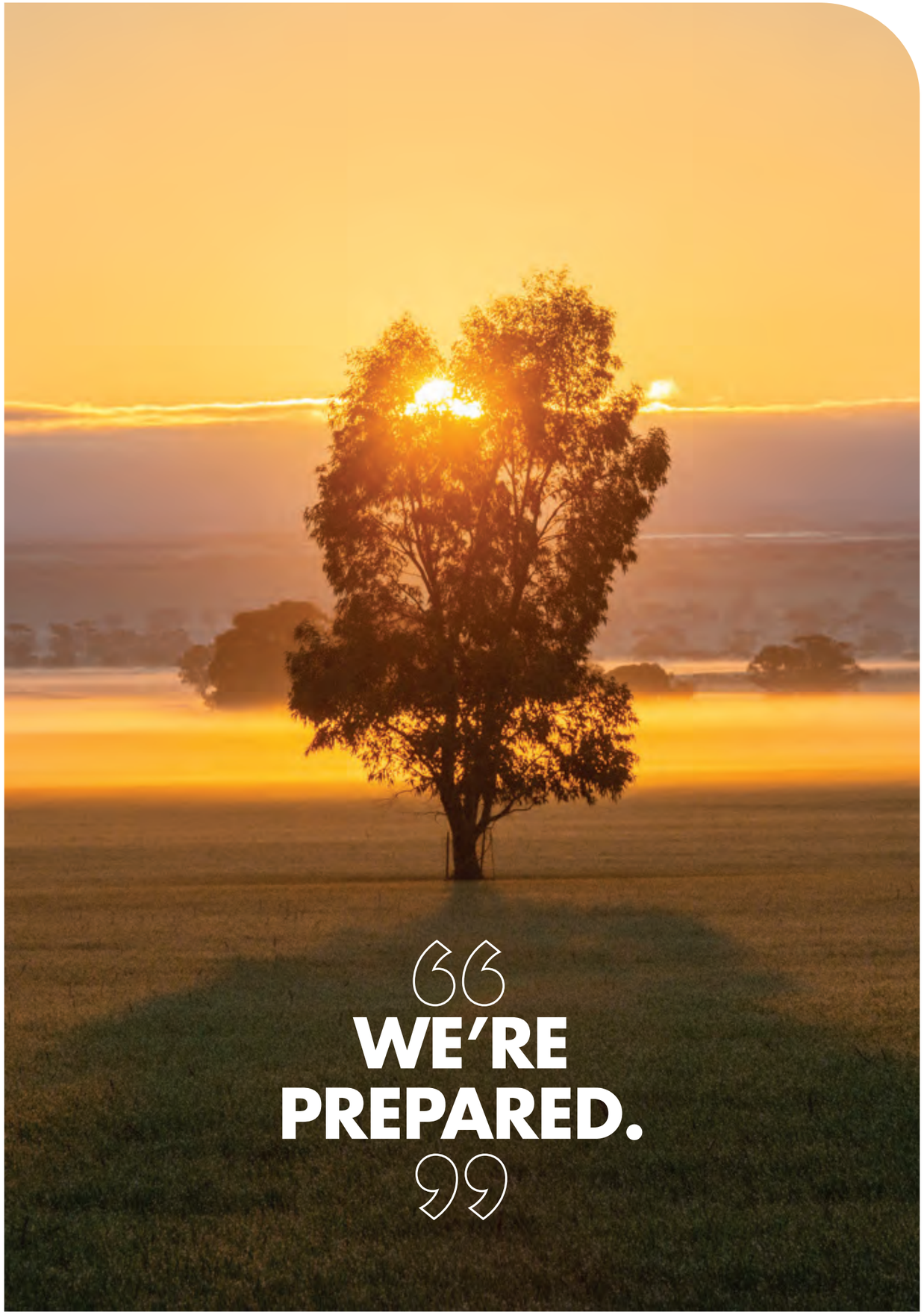
NORTHERN AND YORKE REGIONAL DROUGHT RESILIENCE PLAN.

Report for Northern and Yorke (South Australia) Regional Alliance.

DRAFT PLAN V2 - 2023



EXECUTIVE SUMMARY.

The Northern and Yorke Regional Drought Resilience Plan (NYRDRP) (this document) is designed as a strategic document to inform, plan and prioritise future investment that will help farm businesses, agricultural supply chains and the broader community to build resilience to drought. The document is living and is used to identify, prioritise and coordinate resilience building priorities and actions.

The Northern and Yorke region is one of three South Australian pilot regions developing regional drought resilience plans. The regional drought resilience plans are funded through one of eight funding programs under the Future Drought Fund, an Australian Government initiative designed to increase both farmers and communities’ resilience and preparedness to drought and adapt to changing climatic conditions.

The Northern and Yorke region and its diverse communities and agricultural industries regularly demonstrate personal and organisational adaptive capacity. The region has demonstrated increasing resilience to natural hazards and global drivers of change over the past decades. However, planning for and identifying future opportunities for improvement to build resilience capacity are essential, given projected future drought impacts, such as (Department for Environment and Water, 2020):

- Increasingly severe drought, highlighted by increased evaporation and decreased precipitation.
- More frequent droughts, typified by a projection of 65% time spent in drought by 2030.
- Continued declines in projected availability of root zone soil moisture for crop and pasture growth during the growing season is a chronic driver of drought
- Further projected significant reductions of root zone soil moisture during drought years accentuating acute drought impacts.

As the primary employer and economic activity in the region, agriculture including farm enterprises and the agricultural supply chain are highly exposed to a reduction in rainfall and increase in evaporation resulting from drought and long-term changes to the climate. The impacts of drought also extend to non-agricultural businesses, individuals, communities and organisations. Accordingly, the key role of the NYRDRP is to capture the risks and opportunities arising from drought resilience planning and to set out a series of priority actions in response to these risks and opportunities.

The NYRDRP has been developed through a co-design process and informed through over 90 unique stakeholder engagement experiences and extensive desktop research to accurately report current and future drought related risks.The objectives of the NYRDRP are as follows:

1. Empower the community to identify and understand the impacts of drought.
2. Consultatively develop a regional drought resilience plan to:
    a. Support system scale approaches to agriculture, ecosystems services and social support services.
    b. Encourage increased coordination in planning and the ability to identify and take advantage of opportunities to build economic resilience.
3. Strengthen partnerships and networks between stakeholders to inform drought resilience planning.
4. Support the use of best practice information management to better understand critical factors for resilience to drought, to make robust decisions and to monitor status.

The NYRDRP utilises the CSIRO developed Resilience, Adaptation Pathways and Transformation Approach. This includes accurately capturing the following change categories:

- Incremental change – change that requires an alteration to current methods and practices in order to adapt to future changes to farming systems, primarily driven by the reduction of available soil moisture and changes in climate and rainfall.
- Planned transitional change – change that is not currently adopted but is currently planned for in the future, as conditions change.
- Transformational change – Alteration of a system, driven by the need to overhaul current practices. Transformational change is required when planned and incremental change will not result in the required change to maintain viability of the farming operation. For example, transformational change may require some farm businesses to move from cropping of wheat, barley and other break crops to animal farming systems in order to continue farming.

Through the identification of key drought risk factors and the prioritisation of actions, five key resilience enabling themes and associated key enablers have been identified.

These are as follows:

THEME 1 RESILIENT FARMING ENTERPRISES	**THEME 2** RESILIENT INDUSTRY	**THEME 3** RESILIENT COMMUNITIES	**THEME 4** KNOWLEDGE AND EDUCATION	**THEME 5** RESEARCH AND INNOVATION
Risk management Efficiency Foresight capabilities	Regional economic diversification Liveability and employment opportunities Technology, automation and genetics	Health and well-being Towns and infrastructure Community innovation and cultural partnerships	Climate science and climate projections Education access and diversity of learning Adaptation and transformation adoption	Value-add research Trans-disciplinary and integrated research

Figure 1. The five resilience themes and groupings of enablers

OVER 40 PRIORITIES AND 120 ACTIONS TO INCREASE DROUGHT RESILIENCE ARISING FROM THE THEMES AND ENABLERS HAVE BEEN IDENTIFIED FOR CONSIDERATION AND IMPLEMENTATION.

THEME 1:
RESILIENT FARM ENTERPRISES

Farmers within the Northern and Yorke region have a strong history of adapting to the impact of dry times, drought and other climate stressors. Theme1: Resilient Farm Enterprises focuses on implementing incremental, planned transitional and transformational change required to build resilient within farming enterprises to drought and other inter-related stressors. To do so requires better risk management, increased efficiency and foresight capabilities including understanding, accepting and acting to increase resilience to future climate projections. Priorities for resilient farm enterprises include planning, increased diversification and reduced reliance on rainfall dependent systems and better capture and storage of water on-farm through soils and other means. It is important to note that transitional and transformational change is required, however, achieving this in many circumstances will require a series of incremental changes over time.

THEME 2:
RESILIENT INDUSTRY

To increase the resilience of industries within the Northern and Yorke region there is a ned to reduce the reliance on agriculture for economic prosperity whilst simultaneously promoting and growing other industries. The priorities and actions focus on the established industries (tourism, manufacturing and renewable energy) whilst examining the opportunities for growth linked to strategic Government of South Australia priorities. There is a need to increase the liveability of the region, through providing greater employment prospects but also key assets and services such as child care, aged care and access to housing, whilst reducing reliance on volunteerism. The use of technology, automation and genetics (crops and livestock) and the opportunities that exist to value-add to regionally produced goods and services provide a patway to increase regional economic resilience.

THEME 3:
RESILIENT COMMUNITIES

Health and well-being represent both challenges and opportunities for the region. An aging population demographic and inequitable access to healthcare services requires change, including better integration of services. Greenery and resilient built and living infrastructure within regional towns and centres are important for well-being, amenity and drivers of tourism and economic activity. There are significant opportunities for water capture, storage and reuse options to build resilience across regional urban assets. Improved communty and cultural partnerships are required to ensure Aboriginal knowledge is better utilised and incorporated into resilience systems.

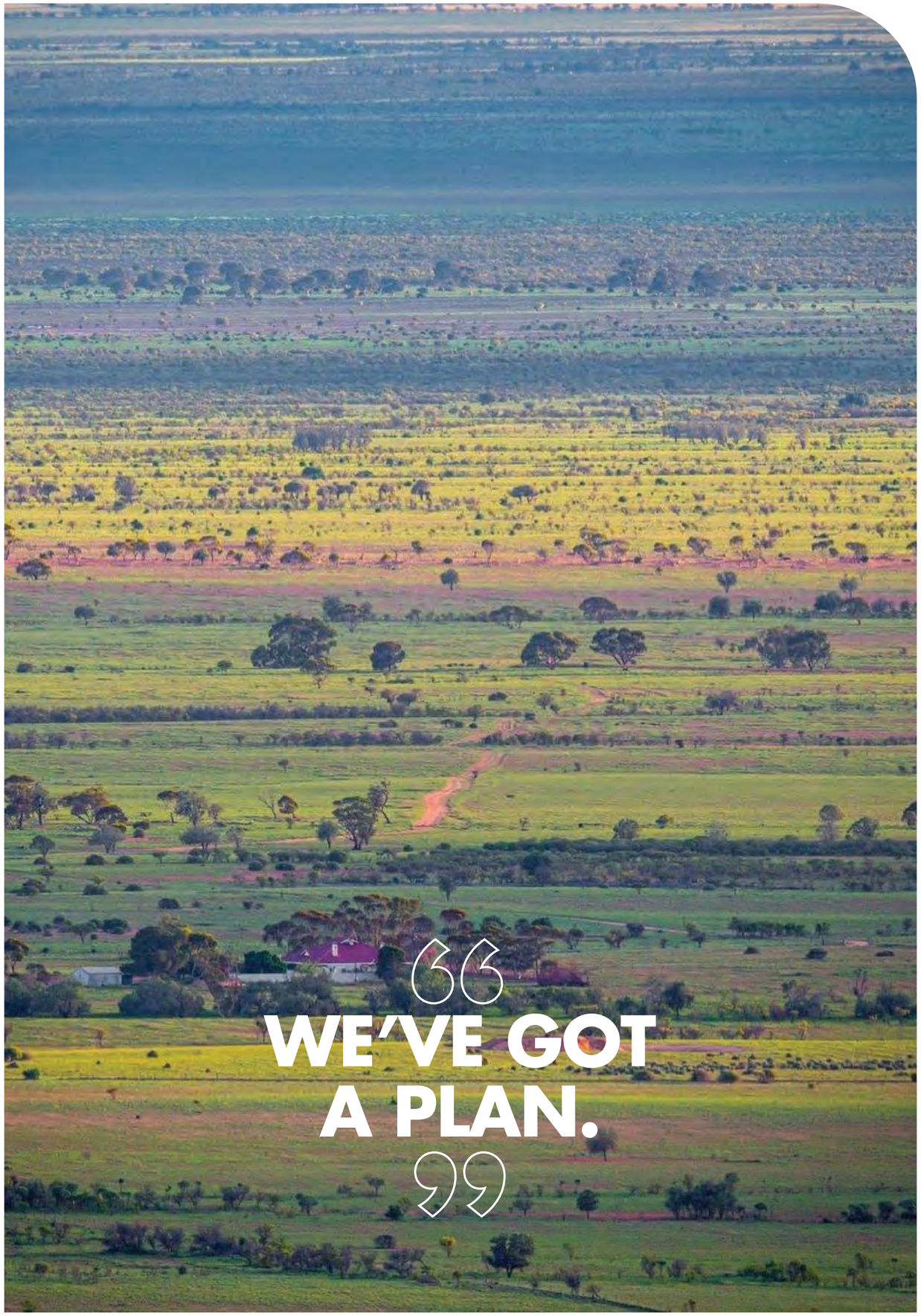
THEME 4:
KNOWLEDGE AND EDUCATION

Key to building resilient communities and systems is the education of individuals across the community. Climate science is complex, as are the projections outlined for the future. Creating easily digestible chunks of information and educating the community about the the impacts of drought and wider changes in rainfall and evaporation patterns is important in order for adaptation to occur. Additionally there is a need to focus on behaviour change programs that extend beyond information dissemination to working with communities to actively transition. Providing programs that attract and meets farmers’ (and supply chain partners’) needs and a diversity of learning styles is essential. There is also a need to seek out subject matter experts and examine how others have already or currently are adapting to reduced rainfall. Investigating and working with the whole community to better plan for and implement adaptation proven to work in drought prone areas of the world.

THEME 5:
RESEARCH AND INNOVATION

Research and innovation within the agricultural industry has historicaly been a focus across Australia, South Australia and within the Northern and Yorke region. Extending research and innovation across other key industries will benefit the region through allowing for cross-industry collaboration (value-adding). Trans-disciplinary and integrated research to better understand market access and the needs of the customer will assist farmers, the agricultural supply chain and other industries to enter new markets and expand others. Locally, a focus on building certain types of tourism (food, wine, caravan, ecotourism, adventure) is a priority.

KEY TO BUILDING RESILIENT COMMUNITIES & SYSTEMS IS THE EDUCATION OF INDIVIDUALS ACROSS THE COMMUNITY.



CONTENTS.

TOGETHER WE ARE DROUGHT RESILIENT.

Project Delivered for: Northern and Yorke (South Australia) Regional Alliance as part of the Regional Drought Resilience Planning Program and is jointly funded through the Australian Government’s Future Drought Fund and the Government of South Australia.

1 ABOUT THIS PLAN.

1.1A Drought Resilience Strategy for the Northern and Yorke Region

The Northern and Yorke Regional Drought Resilience Plan (NYRDRP) (this document) has been developed through a co-design process to capture risks and opportunities to build drought resilience in the Northern and Yorke Peninsula region of South Australia.

The Plan outlines strategies to build economic, social and environmental resilience, with a focus on farm enterprises, agricultural supply chains and communities.

Informed through extensive stakeholder consultation and an assessment of the risk factors to the economic, social and environmental resilience of the Northern and Yorke region, the NYRDRP details the key enablers and actions for drought resilience against five themes and 14 enabler groupings:

14 enabler groupings:

THEME 1 RESILIENT FARMING ENTERPRISES	**THEME 2** RESILIENT INDUSTRY	**THEME 3** RESILIENT COMMUNITIES	**THEME 4** KNOWLEDGE AND EDUCATION	**THEME 5** RESEARCH AND INNOVATION
Risk management	Regional economic diversification	Health and well-being	Climate science and climate projections	Value-add research
Efficiency	Liveability and employment opportunities	Towns and infrastructure	Education access and diversity of learning	Trans-disciplinary and integrated research
Foresight capabilities	Technology, automation and genetics	Community innovation and cultural partnerships	Adaptation and transformation adoption	

Figure 2. The five resilience themes and groupings of enablers

For each theme enablers of resilience are identified that create both small and great change across different time scales. Enablers have been listed as either incremental, planned transitional or transformational and actions for key organisations within the region are identified to ensure the recommendations contained within the plan are operationalised.

1.2 The Future Drought Fund – Investing in a Drought Resilient Future

The development of the Northern and Yorke Regional Drought Resilience Plan has been made possible through the Australian Government's Future Drought Fund (FDF).

In 2018, following the emergence of widespread drought across South-Eastern Australia, the Australian Government announced the development of the FDF (Department of Agriculture, Water and Environment, 2021) which is designed to build drought resilience across Australian farm enterprises and regions through the establishment of six themes and eight distinct funding programs.

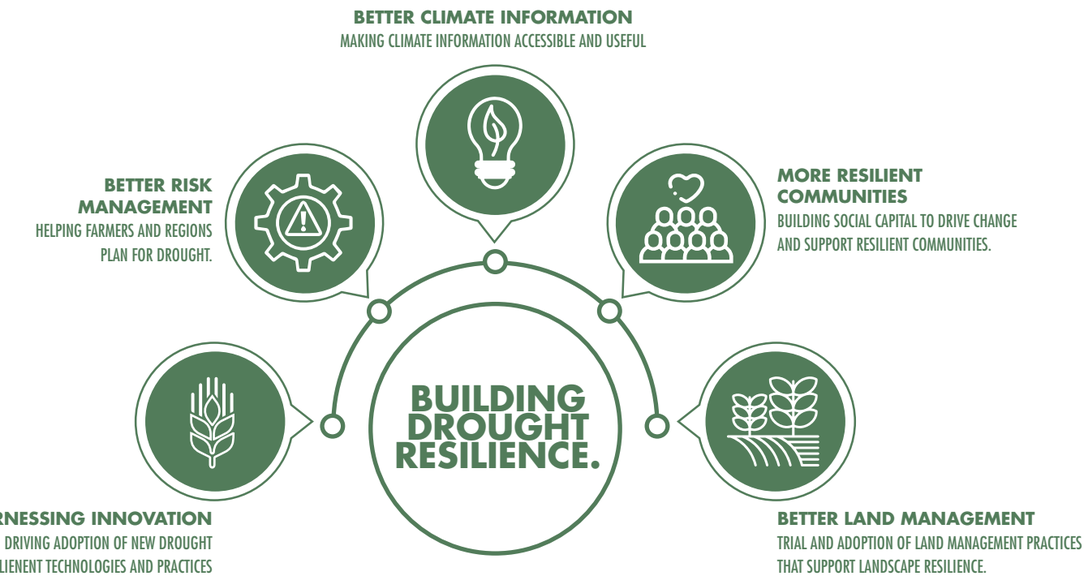


Figure 1. Future Drought Fund themes (Department of Agriculture, Water and Environment, 2021)

The purpose of the FDF is to increase both farmers' and communities' resilience and preparedness for drought and to adapt to changing climatic conditions (Future Drought Fund, 2019).

The FDF has been established as an endowment fund to be preserved in perpetuity, with the aim of providing secure and permanent revenue sources to enhance drought resilience for Australia's farm businesses and communities (Future Drought Fund, 2019).

The Regional Drought Resilience Planning program is one of the eight drought resilience programs, designed to assist regions to prepare for future drought risks by developing regional drought resilience plans (Department of Agriculture, Water and Environment, 2021). The program aims to support regional organisations, local government, communities and industries to partner together to plan for drought resilience measures (Department of Agriculture, Water and Environment, 2021).

The Northern and Yorke region is one of three regions delivering pilots in South Australia under the Future Drought Fund's regional drought resilience plan program. The Plan development (in year one of the pilot) provides a foundation strategy for guiding future investment in drought resilience in the region.

The Plan builds upon historic climate adaptation planning and drought resilience research in the region and recognises the establishment of the Drought Resilience Adoption and Innovation Hub and Hub node within Orrorroo (to the North East of the planning region) (Figure 2).

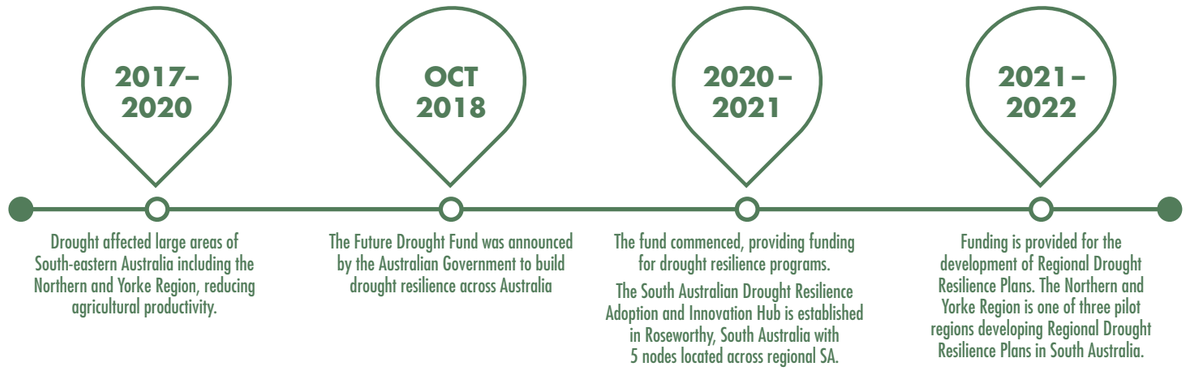
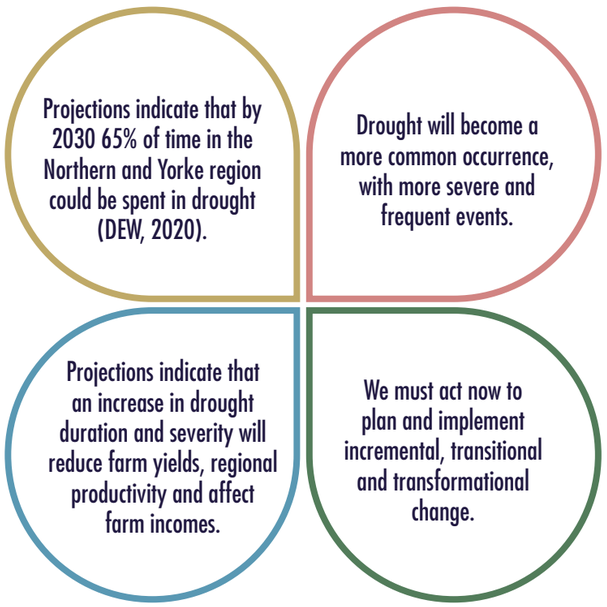


Figure 2. Sequence of major events and initiatives leading to the development of the Future Drought Fund and the Northern and Yorke Regional Drought Resilience Plan (Department of Agriculture, Water and Environment, 2021).

1.3 The Need for Drought Resilience Capacity in the Region

WHY DOES THE NORTHERN AND YORKE REGION NEED A DROUGHT RESILIENCE PLAN?



Drought presents an increasing threat to many regional communities across Australia due to a projected reduction in precipitation, increased evaporation rates and increased mean, maximum and minimum temperatures resulting from climate change (Bureau of Meteorology and CSIRO, 2018).

Australian regional communities and agricultural businesses are now experiencing an ongoing trend of more frequent and severe droughts in most parts of Australia, including South Australia's Northern and Yorke region (Bureau of Meteorology and CSIRO, 2018).

Rainfall has been declining across Southern Australia over the last few decades and is projected to decline further in the future (Hope, 2015). The southward shift of the subtropical desert climate has increased the aridity of the climate of Southern Australia, particularly the northern and eastern areas of the Northern and Yorke region (Hope, 2015). By 2030, the time spent in drought in the Northern and Yorke Region is projected to nearly double meaning up to 65% of time could be spend in drought (Department for Environment and Water, 2020).

Critically important to cropping and livestock farming, average annual rainfall and growing season rainfall (April to October) is projected to decline over time (Department for Environment and Water, 2020). The reduced availability of growing season soil moisture is expected to reduce Australian dryland agricultural production by 9-10% by the year 2030 (compared to 1950-2019 data) (Department of Agriculture, Water and Environment, 2020).

The Department of Agriculture, Water and the Environment note that modelled farm profits across all Australian cropping and animal farming agricultural industries is likely to decline by more than 20% by 2050 as a result of drier conditions (when compared to the year 2000 profits) (Department of Agriculture, Water and Environment, 2021).

The National Farmers Federation vision is to exceed $100 billion in farm gate output by 2030 (National Farmers Federation, 2022). Separately, other peak agricultural bodies in the grain, legumes, meat and livestock, wine and horticulture industries have established revenue and economic growth targets, contributing to state and federal GDP figures. Drought poses a significant threat to achieving such targets, due to challenges in maintaining and growing yields, increasing input costs, quality and farm income when in drought and post drought.

Given the context of a warming and drying climate and the projected increase in extreme droughts arising from reduced rainfall and increased evaporation, it is important that regions, communities, businesses and individuals not only plan for and adapt to drier conditions, but also build resilience capacity.

Many farming districts within the Northern and Yorke region have considerable experience of droughts and have already demonstrated the ability to adapt to the impacts of drought. A focus on continuing to build resilience capacity is important given future regional and global drivers of change.

IT IS IMPORTANT THAT REGIONS, COMMUNITIES, BUSINESSES AND INDIVIDUALS NOT ONLY PLAN FOR AND ADAPT TO DRIER CONDITIONS, BUT ALSO BUILD RESILIENCE CAPACITY.

1.4 The Northern and Yorke Regional Drought Resilience Plan

The Region has a plan to build resilience to drought, with a focus on:

- Farm enterprises
- Industry, including:
- Agricultural supply chains
- Non-agricultural businesses
  - > Communities, including
  - > Towns and regional centres
  - > Health and well-being
  - > Community innovation and cultural partnerships.
- Knowledge and education
- Research and innovation

OBJECTIVES OF THE PLAN

Regional stakeholders have come together through the Northern and Yorke Alliance to develop the Plan to guide future planning and implementation of drought resilience initiatives within the Northern and Yorke region of South Australia. The Plan aims to support those undertaking activities to build resilience and inform the future investment of drought resilience funding in the region.

The Department of Agriculture, Water and the Environment note that modelled farm profits across all Australian cropping and animal farming agricultural industries is likely to decline by more than 20% by 2050 as a result of drier conditions (when compared to the year 2000 profits) (Department of Agriculture, Water and Environment, 2021).

FOOD SECURITY

Human driven climate warming is a global issue, but we are experiencing localised impacts on agriculture which does threaten the productivity of our food systems that we all rely on. In South Australia, the Northern and Yorke region produces 46% of cereal crops, 27% of livestock and 63% of other broadacre crops (e.g., pulses and canola) that had a GRP of $1.7B in 2020/21. The priorities and actions recommended in this report provides a pathway for industry, business and individuals to embed drought resilience into their lives and communities to ensure the region's agricultural productivity into the future.

KEY MESSAGES

The NYRDRP recognises that the region has resilient industries and communities and a strong history of responding to drought and climate variability. The Plan has been developed upon gaining a 'shared understanding' of drought with regional stakeholders, recognising that:

- Drought is an enduring, regular feature of the Australian landscape. It is not a natural disaster.
- While droughts are normal for Australia, drought conditions are likely to become more frequent, severe and longer due to climate change.
- Farming is a business and drought is one of many business risks that should be managed.
- Drought preparations must continue during times of non-drought, including by those not directly affected by drought but who are affected by farming businesses (i.e., the agricultural supply chain and regionally located non-agricutlural businesses).

A CO-DESIGN PROCESS LED BY REGIONAL STAKEHOLDERS

The facilitation of the plan has been conducted by the Northern and Yorke Alliance, led by Regional Development Australian Yorke and Mid North, with input from a steering committee consisting of:

- Central Local Government Region (trading as Legatus Group), representing the local government authorities covered by the Plan region.
- Department of Primary Industries and Regions (PIRSA).
- Northern and Yorke Landscape Board
- Regional Development Australia Barossa Gawler Light Adelaide Plains.
- Regional Development Australia Far North.
- South Australian Drought Resilience Adoption and Innovation Hub.
- National Recovery and Resilience Agency, as observer to the Steering Committee.

BUILDING ON RESEARCH AND FOUNDATIONS FOR DROUGHT RESILIENCE IN THE REGION

The Plan interrelates and builds on existing research, planning and actions taken by organisations within the region, such as:

- The South Australian Drought Resilience Adoption and Innovation Hub Node co-design Workshops report.
- Northern and Yorke Landscape South Australia Goyder's Line: Building Drought Resilience into Transitional Country project.
- Relevant Council planning
  - > Economic Development Plans.
  - > Public Health Plans.
  - > Adverse Event Plans
- The Legatus Wellbeing Gap Analysis: In 2021, a Wellbeing Analysis, including where the gaps in knowledge lie, was undertaken across the Legatus Group Northern Councils to better understand what the future and current wellbeing needs and issues are.
- The Emerging themes for drought response and climate change resilience report developed for the Northern and Yorke Regional Alliance.
- The Future Drought Fund – Opportunities for the Northern and Yorke region report developed for the Northern and Yorke Regional Alliance.

SOUTH AUSTRALIAN DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

The region has benefitted from the establishment of the South Australian Drought Resilience Adoption and Innovation Hub (SA Drought Hub), with the hub located in the regional centre of Roseworthy and one of the SA Drought Nodes located in the north-eastern sub-region, in the town of Orroroo and the SA Drought Hub located in the town of Roseworthy (South Australian Drought and Innovation Adoption Hub, 2021). The role of the SA Drought Hub is to increase resilience through farming systems and communities across South Australia and is not confined to the Northern and Yorke region, however, the location of the hub and node within the region represents an opportunity for action.

The SA Drought Hub team conducted stakeholder consultation across key agricultural regions in South Australia. In-person and online workshops were conducted across seven regional towns in South Australia, with 279 people attending the workshops in person or online (South Australian Drought and Innovation Adoption Hub, 2021). A total of 915 ideas related to drought resilience were received from all workshop attendees (South Australian Drought and Innovation Adoption Hub, 2021).

Key emerging themes from this series of workshops in response to the question

"What are the top things you would like to see the Drought Hub deliver to support your community in the region?"

are listed in order of preference below:

1. Community resilience and wellbeing.
2. Access to drought information and technical support.
3. Farm planning and decision making.
4. Farm business management.
5. Water security and management.
6. Livestock and fodder management.
7. Upskilling advisors, researchers and key influencers.
8. Crop and pasture management.
9. Soil and land management.

Of note, workshop participants reported the need for financial resilience across farm businesses in order to support broader drought resilience goals. Participants discussed the need for implementation of a range of programs and activities across different time scales to increase resilience to drought in the region. Information and data collected through this stakeholder engagement has been considered and incorporated into the findings of this paper and further utilised in stakeholder engagement conducted as part of the development of the draft plan.

LEGATUS GROUP GAP ANALYSIS AND EMERGING THEMES REPORT

In February 2020, the Legatus Group engaged Edge Environment to conduct a gap analysis and emerging themes report, which undertook a stocktake of existing drought resilience and drought related information. The report reviewed existing and past plans, strategies, reports and funding allocated towards increasing drought resilience across the Northern and Yorke Region.

The NYRDRP has considered and built upon the themes and gaps identified through this report, where supported by findings from stakeholder engagement and desktop research.

The key themes emerging from this stocktake are provided below:

- There has been a historic focus on supporting agriculture in the region (and more broadly at a state and national scale) through research, development and extension projects in the region. These projects have focused on planned and incremental changes, rather than transformational change.
- Despite ongoing research, development and extension, there are still gaps in research, particularly for projects that will increase the resilience of farming systems to projected changes in climate conditions and drought. For example, the management of frost in cropping systems and pasture breeds that have a higher tolerance of elevated temperatures and reduced rainfall.
- Natural resources management including water monitoring and management has been well supported in the past, however, programs have been largely reliant on external funding and as such projects have been largely delivered on an ad-hoc basis.
- Wellbeing programs focused on mental and physical health have been conducted in the region in the past, however, programs have not been well distributed across the region and have also been on an ad-hoc basis, limited by ongoing state and/or federal government funding.
- Water capture and reuse is well utilised in some towns and Council areas, however, there are opportunities to increase the use of water sensitive urban design and recycled water for irrigation of greenspaces, street trees and other public amenities.
- The region has an opportunity to better capture and share stories of planned transitional, incremental and transformational change.

DROUGHT CONDITIONS ARE LIKELY TO BECOME MORE FREQUENT, SEVERE AND LONGER DUE TO CLIMATE CHANGE.

1.5 Why Change? The benefits to becoming drought resilient

The successful implementation of the plan will allow for organisations, individuals, communities and the environment to endure longer and more severe droughts and increase the speed of post drougtht recovery.

The plan will be achieved through the deliberate and planned implementation of actions outlined within this document, considering the need to monitor, evaluate and learn from implemented resilience measures.

A community-driven regional plan allows for tailored solutions, specific to the region, considering the environment, communities, culture and assets located within the region. The vision for the region includes a future where, despite the enduring and increasing risks associated with drought, climate change and associated shifts in rainfall and moisture availability, communities in the Northern and Yorke region are able to withstand the economic, social and environmental impacts of drought in order to flourish and prosper. The benefits to stakeholder groups and the environment are outlined in Table 1.

STAKEHOLDER GROUP	BENEFITS OF BECOMING DROUGHT RESILIENT
Farmers	• The collection of a body of evidence outlining demonstrated economic, social and environmental benefits to be trialled, refined and improved over time. • The ability to attract and target funding to the region to address key resilience knowledge and skills gaps. • Increased knowledge of drought resilience planning and implementation. • Improved sharing of knowledge and learnings from resilience strategies and actions between farmers and across agricultural sectors. • Improved knowledge of establishing rainfall independent revenue streams.
Agricultural supply chains	• Increased ability to project and manage alterations to demand for goods and services. • Improved knowledge of establishing rainfall independent revenue streams. • Increased business resilience as a result of factoring in increased drought frequency and severity into business planning. • Increased business resilience resulting from a higher percentage of farms managing drought better and bouncing back from the impacts of drought quicker.
Communities	• Increased awareness of the links between drought and individual and collective community well-being, allowing for greater discussions and funding for targeted mental health support. • Communities are better prepared for the impacts of drought and have spent time planning for drought during times of non-drought. • Communities will benefit from increased greening of assets, such as street trees, irrigated lawn and passive irrigation in regional towns and centres.
The environment	• Increased focus on recycling and targeted use of fit for purpose water for the irrigation of town vegetation will provide a range of ecosystem services. • Farmers adopting land management techniques that increase on-farm soil cover, maintenance of good soil structure and plant varieties more tolerant to drought conditions produce biodiversity, conservation and farming co-benefits.

Table 1. Benefits of becoming drought resilient

2 APPROACH TO PLAN DEVELOPMENT.

In order to engage broadly and deeply with identified stakeholders and to accurately capture the primary themes related to the impact of drought and drought resilience, the approach outlined in Figure 3 was conducted.

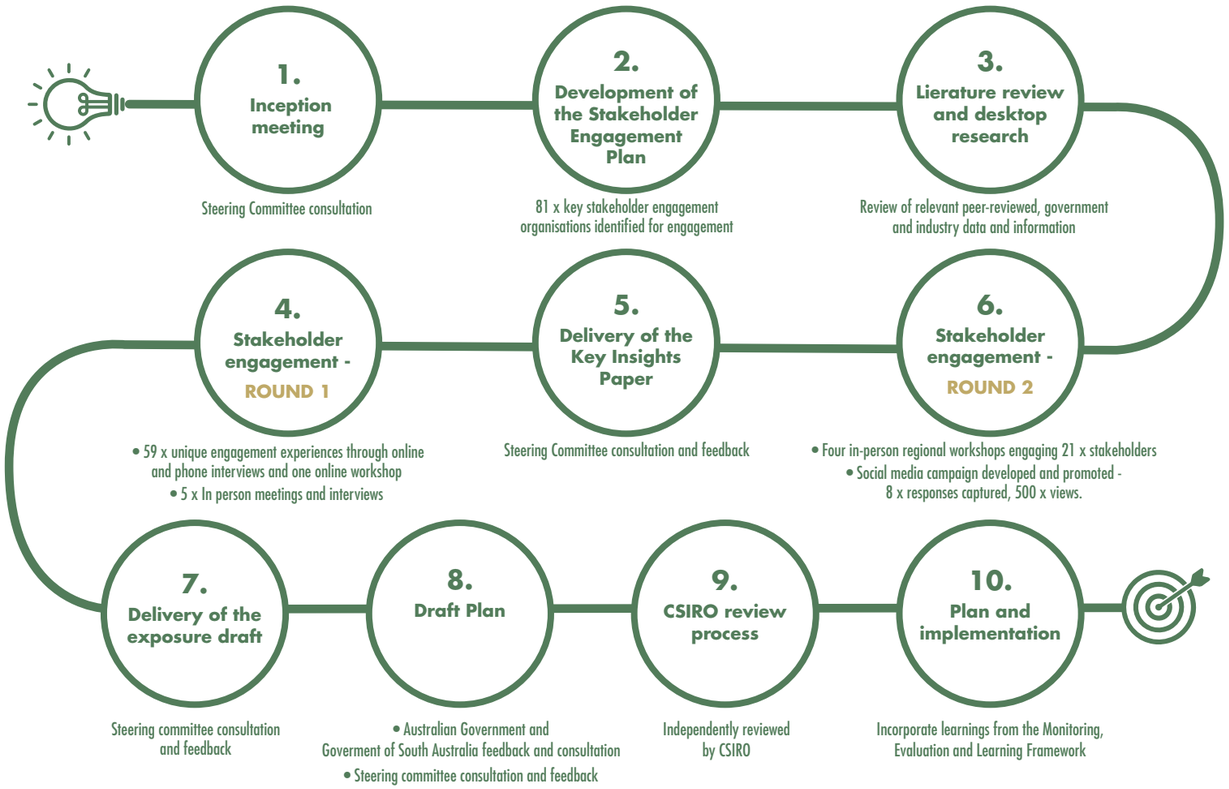


Figure 3. The key development phases of the Northern and Yorke Regional Drought Resilience Plan

The plan has been developed utilising a co-design approach based on the Resilience Adaptation Pathways and Transformation Approach (RAPTA) developed by the CSIRO (O'Connell, et al., 2019).

This includes the following processes:

1. Scoping and goalsetting.
2. Stakeholder mapping and engagement.
3. Imagining change.
4. Describing the system.
5. Exploring scenarios.
6. Analysing the system.
7. Generating options.
8. Sequencing pathways.
9. Implementing pathways.

2.1.1 Plan co-design process

81 stakeholder groups were identified by the Northern and Yorke Regional Alliance. Stakeholders were classified according to the level of stakeholder impact as outlined by the International Association for Public Participation (IAP2) spectrum (Figure 4).

Stakeholder engagement occurred through a variety of medium with in-person engagement limited and where possible postponed due to the COVID-19 pandemic. Co-design occurred through the following engagement practices:

- In-person meetings.
- Online workshops.
- Online interviews.
- Online meetings.
- Phone interviews.
- In-person workshops.
- Social media campaign.

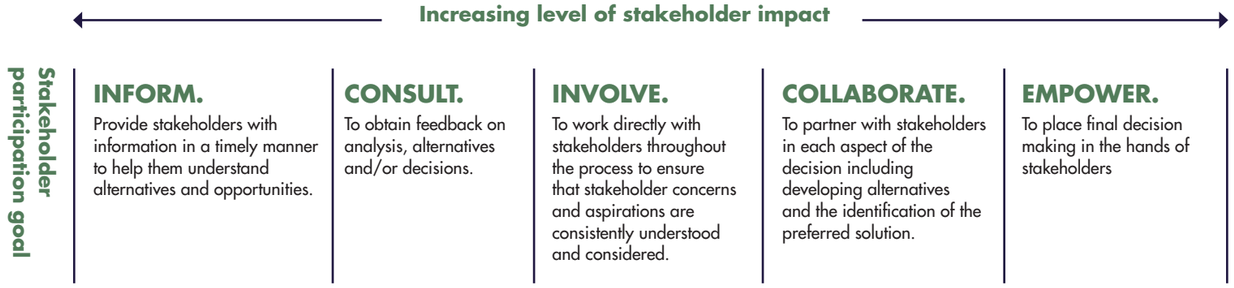


Figure 4. The IAP2 Participation Spectrum

A key principle of the plan development was to utilise a co-design approach through stakeholder engagement. The co-design process utilised the principles presented in Figure 5:

Figure 5. Principles of the co-design process

Identified stakeholders were from the following groupings of organisations:

1
- Farming groups
- Farming businesses
- Regional Development Australia Committees
- Regional Natural Resources Management organisations
- Local Government
- Aboriginal nations

2
- Research organisations
- Farm advisors / consultants
- Drought Resilience Adoption and Innovation Hubs
- Water authorities
- State Government agencies
- Federal Government agencies
- Non-government organisations
- Finance organisations

2.2 Prioritising resilience building actions, adaptation pathways and transformation activities

In order to ensure the actions recommended in the NYRDRP reflect the needs and priorities of the community, there is a need to capture the key current and future risks that interrelate with drought and are likely to be exacerbated by drought. This is part of the process of better understanding drought as it relates to the Northern and Yorke region, generating options and sequencing and implementing pathways for resilience (O'Connell, et al., 2019).

Determining the appropriate resilience actions, adaptation pathways and transformation activities has occurred through the following methods:

1. Stakeholder engagement and desktop research led key risk identification.
2. Prioritisation of key resilience enablers and transformative activities through a Multiple Criteria Analysis.
3. Determining the required type of change, i.e., either incremental, transitional or transformational change.
4. Grouping the key resilience pillars, cross-cutting themes and enablers based on themes emerging from stakeholder engagement and desktop research.
5. Generating priorities and actions to support and increase resilience to drought.

Risks identified through stakeholder engagement and desktop research have been captured in a risk matrix, described in further detail below. Following the categorisation of risk, key enablers to overcome risks were assessed according to a multiple criteria assessment, also detailed below.

KEY RISK IDENTIFICATION

This section provides a high-level risk and resilience initiative analysis of the key risks and resilience initiatives identified through the stakeholder engagement process and literature research. The purpose of the analysis is not to further discuss risk but to establish a framework for identifying the key risks to building and maintaining resilience, identifying the current methods utilised to create resilience and the future required methods for maintaining or increasing resilience to a particular type of risk.

The risk analysis also assists decision makers to determine whether the current resilience initiatives are effectively in controlling risk, based on a Relative Concentration Pathways (RCP) 8.5 scenario, i.e., a high greenhouse gas emissions scenario for the year 2030.

The Multiple criteria analysis then provides a structure for determining whether the newly required resilience initiatives will effectively reduce each risk.

MULTIPLE CRITERIA ANALYSIS (MCA)

The MCA allows for the capture and prioritisation of newly required initiatives for improving drought resilience, alongside planned initiatives. Each initiative is assessed through an analysis and assigned an average weighted score. The average weighted score utilised a traffic light colouring system as a quick reference method to determine the required initiatives that have been identified as of the greatest value from an economic, environmental and social perspective. Newly required initiatives have been assigned a score of 1-5 (1 being low, 5 being high), to determine both the cost and benefit of the initiative.

The change required (incremental/ planned transitional/ transformational) is listed against each newly required control as well as the timeframe of the required change, noting that many newly required controls are ongoing (described further below).

REQUIRED CHANGE CATEGORIES

Change has been categorised across three key categories – incremental/planned/transformational change. Each of the change categories are listed in relation to economic, social and environmental resilience. The enablers of resilience, strategic priorities and actions to facilitate and deliver resilience relate to each of the categories of change. These are represented below in Figure 6.

Enablers, priorities and actions taken to increase drought are separated into three distinct categories:

- Incremental change – Requires an alteration to current methods and practices in order to adapt to future changes to farming systems, primarily driven by the reduction of available soil moisture.
- Planned transitional – Not currently adopted but is currently planned for in the future, as conditions change.
- Transformational change – Alteration of a system, driven by the need to overhaul current practices. Transformational change is required when planned and incremental change will not result in the required change to maintain viability of the farming operation. For example, transformational change may require some farm businesses to move from cropping of wheat, barley and other break crops to animal farming systems in order to continue farming.

Incremental, planned and transformational change can occur at different scales and across different time periods. The Adaptations Pathways approach to resilience allows for the identification of incremental, planned and transformational change across different time scales. This is discussed further in Sections 7, 8 and 9.

Figure 6. An example of the three categories of change and related enablers, priorities and actions as they relate to economic resilience.

GROUPING OF KEY RESILIENCE PILLARS, CROSS-CUTTING THEMES, ENABLERS

Key resilience pillars, cross-cutting themes and enablers have been grouped according to the primary resilience building and transformative change themes emerging from stakeholder engagement and desktop research. The key pillars and cross-cutting themes and enablers are listed below in Figure 24.

GENERATING PRIORITIES AND ACTIONS

Priorities and actions arising from the key enablers have been designed to increase economic, social and environmental resilience to the impacts of drought. More importantly, the actions aim to generate options for farm enterprises, agricultural supply chains and the Northern and Yorke community through building capacity to preparing for and responding to future drought scenarios.

USING THE PLAN

The NYRDRP is a live document that is available for anyone to use to guide planning for drought resilience in the region. The NYRDRP used several companion documents to assist generating the priorities and actions in the plan. These are:

- **NYRDRP** Key Insights Paper
- Department of Environment and Water Climate Projections 2020
- Legatus Wellbeing Report

3 THE CONCEPT OF RESILIENCE.

RESILIENCE IS THE ABILITY TO WITHSTAND BAD TIMES OR DISASTERS – NOT TO JUST GET BACK UP, BUT FIGURE OUT HOW TO MOVE FORWARD, PROGRESS AND GROW IN CAPACITY TO PREVENT IT FROM HAPPENING AGAIN. MUST BE ABLE TO ADAPT TO PREVENT.

ANITA KUSS, UNIHUB SPENCER GULF

The experience of living through hardship or change in normal life can be challenging and disruptive to the wellbeing and cohesion of a community. How challenging or disruptive this is depends on the resilience of the community. For the purpose of this Plan in relation to community resilience, a "community" refers to the groups of people who share a common location such as a town, local council or region.

Resilience has multiple definitions; common traits of resilience include the ability of a system, organisation or individual to withstand adversity and bounce back. For the purpose of the NYRDRP, the definition of resilience has been taken from the Drought Resilience Funding Plan 2020 to 2024 and is described as:

"the ability to adapt, reorganise or transform in response to changing temperature, increasing variability and scarcity of rainfall and changed seasonality of rainfall, for improved economic, environmental and social wellbeing". (Australian Government, 2019).

As all communities are different, even within the region, it is difficult to develop a standard approach to build resilience. However, there are key components within a community that can be built upon that help build resilience. These are known as enablers and include physical, social and procedural elements (McAslan, 2011).

- Physical enablers include such things as access to food, water, shelter, health and wellbeing services as well as protection against accidents, illness and injury, personal security, utilities, communication and banking services, transportation and communications.
- Social enablers are those that develop community cohesion such as social inclusion, effective local leadership and social capital.
- Procedural enablers are systems and strategies that allow a community to prepare and recover from hardships such as drought. These include plans and policies, awareness and education campaigns and sharing of information.

"One size doesn't fit all. Each community is different and any future plan needs to enable the individual community to build the resilience and well being tools that suit them". (Financial Services SA).

A resilient community is one that works together to understand and manage the risks it is exposed to. The resilience of the community is the responsibility of all sectors of the community, including all levels of government, business, the non-government sector and individuals.

Developing resilience involves communities and individual actors understanding risks posed by unplanned or adverse events, taking action to avoid or mitigate these risks, and learning from these experiences to enhance future capacity through an adaptive learning process. This requires resilience to be considered using an approach such as the Resilience, Adaptation Pathways and Transformation Approach. This will allow identification of what changes are needed to be made – incremental, planned or transformational (as discussed in section 1.6) and what adaptive capacity already exists, that will increase the chances of the community's resilience through unplanned events.

The impacts on the economy, community and environment are varied and can be direct or indirect. Informed through consultation with stakeholders and literature reviews conducted as development of the Key Insights Paper, the following impacts were identified:

- Economic
  - > Drought has historically reduced revenue and income for farm enterprises whilst in drought and post drought.
  - > Farms may experience reduced ability to service loans, resulting in compounding economic stress.
  - > Farms may seek access to further financing and funding options in order to remain financiallly viable.
  - > Farms may have to spend more on farm inputs, such as machinery, water supply and irrigation and feed for their animals.
  - > Farm enterprises have reduced available finance for the agricultural supply chain, i.e., the ability to purchase farm inputs, access farm consultants etc.
  - > Non-farm businesses may experience reduced incomes and confidence, resulting from reduced spending by farm enterprises and later the businesses in the agricultural supply chain.
  - > A reduction in the work force as a result of redundancies and employment termination.
  - > Reduced employment opportunities in the regional community resulting regional depopulation and a further reduction in regional economic activity.
- Social
  - > Poorer mental health and wellbeing outcomes.
  - > Health problems related and poor water quality.
  - > Loss of cultural connectivity to land, water and country as a result of altered landscape conditions.
  - > Impact on the landscape, flora and fauna of the region which is intimately linked culturally to the local Aboriginal people.
  - > Health problems related to dust.
  - > Increased risk of suicide, threat to public safety from an increased number of fires.
  - > Reduced incomes.
  - > People leaving the region.
  - > Fewer recreational activities.
  - > Heat related health.
  - > Urban environments – liveability.
- Environmental
  - > Loss of biodiversity.
  - > Loss of habitat for wildlife.
  - > Loss of endemic animal species, especially freshwater species.
  - > Increase in disease in wild animals.
  - > Migration of wildlife.
  - > Reduced availability of surface water and groundwater, resulting in widespread movement of animals to areas with access to water, i.e., farm dams, reservoirs, permanent water holes.
  - > Reduced quality of surface and groundwater, resulting from increased competition for finite resources.
  - > Increase risk of bushfire.
  - > Wind and water erosion of soils.
  - > Soil loss and degradation.

The social, economic and environmental impacts of drought are not held in isolation of each other. For example, when drought occurs, there are environmental impacts such as reduced water availability which in turn impacts crop quality or production. When this happens, especially over multiple seasons, there are economic impacts including loss of income for farmers which can impact social and mental wellbeing.

THE ABILITY TO ADAPT, REORGANISE OR TRANSFORM IN RESPONSE TO CHANGING TEMPERATURE, INCREASING VARIABILITY AND SCARCITY OF RAINFALL AND CHANGED SEASONALITY OF RAINFALL, FOR IMPROVED ECONOMIC, ENVIRONMENTAL AND SOCIAL WELLBEING

(AUSTRALIAN GOVERNMENT, 2019)

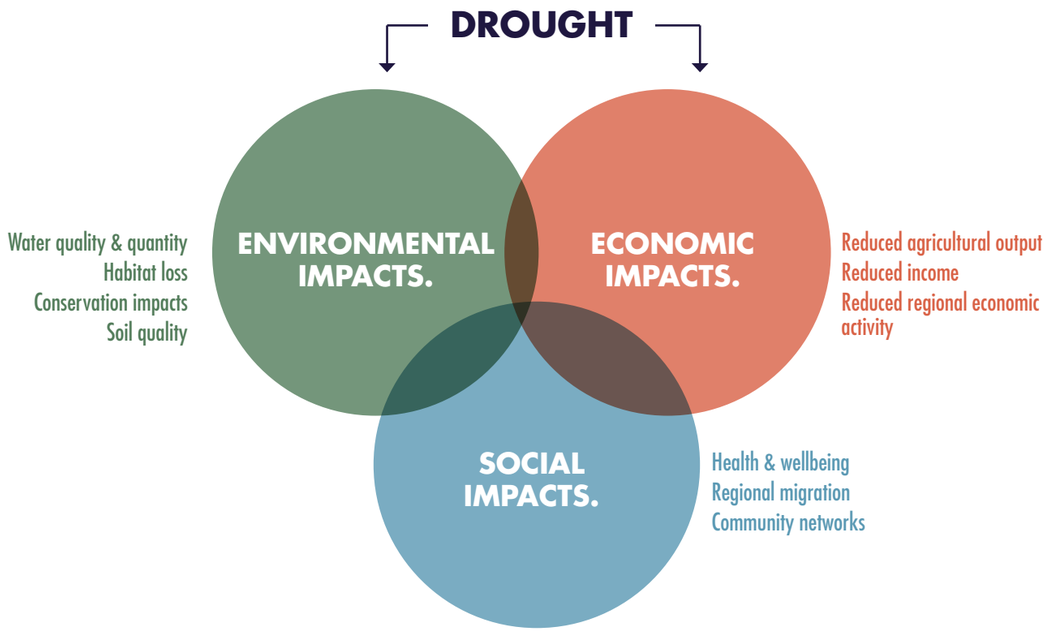


Figure 7. Simplified diagram of interconnectedness of Social, Environmental and Economic levels in Community Resilience

It is important to define the concept of resilience for this Plan in a way that is relevant to the region, and which reflects community feedback. Consultation with a wide range of stakeholders in the Northern and Yorke region enabled an exploration of 'what resilience means to them' (Figure 8), the following concept was defined:

Resilience represents the community's capacity to deal with change, move forward and adapt to minimise the impact of adverse events. A resilient community is innovative, diverse and has the tools to learn from the past to progress in the future.

ONE SIZE DOESN'T FIT ALL. EACH COMMUNITY IS DIFFERENT AND ANY FUTURE PLAN NEEDS TO ENABLE THE INDIVIDUAL COMMUNITY TO BUILD THE RESILIENCE AND WELL BEING TOOLS THAT SUIT THEM.

(FINANCIAL SERVICES SA)

Figure 8 Word cloud representing the most common words used by stakeholders during the engagement process when asked to define resilience

Through stakeholder workshops and interviews as well as desktop research (refer to Section 1.5 – 1.5.1), the concept of resilience for the region was explored taking into account the characteristics and implications of drought for sub-regions with varying rainfall (as defined in Section 3).

The ability to create and build a resilient farming enterprise is a result of decisions planned for and enacted during times of non-drought, whilst in drought and through drought recovery. Resilient farm enterprises are built upon strong, resilient and sustainable production systems that effectively manage the risk of drought and minimise economic and production loss.

The impacts of drought often extend well beyond the farm, with drought-induced losses in production at the farm level typically spreading along the supply chain. Industry and their supply chains are the physical and information systems and processes used to deliver a product or service from one location or entity to another and consist of many connected stakeholders e.g. producers, processors, packagers, distributors, transportation companies, wholesalers, supermarket retailers and consumers. Just like farm enterprises and supply chains, a resilient community will have the capacity to deal with hardship and the ability to get back up and return to normal after an adverse event. As agriculture is the primary industry of the region, the community's economic and social wellbeing is linked to the viability of the sector. Furthermore, the community's resilience is interdependently linked to the community's health and wellbeing in that when one is reduced or strengthened, so is the other (Ziglio, 2018). Resilient farms, industries and communities have certain characteristics that enable this resilience. While resilience of one key pillar is reliant on the resilience of another, there are other elements that link all three together. These are knowledge and education; and research and innovation (Figure 9).

Knowledge and education play a vital role in making the right decisions for building resilience (Oktari et al. 2021). For example, farms, businesses and communities that have access to knowledge hubs or education services, whether formal or informal, are able to make business management, land management or agronomy decisions that may reduce the impact of future drought.

Knowledge and education are linked to research and innovation. Research and innovation are key drivers of diversification of systems, which play a key role in mitigating risks of drought and allows adaptation to occur and to continue functioning through times of change.

RESILIENCE

Resilience can relate to the ability of a system, organisation of individual to withstand adversity and to bounce back from such adversity.
As a concept, resilience represents the community's capacity to deal with change, move forward and adapt to minimise the impact of adverse events.

A resilient community is innovative, diverse and has the tools to learn from the past to progress in the future.

RESILIENT FARM ENTERPRISES

Resilient farm enterprises are built upon strong, resilient and diverse production systems operated in accordance with effective risk management frameworks that enable income production during challenging times.

Key characteristics or attributes include:

- A diverse farming income stream
- Sustainable land management
- Support systems in place for farmer and family health and wellbeing
- Sound production systems
- Appropriate business planning which incorporates risk planning
- Knowledge sharing and education

Key implications or challenges posed by future drought include:

- Reduced and loss of crop and livestock production
- An aging workforce
- Successional change on farms and depopulation
- Reduction in water availability
- Increased water prices and or decrease water quality
- Reduced profit and income
- Increasing input costs e.g. fuel and fertilisers.
- Poorer mental health and wellbeing outcomes

RESILIENT INDUSTRIES

A resilient industry is one that recovers quickly and adapts from an unexpected event, is able to identify process changes that allow it to recover in a better position than prior to the disruption.

Key characteristics or attributes include:

- Flexibility in sourcing, manufacturing or otherwise procuring supply
- Market and product diversity supporting multiple income streams
- Utilises business and disaster planning to anticipate adverse events
- Active preventative maintenance on machinery/equipment
- Active coordination and knowledge sharing between supply chain stakeholders

Key implications or challenges posed by future drought include:

- Increase in product and commodity costs
- Issues with transport infrastructure (e.g. road) causing delays or inability to transport supply
- Loss of markets via demand or credit-worthiness of clients
- Supply delays
- Crop or harvest failure

RESILIENT COMMUNITIES

Communities resilience is interdependently linked to the community's health and wellbeing in that when one is reduced or strengthened, so is the other. A resilient community has the capacity to deal with hardship, can get back up and return to normal after an adverse event.

Key characteristics or attributes include:

- Effective leadership
- Diverse economic activities
- Access to services and infrastructure
- Involved in decision making
- Socially cohesive
- Strong cultural links
- Knowledgeable
- Healthy
- Engaged

Key implications posed by future drought include:

- Poorer mental health and wellbeing outcomes
- Poorer physical health outcomes
- Reduced incomes
- People leaving the region
- Poorer social connections
- Poorer engagement (volunteerism)

KNOWLEDGE & EDUCATION
RESEARCH & INNOVATION

Figure 9. Characteristics and key implications of drought on of resilient farm enterprises, industries and communities

4 THE PLAN REGION.

The Northern and Yorke region (the region) extends from the Northern Adelaide Plains in the south to the Southern Flinders Ranges in the north, bounded by Yorke Peninsula to the west and the Barossa, Regional Council of Goyder, District Council of Peterborough and District Council of Orroroo Carrieton in the east.

The region covers almost 5 million hectares, of which approximately 91% is under agricultural production (CSIRO; Bureau of Meteorology; Farm Link, 2019).

The region is of great importance to the South Australian and Australian agricultural economy, producing almost half (46.8%) of the state's grain production in 2020/21 (Profile ID, 2022). The rainfall and topography varies considerably throughout the region, with the south consisting of a mix of horticulture, viticulture, livestock farming and cropping, whilst the northern and eastern farming districts are predominantly mixed farming enterprises consisting of both livestock and cropping agriculture. The Yorke Peninsual region is dominated by cropping enterprises.

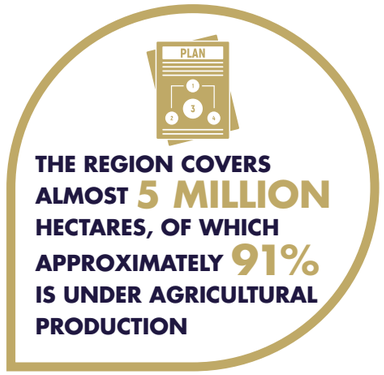
The region contains distinct wine and vegetable production regions. Significant water capture, storage and reuse schemes operate throughout the Northern Adelaide Plains, Barossa and Light Regional Council areas.

The regional population is approximately 150,000 people. Agriculture, forestry and fisheries followed by manufacturing are the major employment sectors and sources of economic activity (Northern and Yorke Landscapes Board, 2020) (Profile ID, 2022). Much of the manufacturing occurring in the region is either directly or indirectly supported by agriculture, either contributing to farm or business practices or in certain locations, value-adding to existing regionally produced agricultural commodities, i.e, wine and fine food production.

The region contains several areas of high ecological value, including the samphire communities and inter-tidal zone of the Adelaide International Bird Sanctuary, pockets of remnant Peppermint Box Grassy Woodland, Grey Box Grassy Woodlands occurring through the Southern Flinders Ranges and Iron-grass Natural Temperate Grassland (Department of Agriculture, Water and the Environment, 2021).

The Adelaide International Bird Sanctuary alone is home to 263 species of fauna and flora (National Parks and Wildlife Service South Australia, 2022).

Data provided in this section has been sourced from a variety of government and non-government sources and represents the RDA Yorke and Mid North and RDA BGLAP regions. The region outlined in this plan (including the southern section of Flinders Ranges Council) does not align with the RDA Yorke and Mid North and RDA BGLAP regions. As such, data for the Flinders Ranges Council area has not been included in the data outlined below.



4.1 Economic profile

$8.08 BILLION
- The 2020/21 Gross Regional Product
- In 2020/21 the region contributed 6.9% of SA's employment and 6.5% of its value added

13,306 LOCAL BUSINESSES

4,193 agriculture, forestry and fishing businesses. 32% of all business in the region (2021 data)

$1.7 BILLION

THE GROSS REGIONAL PRODUCE VALUE OF AGRICULTURE IN 2020/21
- 46.8% of South Australia's grain production.
- 63.6% of South Australia's break crop production
- 34.6% of the state's hay production

34.8% RENTAL STRESS

THE HIGHEST IN REGIONAL SA. Based on 2016 data.
- 29.7% of the population live alone (2016 data)

IN 2018, THE REGION RANKED 54 OUT OF 60 FOR TECHNOLOGICAL READINESS
- 61% of respondents have missed business deadlines due to telecommunications issues (2020 data)
- Local Australian Digital Inclusion Index Score – 61.2 ranging from 59 to 63, below the SA average of 69 (2021 data)

Figure 10. Key Northern and Yorke region economic statistics (Profile ID, 2022) (Infrastructure Australia, 2022)

The region produces 28% of all economic outputs within South Australia. Agriculture provided $1,746,479,433 of Gross Regional Product value to the Australian economy in 2020/21 (Profile ID, 2022)(see Table 1).

COMMODITY	MILLION $	%	REGION AS A % OF SOUTH AUSTRALIA
Cereal crops	624.8	35.7	46.8
Livestock slaughtering	535.9	30.7	27.4
Other broadacre crops	239.3	13.7	63.3
Wool	100.4	5.7	22.5
Crops for hay	93.0	5.3	34.6
Grapes (wine and table)	28.2	3.3	15.7
Vegetables	31.4	1.8	7.6
Eggs	13.3	0.8	58
Milk	12.4	0.7	3.8
Nurseries and cut flowers	7.1	0.4	13.2
Nuts	1.6	0.0	1.0
Other fruit	0.4	0.0	0.3

Table 1. The GRP value of the key agricultural commodities produced in the Northern and Yorke region listed in order of economic value (million $) (Profile ID, 2022).

EMPLOYMENT BY INDUSTRY

The Agriculture, Forestry, and Fishing (AFF) industry is the largest employer in the Yorke & Mid North Region, employing roughly 18% of the local population (Profile ID, 2022). Comparatively, in the Barossa, Gawler, and Light Adelaide Plains region, the AFF industry only employs roughly 10% of the population (Profile ID, 2022). The largest employer in the Barossa, Gawler, and Light Adelaide Plains region is the Manufacturing industry, employing 3,871 people, or roughly 17% of the region (Profile ID, 2022). Much of the manufacturing industry contributes to the food and agricultural industry with more than 50 artisan food producers operating throughout the RDA BGLAP region (Regional Development Australia Barossa Gawler Light Adelaide Plains, 2022).

MUCH OF THE MANUFACTURING INDUSTRY RELIES ON INPUTS FROM THE AGRICULTURAL INDUSTRY

INDUSTRY	BAROSSA, GAWLER, AND LIGHT ADELAIDE PLAINS (2016)		YORKE AND MID NORTH REGION (2016)		SOUTH AUSTRALIA
	NUMBER	%.	NUMBER	%	%
Agriculture, Forestry and Fishing	2,374	10%	4,861	18%	4%
Mining	129	1%	169	1%	1%
Manufacturing	3,871	17%	2,521	9%	8%
Electricity, Gas, Water and Waste Services	137	1%	325	1%	1%
Construction	1,291	6%	1,543	6%	8%
Wholesale Trade	442	2%	738	3%	3%
Retail Trade	2,570	11%	2,965	11%	11%
Accommodation and Food Services	1,866	8%	1,929	7%	7%
Transport, Postal and Warehousing	825	4%	901	3%	4%
Information Media and Telecommunications	170	1%	134	1%	1%
Financial and Insurance Services	291	1%	344	1%	3%
Rental, Hiring and Real Estate Services	240	1%	209	1%	1%
Professional, Scientific and Technical Services	760	3%	584	2%	6%
Administrative and Support Services	1,010	4%	569	2%	4%
Public Administration and Safety	720	3%	1,168	4%	7%
Education and Training	2,151	9%	2,294	9%	9%
Health Care and Social Assistance	2,609	11%	3,723	14%	15%
Arts and Recreation Services	291	1%	142	1%	1%
Other Services	862	4%	947	4%	4%
Industry not classified	816	4%	819	3%	3%
Total persons	23,425	100%	26,960	100%	100%

Table 2. Employment percentage per industry across the Northern and York region (sub-regions: Barossa, Gawler, & Light Adelaide Plains, and Yorke & Mid North Region) compared to South Australia (Profile ID, 2022).

WATER USE AND REUSE

Three treated water pipelines, transporting treated water from the Murray River span across the region. These are as follows (SA Water, 2022):

- **The Swan Reach to Paskeville pipeline:** A 189 kilometre pipeline constructed to deliver water to the Barossa Valley, Lower North and Yorke Peninsula areas. Water is treated at Swan Reach and is pumped into the pipeline.
- **The Morgan to Whyalla pipeline:** A 641 kilometre pipeline supplying treated water to regional towns, such as Jamestown and Peterborough. The pipeline travels through the region and extends to the Eyre Peninsula.
- **Yorke Peninsula:** A new wpipeline reaching from Morgan and Swan Reach provides water to the southern Yorke Peninsula region, including Warooka and Point Turton.

Water storages in the region range from small scale farm dams to large scale reservoirs. Reservoirs in the region are strategically located to capture stormwater run-off and rainfall and some of these can be filled with Murray River water (SA Water, 2022).

Six reservoirs are located within the region, these are as follows:

- **Barossa:** A 4.4 gigalitre (GL) reservoir, located close to the southern boundary of the region in the Barossa Council area.
- **Warren:** A 4.7 GL reservoir, providing water for the Barossa Infrastructure Limited scheme, located in the Barossa Council area.
- **South Para -** The second largest reservoir in South Australia, with a capacity of 44.8 GL, located in the Barossa Council area.
- **Baroota -** A 6.14 GL offline reservoir located on Baroota Creek in the Mount Remarkable Council area.
- **Bundaleer -** A 6.3 GL offline reservoir located in the Nortern Areas Council area.
- **Beetaloo -** A 3.1 GL offline Reservoir located in the Northern Areas Council area.

The expanded use of recycled water has been identified as offering significant potential in improving irrigation capacity and economic output (Infrastructure Australia, 2022).

Existing recycled water supply infrastructure include:

- the Bunyip Scheme (formerly the Gawler Water Reuse Scheme (GWRS))
- Barossa Infrastructure Limited (BIL)
- The Northern Adelaide Irrigation Scheme (NAIS)

All scheme provide significant economic value to the region through providing alternative sources of water for irrigation (Infrastructure Australia, 2022).

Small scale community wastewater reuse schemes also operate throughout regional towns and centres.

Currently, the Barossa and Clare Valley are investigating recycled water and reuse projects.

ELECTRICITY

The region has been identified by the Australian Electricity Market Operator (AEMO) as a key renewable energy zone (Infrastructure Australia, 2022). The region and in particular the Eastern and Northern sub-regional zone and Mid-North sub-regional zone are key producers of both solar and wind energy.

INTERNET AND MOBILE PHONE RECEPTION

In 2021 the region recorded a Local Australian Digital Inclusion Index (ADII) Score – 61.2 ranging from 59 to 63, below the SA average of 69 and the national average of 70 (Infrastructure Australia, 2022). The ADII score represents the level of digital inclusion for a particular region.

Access, affordability and digital ability are equally weighted and considered in the ADII score. Year on year percentage change data indicates that people over 75 years of age, people who did not finish high school and people who fall into the lowest income quintile are being further disadvantaged by lack of access to digital technology (Ausrtalian Dgital Inclusion Index, 2021).

HOUSEHOLD INCOME

The average household income of the residents of the Northern and Yorke region is less than the South Australian state average, with over two-thirds of residents earning less than $1,499 per week (Profile ID, 2022)(Table 3).

WATER STORAGES IN THE REGION RANGE FROM SMALL SCALE FARM DAMS TO LARGE SCALE RESERVOIRS. RESERVOIRS IN THE REGION ARE STRATEGICALLY LOCATED TO CAPTURE STORMWATER RUN-OFF AND RAINFALL AND SOME OF THESE CAN BE FILLED WITH WATER FROM THE MURAY RIVER.

HOUSEHOLD INCOME	NUMBER	%	SOUTH AUSTRALIA %
Nil to $649	13,837	27.0	21.6
$650 to $1,499	20,226	39.5	32.9
$1500 to $2,449	11,018	21.5	20.8
$2,500 or more	6,547	12.6	15.2

Table 3. Northern and Yorke household incomes compared to South Australian household incomes (Profile ID, 2022)

RESIDENT WORKER HOUSEHOLD INCOME PER QUARTILE

Resident worker individual incomes across the Northern and Yorke region were fairly stable in the period from 2011 to 2016. There was a minor shift in individuals moving up out of the lowest quartile group, and from the medium highest group into the highest group (Profile ID, 2022).

	2016			2011			
QUARTILE GROUP	NUMBER	%.	SOUTH AUSTRALIA	NUMBER	%.	SOUTH AUSTRALIA	2011 - 2016
Lowest group	16,122	25%	25%	15,574	26%	25%	548
Medium lowest	16,262	25%	25%	15,680	26%	25%	582
Medium highest	16,908	26%	25%	15,956	26%	25%	952
Highest group	14,660	23%	25%	13,580	22%	25%	1,080
Total Persons	63,952	100	100%	60,790	100%	100%	3,162

Table 4. Northern and Yorke resident worker incomes per quartile compared to South Australian quartiles (Profile ID, 2022)

4.2 Regional Profile

4.2.1 Social profile

Key social statistics for the Northern and Yorke region are presented below in Figure 11

Figure 11. Key Northern and Yorke region social statistics (Profile ID, 2022).

The population of the Yorke and Mid North region had a light increase in population between 2015 and 2020 with an increase of 3.6% (5,260 persons) (Table 5). This was less than population growth of Metropolitan Adelaide with 4.8%. The projected population increase from 2021 to 2036 is 7.9% (9,299 persons), with all regions projected to increase in population, with the exception of the Peterborough, Orroroo Carrieton, Mount Remarkable Council areas (Data SA, 2020)

2015		CHANGE 2015-2020		2020	
Northern & Yorke	Metropolitan Adelaide	Northern & Yorke	Metropolitan Adelaide	Northern & Yorke	Metropolitan Adelaide
146,693	1,313,419	5,240	63,182	151,933	1,376,601

Table 5. Population growth of the Northern and Yorke region compared to Metropolitan Adelaide from 2015-2020 (Profile ID, 2022).

Table 6 summarises the age profile comparison between the Yorke and Mid North region and Metropolitan Adelaide.

AGE GROUP (YEARS)	YORKE & MID NORTH REGION %	METROPOLITAN ADELAIDE %
0-4	5.1	5.6
5-14	12.3	11.9
15-24	11.6	12.6
25-34	9.9	14.1
35-44	10.6	13.0
45-54	12.8	12.7
55-64	15.0	12.1
65-74	12.9	9.8
75-84	7.1	5.6
85+0	2.7	2.6

Table 6. The age profile comparison between the Yorke and Mid North region and Metropolitan Adelaide (Profile ID, 2022)

UNEMPLOYMENT

The absolute number of unemployed people from 2011 to 2016 has increased by 1,256 across the Northern and Yorke region (Profile ID, 2022).

	2016			2011			CHANGE
	Number	%.	% South Australia	Number	%	% South Australia	2011 to 2016
Total persons (unemployed)	4,447	100%	100%	3,191	100%	100%	1,256
Males	2,483	56%	57%	1,748	55%	53%	735
Females	1,972	44%	44%	1,453	46%	47%	519

Table 7. The number of unemployed persons in the Northern and Yorke region compared to the number of unemployed persons across South Australia (Profile ID, 2022).

ABORIGINAL NATIONS

There are five Aboriginal Nations within the Northern and Yorke region (Table 8).

Prescribed Bodies Corporate are integral to dealings with Native Title as it the first point of contact for government and other parties wishing to undertake activities on native title land. It acts as a bridge for traditional owners to deal with the non-Indigenous legal system and provides a legal entity to conduct business.

Aboriginal Nations – refer map	Prescribed Bodies Corporate
Kaurna	Kaurna Yerta Aboriginal Corporation
Narungga	Narungga Nation Aboriginal Corporation
Ngadjuri	Ngadjuri Nation Aboriginal Corporation
Peramangk	Not applicable
Nukunu	Nukunu Wapma Thura Aboriginal Corporation

Table 8. Aboriginal nations within the Northern and Yorke region and the Prescribed Bodies Corporate.

The Socio-Economic Index for Yorke and Mid North region varies significantly. Light, Barossa, Clare and Gilbert Valleys, Orroroo/Carrieton and Northern Areas councils are ranked the highest in terms of their Socioeconomic Index for Areas (SEIFA) scoring 125, 1012, 1001, 991 and 981 respectively.

The remaining areas ranked below the state average of 979.

The Yorke and Mid North region as a whole scored 934 with Wakefield (933), Copper Coast (919), Port Pirie (886) and Peterborough (792) scoring below the region's average. The District Council of Peterborough scored the lowest value.

A low Socio-Economic score represents the highest levels of disadvantage.

4.2.2 Environmental profile

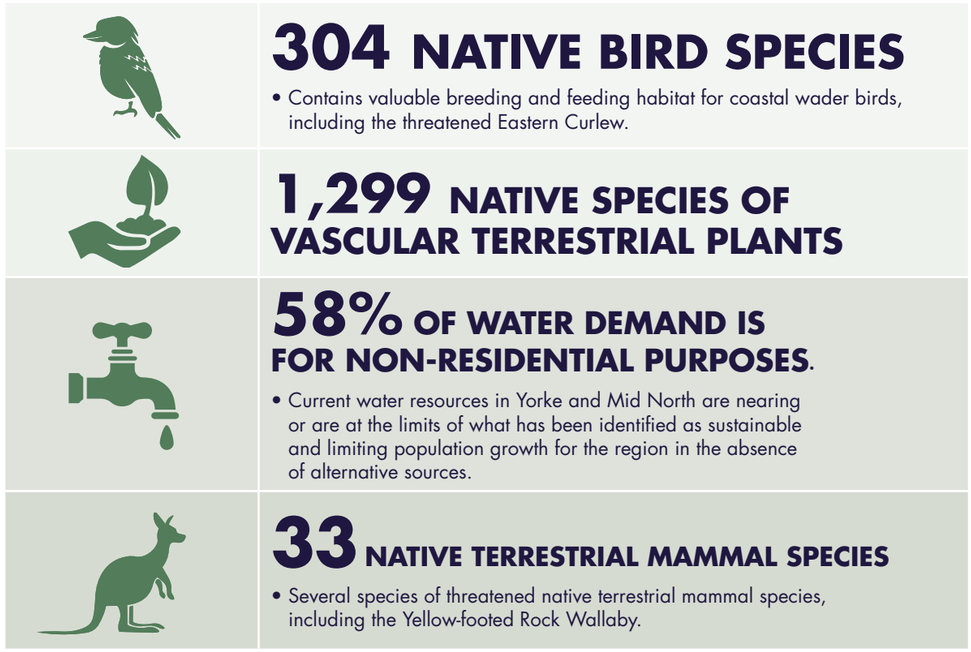


Figure 12. Key Northern and Yorke environment statistics (SA Environmental Protection Authority, 2018) (Landscapes South Australia Northern and Yorke, 2020)

The Northern and Yorke region extends over 38,500 square kilometres, possessing considerable diversity in the environmental assets that it contains with varying levels of biodiversity and remnant and revegetated native vegetation (Landscapes SA - Northern and Yorke , 2022). Surface water and groundwater assets in the region have altered over time, affected by water take, alteration of hydrological systems and removal of vegetation. Soils are of varying quality for agricultural production, with many areas producing high quality, high yield commodities. Water-dependent Ecosystems are key indicators of the health and condition of our creeks and rivers, ongoing reduced rainfall will continue the declines already being observed in these ecosystems.

South Australia, including the Northern and Yorke region are highly reliant on the Murray River for water use for residential and industrial uses. Access to potable water is noted as a key barrier to population growth in the region (SA Environmental Protection Authority, 2018). As part of the Murray-Darling Basin Plan, 450 GL of water is to be delivered to the River Murray through on-farm water efficiency measures (SA Environmental Protection Authority, 2018). The implications of this for the Northern and Yorke region are that there is a requirement to demonstrate water efficiency increases and to source alternative non-potable water supplies (fit for purpose water) for agricultural production.

The imported water dependent agricultural industries (viticulture, horticulture and livestock farming) are currently exposed to the impacts of drought from both within and outside of the region, i.e., drought occurring outside of the region will impact the quantity and quality of River Murray water available for extraction and use in the region.

5 DROUGHT RISK AND VULNERABILITY.

The Northern and Yorke region is projected to be impacted by more severe and frequent droughts, characterised by reduced rainfall and increased evaporation, reducing the availability of water for pasture and crop production.

It is important to note that the nature, timing and extent of these general changes occur will differ between different areas within the Northern and Yorke region. To account for these differences, the Plan adopts four sub-regions to better encapsulate the types of changes expected to occur.

The following information provides the justification for the boundaries of four distinct sub-regional zones.

- Temperature, evapotranspiration and growing season rainfall declines (indicators of chronic drought) are projected to generally increase in the north and spread south. There is also an increased temperature, evapotranspiration and a decline in growing season rainfall from inland regions to the coast.
- The zones are culturally and economically cohesive, i.e., the zones are considered similar in nature, when compared to other zones, noting that there is still considerable intra-zone variance, especially in the Upper North and East Zone. The sub-regional zones are projected to experience similar climatic challenges in the near future (2030) and to a lesser extent the far future (2050).
- The emphasis on the Mid-North Zone as a smaller discrete entity with a rapidly increasing chronic drought risk profile, resulting from increased evaporation and decreased precipitation, resulting in reduced availability of soil moisture. This is true of all zones, however, the Mid-North zone is highlighted as the area most likely to experience an enhanced drying trend. This combined with reduced experience of managing drought conditions within the sub-region, represents a significant risk to farmers in the region who may be less prepared for the rapidly changing climatic conditions.
- The sub-regional zones capture differences in autumn and spring rainfall and therefore growing season length and risk. This is relevant to all agricultural enterprises, but particularly so to cropping enterprises that are solely reliant on soil moisture availability for crop production and to livestock farming enterprises that are somewhat reliant on pasture and groundcover.

It is important to note that the sub-regional zone drought profiles represented in Figure 15 are representative of conditions projected under a high emissions 2030 future scenario and that the risk ratings are relative to each other. All regions are projected to experience more challenging farming conditions as a result of increased severity, duration and frequency of drought. However, when examining the region as a whole, some sub-regions are more exposed to drought than others. The risk profiles reflect this. Under a longer-term (2050) future drought scenario all of the Northern and Yorke region is considered exceedingly high risk.

The purpose of the map presented in Figure 15 is to demonstrate the different risk profiles and types of risks, adaptive capacity and experience in preparing for and responding to chronic drought. The Northern and Yorke region is a diverse region, containing a broad range of agricultural systems that have been successfully built upon based on historic climatic conditions, rather than current and projected climate conditions.

The exposure and vulnerability of each of the sub-regional zones is distinct. The reasons for this are primarily related to the following themes:

- The impact of drought will not be uniformly spread across the region. Certain sub-regional zones, agricultural systems and individual farm enterprises will be more affected by the impacts of future drought than others. Furthermore, drought may impact different locations at different times.
- The projected severity, duration and frequency of drought is unprecedented in recent history. This is typified by (Department for Environment and Water, 2020) (Hope, 2015):
  - > Increasing severity, duration and frequency of drought.
  - > Increased average, minimum and maximum temperatures, resulting in more heat wave conditions.
  - > Increased evaporation resulting in reduced availability of surface water and a reduction in available soil moisture.
  - > Increased evapotranspiration, i.e., the movement of moisture from land to the atmosphere by evaporation from the soils and through plant transpiration, indicating that plants will require access to greater quantities of water to survive and flourish (Webb, 2010). This will impact all rainfall dependent systems, including crops, pasture, native vegetation, weeds and irrigated crops.
- Understanding and acceptance of climate science and future projected climatic conditions.
- Experience and knowledge of preparing for drought from an economic, social and environmental perspective.
- The ability of farm enterprises to manage risk, including on-farm rainfall dependent and independent systems and off-farm rainfall independent income sources.
- The financial, operational and technical capability of a farming enterprise to alter agronomic and land management decisions based on seasonal conditions.
- The reliance of certain agricultural systems on high-cost input systems and the ability of an individual farm enterprise to afford to alter practices, that have historically provided return on investment, but may not consistently do so in the future.
- Market drivers and barriers limiting or discouraging change to more climate resilient farming systems, i.e., the use of high-input systems provides significant financial returns to those organisations supplying the inputs to farmers. A move away from these systems may result in loss of income and revenue for these organisations.

The maps do not account for the counteracting positive effects of farm adaptation or technological improvement (or macroeconomic forces, such as global commodity prices), the results are not projections of absolute outcomes in 2030, but rather projections of 'adaptation pressure': identifying which sub-regions are likely to be under more pressure to adapt due to increases in chronic drought impacts.

ALL REGIONS ARE PROJECTED TO EXPERIENCE MORE CHALLENGING FARMING CONDITIONS AS A RESULT OF INCREASED SEVERITY, DURATION AND FREQUENCY OF DROUGHT.

5.1 Sub-regional zones

There are four distinct sub-regions or zones within the Northern and Yorke region. These are as follows:

UPPER NORTH AND EAST ZONE

The Upper North and East Zone is an area that has experienced and continues to experience reduced rainfall conditions. Stakeholder groups operating within this region have already demonstrated a high adaptive capacity to alter land and business management decisions based on climatic and associated environmental conditions.

The zone contains a high number of mixed farming enterprises (i.e., broadacre farming operations including cropping and livestock grazing).

The zone is categorised as an exceedingly high drought risk profile. However, the risk profile for this area, does not consider the success of previous adaptation and resilience measures that have allowed farm enterprises and agricultural supply chains to continue to be financially viable through the 2018 drought and previous droughts, due to knowledge and experience of operating in drought conditions over long periods of time. This is not necessarily the case for other sub-regional zones in the Northern and Yorke region, that despite being labelled as either very high or high drought risk profiles are considered as more vulnerable and exposed to the effects of drought as a result of poor experience of handling drought.

Key factors associated with this zone are as follows:

- Greater experience of recent drought conditions resulting in increased knowledge and skills to manage drought and dry times (refer to Consultation Summary Appendix).
- Many towns (Peterborough, Quorn, Melrose) have benefitted from increased tourism, which has somewhat offset the economic impacts of drought (Regional Development Australia Yorke and Mid North, 2022) ((Brown, 2022).
- The growth of the tourism sector is a key priority for the entire region. The Northern and Eastern sub-regional zone Councils are targeting caravan, camping and the outdoor based activity tourism sector (Stevenson, 2022) (Brown, 2022) (Regional Development Australia Yorke and Mid North, 2022).
- Reduced access to internet and mobile phone reception compared to the Plains and Ranges zone and large sections of the Peninsula zone (Infrastructure Australia, 2022) (Stevenson, 2022).
- Reduced access to health care services, child care services (particularly through the more northern districts) and reduced employment opportunities (Ting, et al., 2022) (Health Map, 2022).
- Inequitable and poor access to mental health care and financial advisory services. This may exacerbate rapid changes to rainfall expected in the region (Health Map, 2022).
- A higher percentage of farms with a reduced financial capability to alter current practices as a result of long-term drought exposure and tighter profit margins arising from the recent drought conditions (refer to Consultation Summary Report).
- The economic and mental health impacts, particularly related to the sale and destruction of livestock as a result of drought and farm management decisions has impacted farmers, farm advisors and particular sectors of the agricultural supply chain (Kellock, 2022).
- Varying understanding and acceptance of projected drought conditions and associated future climate projections across the zone (refer to Consultation Summary Report).
- Limited willingness, knowledge or ability to alter current systems (refer to Consultation Summary Report).
- Overconfidence in existing systems that have provided incremental increases in resilience, may mean that planned transitional and transformational adaptation measures are not trialled or adopted.

MID NORTH ZONE

The Mid North Zone can be distinguished from other zones by the projected future exposure to drought and the regions experience managing drought conditions. This zone is highly exposed to near-future (2030) conditions, meaning that farmers in this area have a reduced time period to adapt to expected changes to climatic conditions, including drought and little knowledge or experience of how to withstand and bounce back from these conditions.

The Mid North Zone has not experienced the severity or frequency of drought of the Upper North and East Zone. As such, farmers in this region have not developed the equivalent skills and knowledge of the Upper North and East Zone to adequately adapt to the projected changes to precipitation and evaporation and alter farming systems to withstand the projected future conditions. The Mid North Zone is projected to experience drought conditions that will challenge farmers and land managers due to the near future climate projections, of which the severity and frequency of drought conditions have not been previously experienced.

Key factors associated with this zone are:

- Varying understanding and acceptance of projected drought conditions and associated future climate projections across the zone.
- Limited time to plan and prepare for a more severe, frequent and longer lasting drought scenario.
- Reduced access to internet and mobile phone reception compared to the Plains and Ranges zone and large sections of the Peninsula zone (Infrastructure Australia, 2022) (Stevenson, 2022).
- Reduced access to health care services and childcare services (Ting, et al., 2022) (Health Map, 2022).
- Non-agricultural businesses and organisation that are somewhat reliant on a prosperous agriculture industry and profitable farm enterprises, are not prepared for the projected rapid alteration to precipitation and evaporation. This may result in widespread economic, environmental and social shocks.
- Inequitable and poor access to mental health care and financial advisory services. This may exacerbate rapid changes to rainfall expected in the region (Health Map, 2022).
- Over-reliance on the Murray River, Adelaide Hills Reservoirs and the Lonsdale based desalination plant as sources of high-quality water. The reliance on irrigation across horticulture and viticulture regions is notable. Any reductions in access to the required quality and priced water will have significant farm business implications, including reduced yields, reduced quality produce, increased financial stress and reductions in farm income
- A possible reduction in tourism resulting from rapid climatic shifts and resulting reduced environmental conditions of the zone.

PLAINS AND RANGES ZONE

The Plains and Ranges Zone represents the greatest diversity of farming and agricultural systems of the Northern and Yorke region. This zone includes distinct wine production regions, indoor and outdoor horticultural systems, mixed farming systems, egg and chicken production, livestock farming and cropping systems. However, the overwhelming percentage of land is dedicated to cropping and mixed farming systems. Although the Plain and Ranges Zone attracts a lower risk classification (high) than the Mid North and Upper North and East zones, it is important to note that operators of farming systems typically exhibit lower levels of familiarity with the types of knowledge and experience needed to effectively plan for future drought risks.This includes a knowledge of how to actively prepare for and increase the capacity of individuals, businesses and systems to withstand a reduction in rainfall and increase in evaporation.

> **WATER IS THE NUMBER ONE ISSUE FOR THE BAROSSA**
>
> M. MCCARTHY, CEO, BAROSSA COUNCIL.

Key factors associated with this zone are as follows:

- In general, a closer proximity to Adelaide (than other zones) provides significant economic opportunities, such as tourism, access to labour, freight and logistics advantages etc.
- Greater access to health care services and childcare services, particularly through towns such as Nuriootpa, Clare, Snowtown (Ting, et al., 2022) (Health Map, 2022).
- High competition for aged care facilities and services (Infrastructure Australia, 2022).
- Reduced ability to alter existing agronomic systems, due to a high reliance on current high-cost practices and inputs that encourage economies of scale efficiencies to provide a return on investment.
- Low appetite for adoption of transitional and transformational adaptation pathways, due to historically successful incremental changes providing productivity gains.
- Over the past 30 years, grain growers have experienced a limited run of dry years, buffered by either high grain prices or high yields and reduced grain prices either during, preceding or proceeding reduced rainfall years (Faulkner, 2022). This has provided an economic buffer to previous experiences of reduced rainfall conditions (Faulkner, 2022). Dry times have been experienced although not over an extended period. As such, there is limited knowledge and experience of how to prepare for increased severity and duration of drought.
- Many younger farmers in the zone would not have experienced extended dry periods (Faulkner, 2022).
- Increased options for irrigation resulting from the development of multiple alternative water supply schemes, primarily targeted at viticulture but also stock watering and horticulture (Infrastructure Australia, 2022).
- Over-reliance on the Murray River, Adelaide Hills Reservoirs and the Lonsdale based desalination plant as sources of high-quality water for viticulture irrigation and stock watering (Infrastructure Australia, 2022) (SA Environmental Protection Authority, 2018).
- Horticultural enterprises in the southern area of the zone are exposed to changes in regulatory settings under water allocation plans related to the take of groundwater and surface water (Koch, 2022).
- Decreasing availability of surface water and groundwater resulting from reduced average annual rainfall, experienced over the past 30 years leading to (SA Environmental Protection Authority, 2018):
  - > A reduction in access to fit for purpose water for horticultural and viticultural systems.
  - > Declining water quality across groundwater and surface water systems resulting in reduced water available for irrigation dependent systems, livestock and chicken production.

PENINSULA ZONE

The Peninsula Zone covers the Yorke Peninsula, including the local government areas of Barunga West, Copper Coast and Yorke Peninsula. The area is synonymous with cropping, with the central areas of the zone, considered to be highly productive and profitable as a result of favourable and historically consistent rainfall conditions and productive soils. Much of the zone is bounded on both sides by large water bodies that help to mitigate heat, especially overnight temperatures during warmer months. As such, the impact of increased average, minimum and maximum temperatures is typically not as pronounced as in the other sub-regional zones. Due to the productive nature of the soils and historic reliability of in-season rainfall, the perceived risk of drought amongst many farmers, particularly those in the central and southern parts of the zone is low. The northern parts of the zone contain areas of sandy soils and have experienced dry times in recent years.

Key factors associated with this zone are as follows:

- Cropping of wheat, barley and break crops is the primary agricultural industry (Young, 2022). Animal agriculture has reduced in areas of the zone, due to the historical high return of grain and break crop production in favour of animal agriculture (Dahl-helm, 2022).
- Across South Australia, grain yields have increased by almost 2% year on year over the past 30 years (Primary Indutries and Regions South Australia, 2020). The Yorke Peninsula, as a key grain producing region has benefitted from this year-on-year increase (Australian Export Grains Innovation Centre, 2018) (Figure 17). The continuing increases in yields, have led to an expectation that high yielding years will continue into the future. Many farmers in this sub-region do not consider drought a key risk, particularly through the central and southern areas where rainfall has historically been relatively reliable (See Consultation Summary Appendix). As such, the need to adapt, transform and increase resilience to drought has not been recognised and implemented historically.

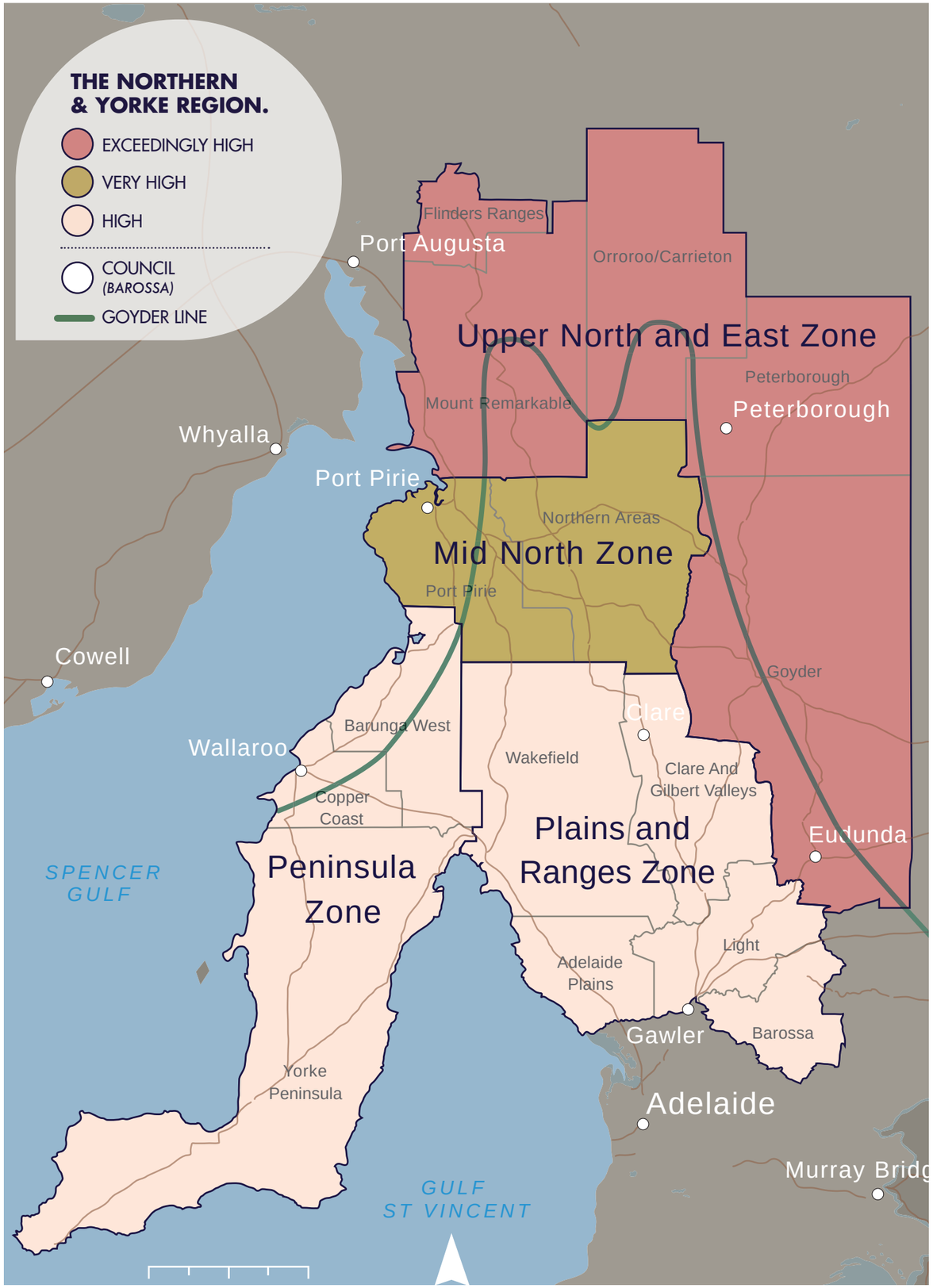


Figure 15. The Northern and Yorke Region includes four distinct zones, representing three distinct 2030 drought risk profiles.

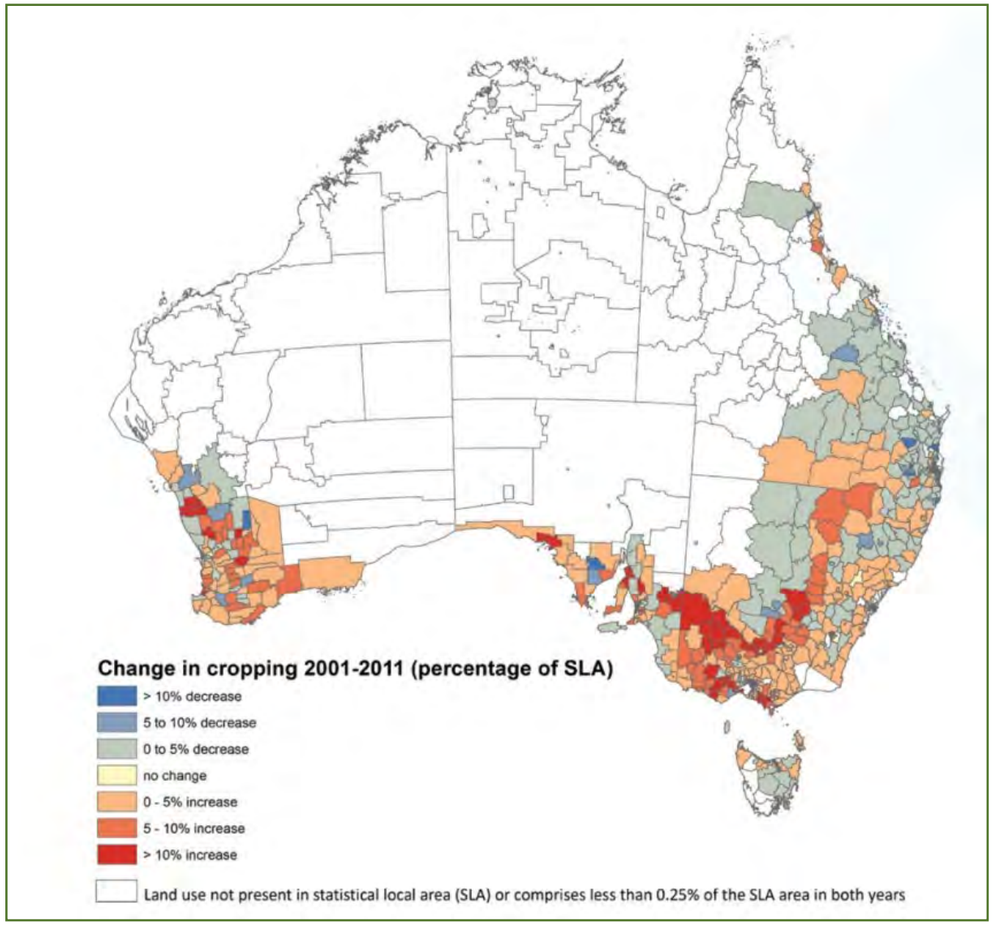


Figure 16. Change in cropping from 2001-2011 in key Australian cropping districts (Australian Export Grains Innovation Centre, 2018).

- Agronomic research and development advances have allowed the use of break crops, such as lentils to extend into areas previously thought unsuitable for production. Advances such as this have provided increased options to farmers for risk management and improving soil nutrition through nitrogen fixing (Schmidt, 2022).
- Drought is not perceived as a high risk to farming profitability, despite other observed changes to climate, such as an increase in the prevalence of in-crop frost (resulting from more cloudless night skies and cold conditions) and dry finishes associated with poor spring rains during the grain fill period (See Consultation Summary Appendix).
- Reduced ability to alter existing agronomic systems, due to a high reliance on current high-cost practices and inputs that encourage economies of scale efficiencies to provide a return on investment (Leonard, 2022) (Kellock, 2022).
- Limited willingness, knowledge or ability to alter current systems (See Consultation Summary Apendix).
- Predominantly consisting of Calcareous soils, Deep sands and smaller pockets of sand over clay soils and hard red-brown texture contrast soils with neutral to alkaline subsoil. Other sub-regional zones soils contain greater areas of hard red-brown texture contrast soils with neutral to alkaline subsoil, calcareous soil and shallow soils on rock (Department for Environment and Water, 2018) (see Appendix B).

5.2 Soil Moisture Projections across the Region to 2030

Root zone soil moisture is critical for agricultural production across the region. It is also a key indicator and measure of agricultural drought. It is important to explore the variations in root zone soil moisture projections for Winter and Spring across the region for 2030 under a continuing high global emissions scenario (RCP8.5). The following seasonal projections are sourced from the Bureau of Meteorology, with the projections being a key component of the Australian Water Outlook. They show a projected decline in average root zone soil moisture in the northern half of the region over winter and over the south and east in the spring. Noting that particular soil management practices at the farm scale will either increase or decrease the capacity of soils to absorb moisture, Figure 13 and Figure 14 below indicate seasonal root change moisture changes over time. The central areas of the Peninsula and Plains and Ranges are projected to have slightly higher average root zone soil moisture in Winter (Figure 13).

WINTER

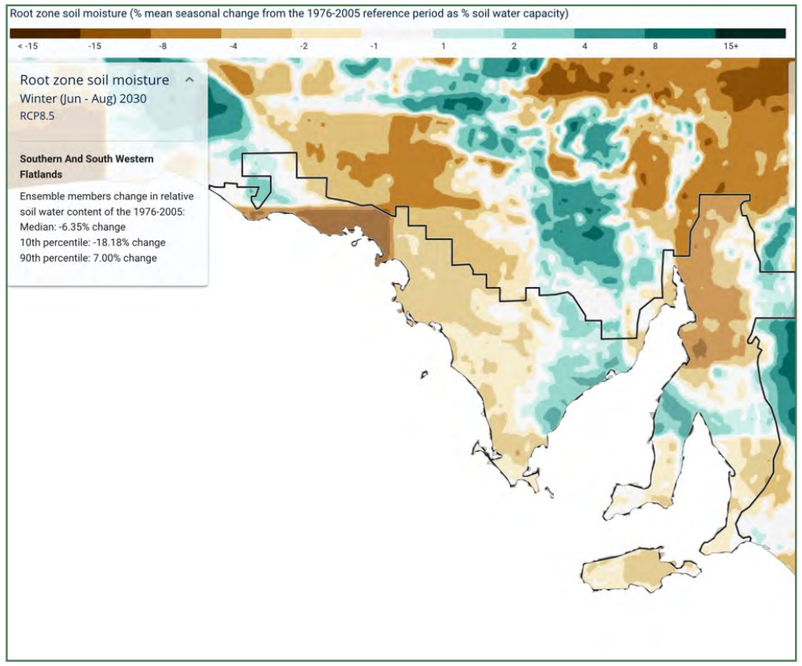


Figure 13. Southern South Australia winter root zone moisture (%) changes from 1976 – 2005 (Bureau of Meteorology, 2005).

SPRING

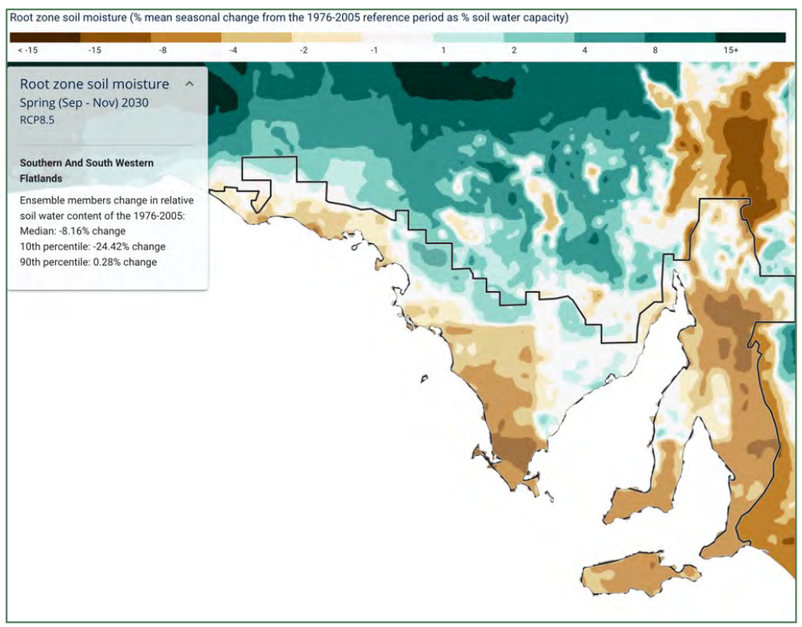


Figure 14. Southern South Australia spring root zone moisture (%) changes from 1976 – 2005 (Bureau of Meteorology, 2005).

It should be noted that these maps represent the change in average seasonal root zone soil moisture between the 1976-2005 reference period and the average conditions projected to occur across the future period from 2020 to 2039, centred on 2030. As this Plan is focussed on resilience to the phenomena experienced during drought years it very important to look at the projected changes in root zone soil moisture during the driest 10 per cent of years, and not at the changes in the median or average conditions as shown in the maps above. As shown in the caption within the figures, the root zone soil moisture in the driest 10% of years (10th percentile) is expected to decline by a further 18% in Winter and 24% in Spring by 2030 across the south and west of Australia from that already experienced across the driest 10% of years in the 1976-2005 reference period.

These are broadscale changes that will affect the whole region as they are driven by increases in temperature, evaporation and evapotranspiration during the driest of years.

Agronomic actions at the farm scale can assist in reducing soil temperatures and in doing so can reduce evaporation and increase the water holding capacity and storage capability of soils. The effects of decreased precipitation and increased evaporation at the farm scale can be influenced by management practices and actions, however, there is a limit to which these incremental adaptation initiatives can buffer the impact of both long-term and severe drought.

THE ECONOMIC AND MENTAL HEALTH IMPACTS, PARTICULARLY RELATED TO THE SALE AND DESTRUCTION OF LIVESTOCK AS A RESULT OF DROUGHT AND FARM MANAGEMENT DECISIONS HAS IMPACTED FARMERS, FARM ADVISORS AND PARTICULAR SECTORS OF THE AGRICULTURAL SUPPLY CHAIN.

5.3 Key interrelated drought factors

Drought does not occur in isolation of other economic, social and environmental risk factors. For example, for many farmers in the region, the 2018 drought did not have as greater economic impact on farmers as previous droughts, due to improved adaptive capacity and learnings of previous experiences of drought, better risk and economic management practices, reduced spread of drought conditions and favourable macroeconomic conditions, such as high commodity prices (Department of Agriculture, Water and the Environment, 2018-2022) (Ashton, 2022) (Kellock, 2022). Figure 17 showcases farmer stressors and sub-stressors resulting from drought. Stressors extend across economic, social and environmental sectors and inter-relate with one another, often creating a compounding effect on farmers health, well-being and the financial solvency of the business. In turn the environment (soils, water, vegetation) which supports farming can suffer.

The stressors outlined in Figure 17 are not comprehensive and do not consider the far reaching impacts beyond the farm gate or the nuances of compounding chronic drought compared to acute drought. Additionally, it is known that the impacts of drought will be largely determined by socio-economic factors, individual circumstances and the preparedness of a farm enterprise to buffer the impacts of drought. Drought exacerbates existing economic, social and environmental stressors that were present prior to the onset of drought.

It is important to capture the primary ways in which drought interrelates with other economic, social and environmental factors, these have been categorised as follows:

ECONOMIC FORCES

Key economic forces, such as prices for farm inputs and prices received for commodities produced on farm heavily influence decision making and the resilience capacity of farmers. For example, the current high prices for fertilisers are causing some farmers to reduce fertiliser use through reducing per hectare application rates. This has flow on impacts for the agricultural supply chain producing, distributing and on-selling fertilisers to farmers. A reduction in money received by farm enterprises, results in reduced local employment opportunities through the supply chain and a reduction of localised spending in supply chain and other businesses (Australian Government - The Treasury, 2004). When profit margins are squeezed, the onset of drought compounds existing financial issues for farm enterprises and those in the agricultural supply chain. Furthermore, in times of drought, reduced agricultural outputs and yields can result in increased costs for consumers and the agricultural supply chain as accessing the same commodities from overseas and interstate markets is often more costly (Australian Government - The Treasury, 2004) (Ding, et al., 2010).

Farmers also report difficulty in accessing off-farm income during times of drought, especially where the off-farm income source is directly derived from industries reliant on rainfall (Schmidt, 2022).

> **PRICES HAVE BEEN SKY HIGH (MORE RECENTLY) IN DRY YEARS... I'M NOT SURE WHAT HAPPENS WHEN DROUGHT & LOW PRICES COMBINE.**

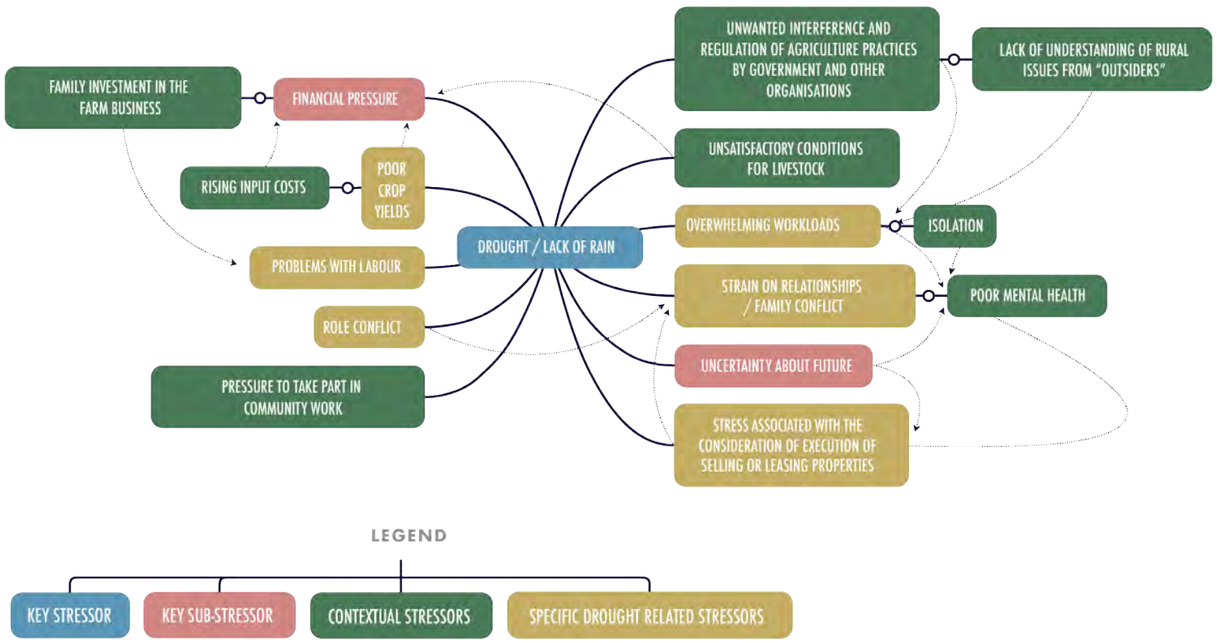


Figure 17. Key stressors, sub-stressors, contextual stressors and specific drought-related stressors adapted from (Fennell, et al., 2016)

SOCIAL FORCES

As previously described drought has varying well-being impacts on farmers and those living in drought affected communities. The impact varies depending on a range of factors. The impact of drought can exacerbate existing mental health issues, especially as a result of reduced farm income. Drought affects the well-being of an individual or collective community in different ways. It has been shown to affect certain groups of people more than others, i.e., younger farmers, farmers working in more remote areas etc (Alston, M. & Kent, J., 2004). Furthermore, drought can increase family stress affecting children. Educational outcomes are reduced for some children who are affected by drought (Alston & Kent, 2006).

Rental stress within the region is the highest in South Australia (38%) (Infrastructure Australia, 2022). Access to housing is limited through many towns in the region and this appears to be a major barrier in attracting and retaining inter-regional workers. The onset of drought may allow for an increase in availability of housing if the area experiences depopulation.

The region is heavily reliant on volunteerism. This is evident through the use of volunteers for ambulance, fire fighting and agricultural research and development operations.

The region has an aging population. This creates demand for aged care facilities and services.

ENVIRONMENTAL SERVICES

Ecosystem services required to support agricultural production, such as healthy and productive soils, pollination and water suitable for animal watering are under threat. Threats from land clearance, pests, disease and habitat loss have been exacerbated by climate change and will continue to be increasingly impacted by climate change and in particular drought.

Farmer behaviour can change during drought as a result of increased financial and social stress. This has flow-on effects for the ability of land to bounce back from drought when drought ceases. Evidence suggests that maintaining natural capital (plants, soils, fungi, beneficial bacteria, animal and plant relationships etc) allows farms to recover quicker post drought (Price Waterhouse Cooper, 2020). Farmers who are already financially stressed pre-drought may degrade land and reduce the productivity of land for short term gains and the need to stay financially solvent. When rains return, the productivity losses can take many years to recover and this can further exacerbate financial issues, ultimately producing a less productive and profitable farm.

CURRENT DROUGHT RESILIENCE MEASURES

Categorised below are the primary themes related to drought resilience in the region. It is evident that those who have experienced the effects of drought are better prepared and have already demonstrated adaptive capacity. However, the overwhelming majority of change has been across the planned transitional and incremental change categories, with little evidence that farming systems are prepared for the projected future impact of drought or the identification of the parts of the system that require transformational change.

This appears to be common, not just amongst farming groups located in the Northern and Yorke region but from across the state (South Australian Drought and Innovation Adoption Hub, 2021). The stakeholder engagement process conducted by the SA Drought Hub demonstrates that stakeholders are willing to engage in a process to identify gaps in current resilience frameworks that will assist with planned and incremental change. Ideas from the SA Drought Hub stakeholder engagement were categorised across ten themes related to water security, knowledge, education and communication, agronomy, natural resources management, community well-being and business management.

Whilst the themes and ideas expressed through the SA Drought Hub engagement process are beneficial, there is a need to upskill and collaborate with the community to identify and plan for transformational change, where it is required.

The primary drought resilience themes emerging from stakeholder interviews are as follows:

- Many parts of the community have already demonstrated adaptive capacity and resilience and have thus far, successfully managed the effects of drought. This has been demonstrated by changes to:
  - > Drought and business planning and management.
  - > Utilising experience and knowledge of weather and environmental conditions to guide decision making, even at the expense of the business, including loss of revenue.
  - > Sourcing of mental health professionals at agricultural organisation events, such as crop walks, information days etc.
  - > Sharing of stories of difficulties with mental health from both local community members and from those from outside the community.
  - > The establishment of local community groups to support farmer health and wellbeing.
  - > The establishment of community groups to connect locals and act as a means of social connectivity and stress relief.
  - > Building advocacy strength through regional organisations.
  - > Accessing education services, both formal and informal to build knowledge and skills across business management, agronomy and land management.
- It is predominantly livestock and mixed farming operations in areas that are exposed to and have experienced drought and dry conditions that have already demonstrated considerable adaptive capacity. These businesses are already demonstrating resilience on an individual and business scale and through practices, such as:
  - > Diversification of on-farm income streams, in particular adopting rainfall independent income streams.
  - > Diversification of off-farm income streams.
  - > Forward and proactive business planning, including succession planning.
  - > Understanding trigger points related to the climate, weather and environment and the need to adapt the approach to farming, based on environmental conditions.
  - > The ability to act quickly and to alter agronomy decisions, based on real time information and experience.
  - > The use of both off-farm and on-farm advisory services, i.e., including staff and consultants in decision making.
  - > Taking responsibility for the health and well-being of themselves and others in the community.
- Agricultural groups provide an essential service to the community, not only through the selection and dissemination of pivotal information related to farm management and agronomy, but also through bringing people together. This role aids in developing resilience across the community.
- The depopulation of regional centres and towns poses a significant risk to community resilience. A reduction in population leads to the loss of services and threatens the availability of a locally skilled workforce which is a risk to the viability health and social sectors. The towns that are thriving, tend to be well supported by agriculture and other industries, such as the wind farm operations surrounding Jamestown, or the tourism supporting the towns of the Clare and Gilbert Valleys. Resilience within a local town or regional centre requires the town to have a diversified economy, and workforce not solely reliant on agriculture.

- Access to suitable quality water at a suitable price point is essential for viticulture and horticulture in the region. This is the primary issue for the Barossa Valley, Eden Valley and Clare Valley wine regions. However, it is not just the vignerons and wine businesses that require a suitable water quality product at a suitable price point, livestock farmers are also in need to a suitable water product.
- Access to reliable phone and internet services is essential for farmers and agricultural supply chains.

STATE OF THE ENVIRONMENT

Assessing the state of the environment is complex, due to the constant state of flux and the interrelated and multiple threats to the environment. Furthermore, environmental monitoring is inconsistent and the resources are not available to regularly conduct monitoring of large scale areas. As such, information related to the state of the environment within the Northern and Yorke region as an entire region is dated or only available for pockets of the region. Ecological surveys, including bushland condition monitoring, flora and fauna surveys are conducted on a semi-regular basis, however the extent of such surveys are not necessarily representative of the broader sub-region or region.

The major threats to ecosystems, conservation of threatened species and biodiversity in the Northern and Yorke region are similar to other parts of Australia and include the following (Landscapes SA - Northern and Yorke , 2022) (Jackson, et al., 2017):

> Habitat fragmentation.

> Clearance of native vegetation through land use change.

> Overuse of limited resources.

> Competition between native and invasive species for limited resources.

> Predatory invasive species.

> Soil acidification

> Inappropriate fire regimes

> Climate change

WATER

Due to the limited supply of surface and potable groundwater, the region is mostly reliant on water sources imported from outside of the region, including water sourced from the River Murray, Adelaide Hills reservoirs and the Lonsdale based desalination plant. Approximately 75% of the water taken from the River Murray is used for primary production, and major pipelines supply metropolitan Adelaide and regional communities (SA Environmental Protection Authority, 2018).

Climate change will increase the demand for irrigation, as rainfall declines and evaporation increases across the region. This will increase the pressure on the River Murray. Part of the Murray Darling Basin Plan is the need for a long-term annual average surface water volume of 2,750 GL to be recovered from consumptive uses to meet the agreed basin-wide sustainable diversion limit of 10,873 GL (SA Environmental Protection Authority, 2018). A further 450 GL of water is to be delivered through investment in on farm efficiency measures (SA Environmental Protection Authority, 2018). It can be seen that without an alternative source of water, the Northern and Yorke region and other South Australian regions are exposed to reduced access of suitable water through the Murray Darling River system.

Investment in recycled water reuse and alternative water schemes is common and widespread through certain council areas, such as Barossa Council (McCarthy, 2022). In these areas, both stormwater and wastewater are captured, recycled and utilised for agricultural production and irrigation of greenspace. Despite the success of schemes, such as Barossa Infrastructure Limited, the Bunyip Scheme (formerly the Gawler Water Reuse Scheme) and the Northern Adelaide Irrigation Scheme (NAIS), population growth, climate change and rising demand for water places pressure on these systems (Infrastructure Australia, 2022).

Recycled water use is not contained to the Barossa, with many other council areas reusing wastewater for irrigation purposes. Further opportunities exist and will be required to make better use of stormwater and wastewater in a drying climate.

Little cost benefit analyses has been conducted to quantify and better understand the highest and best use of recycled water. The capture of non-market benefits of localised greening, such as health, urban cooling, amenity of spaces, aesthetics, carbon capture and storage, water filtration and oxygen production would assist councils to make decisions related to water reuse for agriculture compared to urban greening.

TOWNS AND REGIONAL CENTRES

Small towns are scattered throughout the region, with many towns facing similar key social issues related to:

> Poor access to housing

> Poor access to aged care facilities

> An inequitable distribution of health care facilities often accompanied with limited availability.

> Poor employment prospects through many regions.

> Increasing land prices

> Below average household incomes (when compared to the state average).

Regional centres (larger towns) are important health care, education, community services and business hubs. The Regional centres provide many of the goods and services now no longer available in smaller towns.

“DAMS AREN’T FILLING... ECOLOGICAL SYSTEMS AREN’T GETTING OVERFLOW... GROUNDWATER QUALITY IS DIMINISHING...THE WHOLE KIT & CABOODLE.”

“COMMUNITIES ARE SHRINKING, SOME TOWNS CAN’T FIELD A FOOTY TEAM.”

6 HISTORY OF DROUGHT IN THE REGION.

Drought is generally defined as the persistent deficiency of water for a prolonged period compared to the climatological mean over a region (Rashid & Beecham 2019).

This definition is then further specified to elements of the hydrological cycle and the socio-economic measures of drought which are to be measured and monitored for drought stress, namely:

1. Meteorological drought, as measured by rainfall deficiency
2. Agricultural drought, as measured by soil moisture deficiency
3. Hydrological drought, as measured by surface and groundwater deficiency
4. Socio-economic drought, as measured by people’s perception of whether they were currently or had been in drought in recent periods, determined by experience and observations.

Severe droughts are an expression of one of the extreme phases of natural climate variability across the Australian continent.

These events are primarily the result of complex interactions between different oscillations of oceanic sea surface temperatures and atmospheric pressures across the vast oceans surrounding the continent. The key drivers of severe and prolonged drought are the El Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD) and the Southern Annular Mode (SAM). These oscillating climate drivers regularly act in unison, usually around twice every decade, to compund their effects on the Australian climate and produce prolonged periods of widespread very wet or very dry conditions.

A combined La Niña and Negative IOD event will likely result in heavy rainfall and cooler than average conditions across large parts of the continent, particularly the north and east. Historically, these wet phases have contributed to decisions involving and agricultural expansion into more drought prone areas across much of Eastern Australia. In opposite states, a combined El Niño and Positive IOD event will likely result in extended periods of drier and hotter than average conditions, leading to widespread drought and heatwaves
(Table 9). Multi-year prolonged drought events continue to test the adaptive capacities of even the most resilient agricultural, social, environmental, and economic systems.

HISTORICAL SEVERE MULTI-YEAR DROUGHT EVENTS	
1863 to 1866	1965 to 1968
1880 to 1888	1982 to 1983
1895 to 1902 (Federation Drought)	2002 to 2009 (Millennium Drought)
*1914 to 1915 (World War 1 Drought) *Includes most severe 12-month meteorological drought on record in the region*	*2018 to 2019 *The most severe 24-month meteorological drought on record in the region*
1937 to 1945 (The World War II Drought)	

Table 9. Historical severe multi-year meteorological droughts impacting the Northern and Yorke region (Sources: ABS 1988, 1301.0 – Yearbook Australia & BoM)

The history of European settlement of South Australia is an example of optimistic bias resulting in waves of agricultural expansion into drier regions during temporary high rainfall phases. The colony was established in 1836 and rapidly expanded inland in response to a series of unusually wet growing seasons. Major land degradation and socioeconomic disruption subsequently impacted the region following a reversion to significantly lower rainfall patterns (Nidumolu et al. 2012). After the severe drought of 1863 to 1866, the then Surveyor-General of South Australia George Goyder established a line which demarcated the areas of reliable rainfall which were able to support mixed agriculture, to the south, from the areas of erratic and unreliable rainfall to the north. The now famous line was used to determine where mixed cropping and grazing systems should transition to more drought resilient pastoral grazing.

The history of the Northern and Yorke region is likewise one of continued agricultural expansion during wet climatic phases into the more drought prone areas to the north of Goyder’s Line. In recent years no-till farming practices have resulted in reliable cropping, even in difficult seasons, extending as far as 100 kilometres north of the line (GRDC 2016). The extension of grain growing to regions considerably north of Goyder’s line has increased community exposure to drought risk in areas with more erratic and unreliable growing season rainfall (Figure 18).

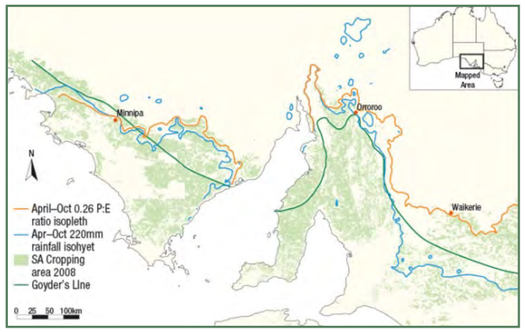


Figure 18. The position of Goyder’s Line relative to the 0.26 P:E ratio isopleth and the 220mm growing season isohyet (Source: GRDC 2016)

Through the 20th century many studies sought to redefine the limit of 'safe' cropping districts in South Australia using both rainfall and evaporation records. Multiple studies found a precipitation to evapotranspiration (P:E) ratio of 0.26 for April to October rainfall to be the 'safe' limit for cropping zones across the southern areas of the country (French, 1988). Nidumolu et al. 2012 found that it represented the boundary of not only the South Australian grain belt but also much of the Australian grain belt. Despite significant differences in soil type, summer rainfall, cereal varietal research and levels of drought support available, the close relationship between the 0.26 P:E isopleth and the margin of the grain belt indicates that the boundary is primarily determined by climate (Figure 18). The 0.26 P:E ratio therefore represents a climatic 'hard edge' for the Australian grain belt (Nidumolu 2012).

Observed decadal decreases in growing season rainfall combined with increases in temperature and evapotranspiration across the region have increased chronic drought stress and have pushed this 'hard edge' for traditional mixed agriculture systems to the south and towards the coast.

Chronic drought stress, particularly in the Upper North and East sub-regional zone now combines with the acute impacts of severe droughts, especially prolonged multi-year events which tests the resilience of the communities of the region (Table 10). Interventions which hydrate the landscape by retaining rainfall while reducing temperatures and evaporative losses will assist in addressing the migration of the chronic drought stress zone south and towards the coast.

DROUGHT DURATION (MONTHS)	NUMBER OF DROUGHT EVENTS 50-YEAR PERIOD 1960-2010	AVERAGE RECURRENCE INTERVAL BETWEEN DROUGHT EVENTS (IN YEARS) 1960-2010
3	34 to 40	1.3 to 1.5
6	23 to 26	1.9 to 2.2
12	12 to 17	2.9 to 4.2
24	6 to 13	3.8 to 8.3

Table 10. Total number and average frequency of drought events based on the Standardized Precipitation Index (SPI) at time scales of 3, 6, 12 and 24 months between 1960 and 2010 across the Northern and Yorke Region (Source: Rashid & Beecham 2019)

Recent studies indicate that across the south of South Australia long-term (prolonged) droughts tend to be more intensified than short-term droughts over the historical period. Droughts have intensified over the winter rainfall dominant region of SA, where most of the population resides, therefore posing a threat to society and the environment (Rashid & Beecham 2019). Additionally, a significantly negative trend in the 24-month Standardised Precipitation Index (SPI) series indicates a strengthening of long duration droughts over the period 1960–2010 (Rashid & Beecham 2019). The most recent 24-month drought, 2018-2019, was the hottest and most severe meteorological drought on record across the Northern and Yorke Region.

DROUGHTS HAVE INTENSIFIED OVER THE WINTER RAINFALL DOMINANT REGION OF SA, WHERE MOST OF THE POPULATION RESIDES, THEREFORE POSING A THREAT TO SOCIETY AND THE ENVIRONMENT.

7 FUTURE OUTLOOK FOR DROUGHT IN THE REGION.

Globally, greenhouse gas emissions intensified drought risk over the second half of the 20th Century (Dai, 2013). Global climate models project a continued increase in drought frequency and intensity across many parts of the world, including southern Australia, during the 21st century (Touma et al., 2015).

Greenhouse gas emissions produce changes in atmospheric circulation patterns, and this manifests in the poleward expansion of the subtropical ridge of high pressure resulting in the poleward expansion of subtropical dry regions (Chiang et al. 2021). The southward shift of the subtropical desert climate has increased the aridity of the climate of southern Australia.

The 'Guide to climate projections for risk assessment and planning' published by the South Australian Department of Environment and Water in November 2020 stated critically for the Northern and Yorke Region, the frequency of drought is set to rapidly increase to 2 in every 3 years by 2030. The time spent in drought is projected to increase to 65% across the region (DEW 2020). This is outside of the range of observed natural variability and will represent the emergence of a new more arid climatic regime across the area through the 21st Century.

This has and will continue to influence the viability of some agricultural systems in the region.

Table 11 and Table 12 describe weather and climatic related conditions, the potential impacts of the climate conditions and projected climate for the Northern and Yorke region under a high greenhouse gas emissions (RCP8.5) scenario (Bureau of Meteorology and CSIRO, 2018). It is important to recognise that including a projected increase in the severity and frequency of droughts, there are other climatic factors that are likely to influence soil moisture availability, such as an overall drying trend across southern mainland Australia and an increase in summer rainfall including a change to rainfall intensity (Hope, 2015).

Drought is likely to increase the prevalence and severity of bushfire, especially when combined with heatwave conditions. A reduction in both average spring and autumnal rainfall combined with increased evaporation rates will result in the drying of vegetation earlier in the season and the increasing likelihood of an extension of the fire "season" beyond the traditional November to April period (Hope, 2015).

Dust storms are not a climatic event, rather they are the combination of weather, climate and environmental conditions, often exacerbated by human induced changes and management approaches, such as tilling fields, excessive soil disturbance, and over grazing of livestock. The exposure of soils to water and especially wind erosion may increase as a result of increasingly challenging growing conditions for non-arid plant species associated with drought. Prolonged exposure to dust storms can lead to chronic respiratory and possibly heart problems (NSW Health, 2022).

The loss of farming topsoils as a result of exposure to wind is seen to cause a ripple effect whereby, soils continue to erode over time. This results in a reduction in the ability of soils to capture and store moisture, in turn, reducing yields and increasing input costs as farmers seek to compensate for loss of soil productivity through increasing fertiliser use (Department of Environment, Water and Natural Resources, 2013).

	EVENT	TENDENCY	CONFIDENCE
	Temperature and heatwaves	Average temperature will increase as well as number of hot days and heat waves	Very high confidence
	Mean maximum and minimum temperatures	Continued substantial increases in maximum and minimum temperatures	Very high confidence
	Extreme rainfall	Increase in the intensity of extreme rainfall	High confidence
	Winter rainfall	Decreasing winter rainfall	High confidence
	Spring rainfall	Decreasing spring rainfall	High confidence
	Drought	Time spent in drought will increase	Very high confidence
	Bushfire	A harsher fire weather regime is projected	High confidence

Table 11. A description of the potential impacts of drought

HAZARD	DESCRIPTION AND POTENTIAL IMPACTS
Heatwaves	Heatwaves are defined as three or more consecutive days of hot weather (greater than 35ºC) and are of key concern due to their potential impacts upon human and farm animal health, built infrastructure and building occupant comfort. Increased electricity demand for cooling is a key risk to grid reliability while also (likely) impacting energy costs.
Droughts	Droughts are defined as prolonged periods that are abnormally dry when available water is not sufficient to meet the needs of society (BOM 2017). An adequate water supply is crucial for many processes within property construction and operation, and chronically low regional water supplies can increase water costs and drive the introduction of water use restrictions.
Floods	Floods occur during periods of increased rainfall and/or storm surge and can lead to significant damage to property. Floods can result in complex economic and environmental impacts upon the built environment and are thus a key consideration for this assessment.
Storms	Storms are periods of severe weather, resulting in any combination of increased rainfall, high winds, lightning, and ocean storm surges. Storms are of concern for the built environment due to structural and access-related impacts, as well as indirect impacts associated with disruption to the power supply.
Hailstorms	Hailstorms refer to storms that produce hailstones with a diameter larger than 0.5 mm. Hail can cause serious damage to the built environment, including building façades, windows, and roofing. Extreme cases can lead to potential roof collapse.
Bushfires	Bushfires pose significant fire risk to property near to bushland areas. Indirect impacts include smoke and particulate matter release into the atmosphere, which can have significant environmental health implications in buildings through fresh air intakes. Direct bushfire risks are relevant to property assets located close to bushfire prone areas.
Dust storms	Dust storms are prevalent throughout arid and semi-arid regions and can cause adverse health implications, electricity and infrastructure disruptions and economic implications. Dust storms are highly correlated with drought frequency and intensity.

Table 11. A description of the potential impacts of drought

7.1.1 Drought and anthropogenic climate change

The four key natural drivers of drought cycles in Australia described in 2.1.1 are now joined by an additional critical global climate driver, anthropogenic climate change.

Rainfall in southwest and southeast Australia has been declining in recent decades and is projected to likely decline further, especially during the growing season (April to October). The observed 20-year running average annual rainfall has been tracking the dry end of the projections (even though year-to-year values may fall outside the range), showing that the observed trends are consistent with these projected changes in rainfall. Importantly there is no evidence that the climate projections are overestimating the ongoing drying trend to date (BoM & CSIRO, 2020). In addition to the observed rainfall declines there have been increases in evaporative demand which has increased drought frequency, duration and intensity across Southern Australia as measured by the standardised precipitation-evapotranspiration index, the SPEI (Chiang et al. 2021).

As Table 1 shows, the historical average recurrence interval of 12-month duration drought in the region was approximately once in every 3 to 4 years during the period 1960 to 2010 (Rashid & Beecham 2019). The potential time spent in drought is projected to increase to 65% across the region (DEW 2020). This is outside of the range of observed natural variability and will represent the emergence of a new more arid climatic regime across the area through the 21st Century.

Enhanced warming caused by greenhouse gas emissions now acts to amplify the effects of the interactions between the natural climate drivers and, importantly, also acts on the prevalence and intensity of the key natural climate drivers themselves.

The amplitude and frequency of strong El Niño events is projected to increase under greenhouse warming. Likewise, the frequency of extreme positive IOD events is also projected to increase under more prevalent greenhouse effects, leading to more occurrences of severe drought, heatwaves and bushfire over Australia (NESP, 2019). Concerningly, it has been determined that the increased risk of extreme El Niño events continues for up to a century after global mean temperature stabilises. In contrast, the frequency of extreme positive IOD events stabilises with stabilised global mean temperature (NESP, 2019). This means the increased frequency of extreme El Niño events is set to impact eastern and northern Australia for many decades even if global greenhouse gas emissions are stabilised. However, limiting global temperature increases would have an immediate impact on halting the increasing frequency of extreme positive IOD events (NESP, 2019).

In a warming world, when these natural climate drivers are active, particularly if in unison, the impacts are now further amplified. Higher sea surface temperatures surrounding the continent results in greater moisture availability and higher rainfall intensities during the flood phases. Higher land temperatures result in higher evapotranspiration and additional heat and water stress during drought phases.

Net water availability will continue to decline as evaporative demand increases, consequentially increasing the likelihood of meteorological droughts from a supply and demand perspective (Chiang et al. 2021).

HIGHER SEA SURFACE TEMPERATURES SURROUNDING THE CONTINENT RESULTS IN GREATER MOISTURE AVAILABILITY AND HIGHER RAINFALL INTENSITIES DURING THE FLOOD PHASES.

7.1.2 Flash Drought

Global warming is leading to higher temperatures and lower rainfall across the Northern and Yorke region, particularly in spring during strong El Niño and positive IOD events.

During such periods drought conditions can emerge very rapidly in the form of 'flash droughts'. The term 'flash drought' is used to describe the sudden onset of drought conditions across a region formerly experiencing relatively benign conditions. Droughts only occur when there is insufficient rainfall, but flash droughts intensify rapidly over timescales of weeks to months because of other factors such as the sudden onset of high temperatures, low humidity, strong winds and clear skies. These conditions increase the evaporative demand. This means more water evaporates from the surface and transpires from plants, rapidly depleting soil moisture. Under these conditions, evaporation and transpiration increase for as long as moisture is available at the surface. When this moisture is depleted and there is no rain to replenish it, the lack of water the limits evaporation and transpiration from the plants and the soil surface.Crop and vegetation stress spreads quickly as the 'flash drought' suddenly emerges (Parker & Gallant, 2021). Flash droughts have no restriction on their duration but the term is most often used to solely describe the rapid onset and intensification phase rather than the ongoing persistence of dry conditions once established (Nguyen, 2019).

As anthropogenic climate change increases spring temperatures and decreases spring rainfall it acts to amplify the likelihood of flash droughts across the Northern and Yorke region. The likelihood and severity of flash droughts in the region are also set to rise due to the influence of anthropogenic climate change on increasing the frequency of extreme El Niño and positive IOD events, two key natural drivers of spring drought and heatwave conditions across South Australia.

The rapid intensification of flash droughts usually results in impacts arising too quickly to deploy traditional drought-coping mechanisms for agricultural systems. Selling stock, obtaining hay, securing water supplies or deciding to reduce the areas sowed for cropping all require significant lead times for cost effective deployment.

Flash droughts therefore present critical challenges to the successful management and adaptation of agricultural enterprise and water resources to a rapidly drying and warming climate.

7.1.3 The impact of climate change on the margin of the grain belt in South Australia

While current cropping systems have supported cropping north of Goyder's line, climate change could return the cropping margin back to this historic boundary (GRDC 2016).

Temperatures, evapotranspiration and aridity are all projected to significantly increase across the region by 2030 and continue to increase throughout the 21st Century (DEW 2020). Growing season precipitation is projected to decline while evaporative demand increases. This will lead to significant changes in the critical precipitation:evaporation (P:E) ratio which, as discussed in 2.1.3, has been found to represent the margin of the grain belt across Australia. Nidumolu et al. 2012 found that the warming and drying trend will likely shift the 0.26 P:E isopleth and hence the margin of the grain belt towards the coast. The study found that if the drying projection of CSIRO's Mk3.5 model eventuates, by 2050 the margin of cropping on Eyre Peninsula and parts of the Murray Mallee will be about 50 to 100km further south than the long-term mean P:E ratio boundary. In most parts of SA that would take the margin back much closer to Goyder's Line (Figure 19).

As this study was conducted in 2012, using the now supplanted older CMIP3 models, it is recommended that the findings be revised using the latest CMIP6 models. An assessment using the CMIP6 model output may present a significant change in the projected position of the 0.26 P:E ratio isopleth and therefore the margin of the reliable cropping zone across the Northern and Yorke region.

Areas in the Upper North and Eastern zone (coastal and eastern basin) have strong gradients of topography, climate, soils and vegetation, crop production and hence land values. In these sites, there will likely be smaller changes in the location of the P:E isopleth. However, as can be seen in the transect of the current P:E in Figure 19, most of the grain belt on the Eyre Peninsula and the Murray Mallee is on an extensive plain with widely spaced isopleths of P:E. When climate change is measured in a southerly shift (km per decade) of the 0.26 P:E ratio isopleth, the fastest rate of change will be across these relatively flat plains of the region. This rate of change may be a challenge for individual farm enterprises, communities and governments (Nidumolu et al. 2012).

A warming and drying climate will not have uniform effects across the region. Natural variability in rainfall and the ability of soils to absorb and store moisture will allow some farmers greater natural resilience to drought more than others. As such, some farms and districts will be more vulnerable to the impacts of drought. The International Panel on Climate Change describe vulnerability as:

"The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." (McCarthy, et al., 2001).

The Mid-North sub-regional zone is considered the most vulnerable to the impacts of drought. Despite the Upper North and Eastern sub-regional zone being considered a higher risk of drought, the farmers in this zone have experienced drought conditions on a semi regular basis and have already created incremental and some planned transitional actions to buffer the impacts of drought. The farmers through the Mid-North zone, particularly those close to Goyder's line are more exposed to increased drought conditions and have comparably reduced experience of drought and as a result of this are less prepared to respond to drought conditions. This is also true of the Plains and Ranges and Peninsula sub-regional zones, however, farmers through these zones are projected to have more time to plan and prepare for long-term reduced rainfall conditions.

Low rainfall farming communities understand the risk profile of farming in a low-rainfall district, with most maintain that they can cope with the early stages of a warming and drying trend with current and future technologies (Doudle et al. 2009). The surprising but concerning finding from the Nidumolu et al. 2012 study is that so many low rainfall farming communities around Australia are on a similar climatic edge. They conclude the study by stating "This does not mean that there is no future for low rainfall farming regions, but it does mean that there are no obvious Australian grain farming regions that low rainfall farmers in South Australia can visit to get an idea of how their farming future may look".

In fact, climate analogues provide a means of understanding the locations across Australia which currently experience climates similar to those projected for the future climate of the Northern and Yorke region.

Whilst the Nidoumolu et al. 2012 study tends to focus on cropping districts, the findings of the study can be applied to other agricultural industries that are either wholly or partly reliant on rainfall for the viability of a commodity. Increasingly, livestock grazing in the region has moved towards containment feeding regimes, particularly through early season and late season periods. This is an example of an adaptive change that has occurred, whereby livestock farming can continue without the need for large swathes of land. However, the economic sustainability of this practice may be questioned if and when prices for feed increase and prices for livestock reduce, resulting in a reduced or negative return on investment. As such, further resilience measures are likely to be required.

Viticultural practices and horticultural practices tend to be reliant on water sources that are declining in either quality or quantity (often both), including mains supply water. The increasing demand for irrigation, resulting from reduced average annual rainfall and increased evaporation will place further demands on these resources.

> **THE DEGREE TO WHICH A SYSTEM IS SUSCEPTIBLE TO, OR UNABLE TO COPE WITH, ADVERSE EFFECTS OF CLIMATE CHANGE, INCLUDING CLIMATE VARIABILITY AND EXTREMES. VULNERABILITY IS A FUNCTION OF THE CHARACTER, MAGNITUDE, AND RATE OF CLIMATE VARIATION TO WHICH A SYSTEM IS EXPOSED, ITS SENSITIVITY, AND ITS ADAPTIVE CAPACITY.**
>
> MCCARTHY, ET AL., 2001

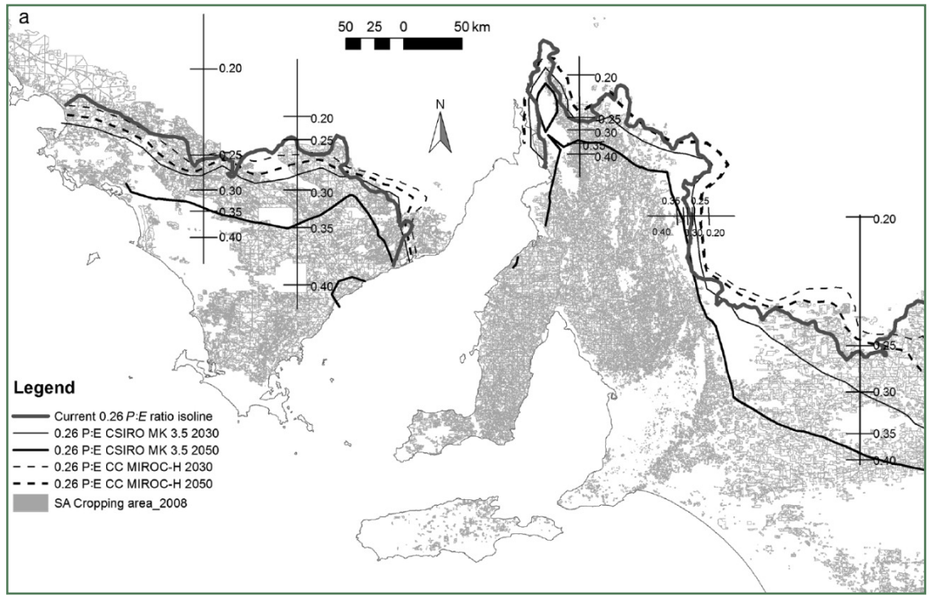


Figure 19. Precipitation:evaporation (P:E) ratio of 0.26, generated for 2030 and 2050 using CSIRO Mk3.5 and CC MIROH-H climate models. Transect values = P:E ratios of current climate along Goyder's Line in South Australia (Source: Nidumolu et al. 2012).

7.1.4 The impact of drought on communities and supply chains

The socio-economic impacts of drought examine both the economic and associated social impacts of drought to farmers, those working in agricultural supply chains and the broader community.

Drought is one of multiple stressors that farmers encounter. The socio-economic impact of drought is complex, with drought interacting with:

- Economic forces (input and output prices)
- Farm resilience factors (soil type, management decisions, location, size etc)
- Individual resilience characteristics of the farmer and farmer support network (family, advisors, farm boards, community etc).

As such, the financial performance of an individual farm whilst influenced by drought is not necessarily wholly determined by the availability of soil moisture resulting from rainfall. In fact, the ability of a farming business to source income from rainfall independent sources is a key risk management tool that can increase resilience to drought (Grainger, et al., 2021). As discussed further in the NYRDRP, resilience to drought can and does assist farmers to buffer the impacts of drought and improve processes and practices that do not support drought resilience.

The impact of drought on communities has been studied within Australia and other jurisdictions and the findings of these studies can be applied to Northern and Yorke region to project the expected socio-economic impacts of drought (Edwards, et al., 2018). The socio-economic impacts of drought vary depending on the severity, duration and frequency of drought and the capacity of the individual, business and community to respond to, prepare for and improve processes and systems as a result of drought.

The far-reaching and wide-ranging social and economic impacts of drought are difficult to capture due to the indirect economic costs across various sectors of the supply chain and the ongoing social and economic costs of drought that extend beyond the in-drought period (Ding, et al., 2010).

Socio-economic impacts of drought are often grouped into the following categories:

- Financial well-being – Drought reduces farm household income, both whilst in drought and post-drought in the recovery phase. A 2018 study estimated that drought reduced farmer's equivalent income by $20,483 per year compared to farmers who had not experienced drought in the past three years (Edwards, et al., 2018).

There are further indirect economic losses, such as a reduction in available money for spending through agricultural supply chains and local businesses and other indirect costs associated with drought such as loss of topsoil, a reduction in soil structure and quality, loss of vegetation and closure of local services.

A 2004 report by the Australian Government of the impact of drought in the 2002/03 financial year period found that drought reduced farm GDP by 24.3 percent, rural exports reduced by 26.6 percent and agricultural income fell by 46.2 percent (Australian Government - The Treasury, 2004). Despite agriculture only representing 3 percent of Australia's GDP in 2002/03, the drought reduced Australia's GDP by 1% over this period (Australian Government - The Treasury, 2004). This highlights the indirect economic impacts that extend beyond agricultural communities.

- Mental and physical health - Drought has been shown to contribute to mental distress, suicide and creating vulnerabilities for maintaining good health (Luong, et al., 2021). In general, farmers experience significant stress related to drought, themselves, their families and their communities. However, the impact of drought on mental and physical health differs from individual to individual, with many people in drought-affected communities displaying mental adjustment to drought over time (Luong, et al., 2021). Studies demonstrate a range of mental and physical health outcomes for those affected by drought (Luong, et al., 2021). One study found that stress and mental health outcomes are most pronounced in the first 2.5 to 3 years of drought (Luong, et al., 2021).

Austin et al (2018) found that personal drought related stress was experienced more by those farmers who were under 35 and both lived and worked on a farm, were located in remote locations and experiencing financial hardship (Austin, et al., 2018).

Drought has been shown to increase the percentage of farmers employed in off-farm work and therefore increasing the work hours to both manage their farm and access off-farm income (Edwards, et al., 2018). The health impacts of this were not assessed.

The impact of drought on health, extends beyond the associated stress related to economic factors (Stanke, et al., 2013). Drought reduces both the quality and quantity of available surface water, resulting in shortages of water suitable for stock watering. Drought can also increase the range and extent of diseases and impacts air quality through the loss of cover vegetation and the associated blowing of topsoil by winds. A reduction in air quality creates and exacerbates respiratory health issues (Stanke, et al., 2013).

- Employment – The impact of the 2002/03 drought is estimated to have directly reduced agricultural employment by 100,000 people (Australian Government - The Treasury, 2004). Edwards et al (2018) discovered that employment rates in drought affected areas were on average 2% lower than in above-average rainfall areas (Edwards, et al., 2018).
- Access to health services – Those living and working in remote locations do not have the same access to health care services, as those living in urban environment and rural centres. Despite multiple online and telehealth services available to those located in both rural and urban environments, those in remote locations, such as many parts of the Northern and Yorke region have reduced access to both internet and phone reception, resulting in reduced access to health and other online services.

Access to education – In some circumstances, drought has been shown to reduce educational outcomes (Alston & Kent, 2006). In particular, the closure of schools and the impact on those (particularly mothers) who are required to travel great distances to drop off and pick up children from school. Furthermore, mothers in remote areas have significant pressure placed on them to perform educational roles as well as work on and off farm (Alston & Kent, 2006).

7.1.5 Climate Analogues – Where to see the future climate of the Northern and Yorke region, right now.

The Analogues Explorer on the Climate Change in Australia website provides an easy to use tool to visualise which parts of Australia have a current climate that is representative of the likely future climate of the Northern and Yorke Region across the 2030, 2050 and 2090 time horizons. The tool enables the user to explore the climate analogues under a range of future emissions scenarios. The scenarios available are among those used in the Intergovernmental Panel on Climate Change Fifth Assessment Report (2013).

These are referred to as RCPs (Representative Concentration Pathways):

1. RCP 2.6 (Low emissions trajectory, peaking around 2020)
2. RCP 4.5 (Intermediate emissions trajectory, peaking around 2040)
3. RCP 8.5 (High emissions trajectory, a future with little curbing of emissions, with a CO2 concentration continuing to rapidly rise, reaching 940 ppm by 2100)

The analogues tool looks up the current average maximum temperature and rainfall for the selected seasons. The projected changes in maximum temperature and rainfall from the climate models are then applied to the historic values. The tool then searches the database of current climates across Australia to find all locations that match the new values within the set tolerances. It is important to note that some potentially important aspects of local climate are not considered with this approach. These include: evapotranspiration, frost days and other local climate influences, radiation and soil types (CSIRO & BoM 2021).

As a representative site for the Northern and Yorke Region the climate analogues for Port Pirie under an RCP 8.5 emissions scenario are shown for 2030 (Figure 20), 2050 (Figure 21) and 2090 (Figure 22). Analogues of select Northern and Yorke towns are included in Appendix A. The analogues show a general tendency for the climate of the region to become more like that of the Central to Eastern Wheatbelt of Western Australia through the course of the 21st Century.

This presents a key opportunity to collaborate and learn from the successes and failures of adaptation actions already trialled across the drying Western Australian wheatbelt.

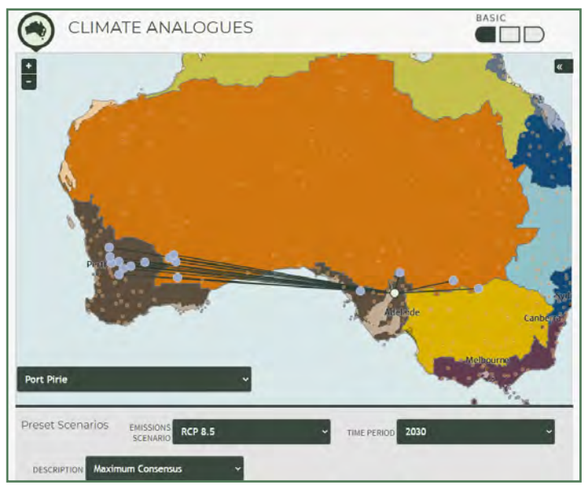


Figure 20. 2030 climate analogues for Port Pirie under an RCP 8.5 emissions scenario (Source: CSIRO & BoM 2022)

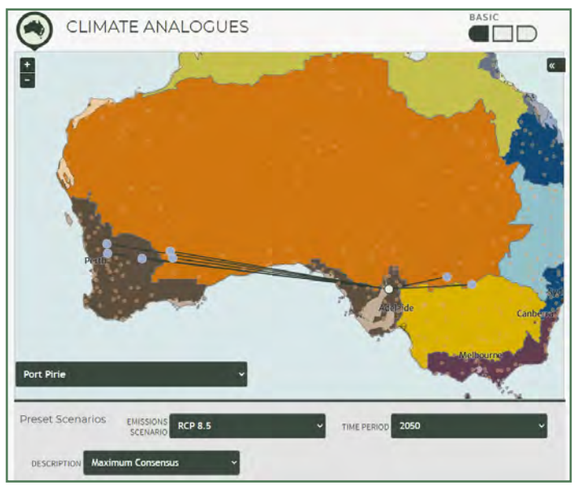


Figure 21. 2050 climate analogues for Port Pirie under an RCP 8.5 emissions scenario (Source: CSIRO & BoM 2022)

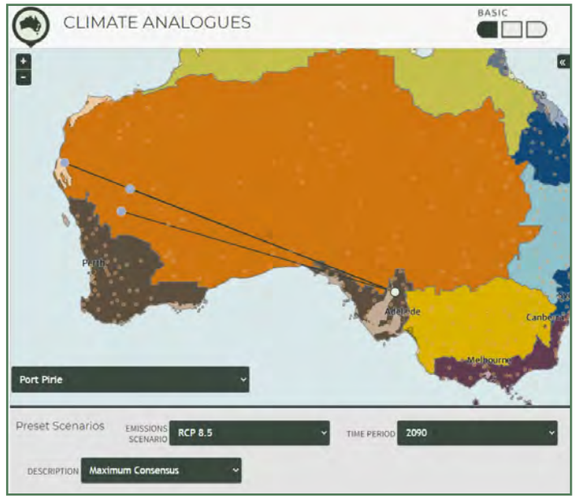


Figure 22. 2090 climate analogues for Port Pirie under an RCP 8.5 emissions scenario (Source: CSIRO & BoM 2022)

“WITH AVERAGE FARM EQUITY AT 80% IT MEANS THERE ARE MANY FARMS IN WA THAT ARE CLOSE TO BEING DEBT-FREE. THOSE BUSINESSES ARE NOW IN A REALLY HEALTHY POSITION AND ABLE TO EMBRACE EXPANSION OPPORTUNITIES.”

The Western Australian wheatbelt commenced a long-term drying trend in the mid-1970s, much earlier than south-eastern Australia, where it commenced in the mid-1990s. The WA wheatbelt therefore provides a key insight into the socioeconomic and biophysical dynamics that are likely to produce some similar impacts across the Northern and Yorke Region through the coming decades. The continued resilience and profitability of agricultural enterprise in the WA Wheatbelt also demonstrates the capacity of the South Australian grain belt to further adapt to the drying climate.

Western Australian farm businesses are in good shape despite May to October rainfall declining by 10 to 30 per cent over the past 15 years compared with the previous 90 years, according to Australian Export Grain Innovation Centre Chief Economist Professor Ross Kingwell (GRDC 2016). Western Australian farm businesses are employing a variety of agronomic, genetic and economic strategies to keep abreast of climate and price fluctuations. Professor Kingwell stated “Most farm businesses in WA operating in the past 15 years have experienced an environment in which the growing-season rainfall has been much less than for their fathers or grandfathers. Yet in spite of this drying trend, farm businesses have been able to improve the efficiency with which they use the rainfall they receive. In recent years many farms have focused on paying off debt, such that average farm equity is now back at about 80 per cent.”

Professor Kingwell said “With average farm equity at 80 per cent it means there are many farms in WA that are close to being debt-free. Those businesses are now in a really healthy position and able to embrace expansion opportunities,”. The top 25 per cent of WA farm businesses have been generating returns as high as 15 per cent however, there is a huge range between the top performers and the bottom performers and the playing field, in terms of rainfall, is not level. He noted the drier eastern wheatbelt experiences more seasonal extremes, so playing the season in these marginal areas becomes critical for financial success. Professor Kingwell said the main messages from his research were that most WA farm businesses are coping with climate challenges owing to technical advances and management skill: “If you were to make the assumption that the drying climate has sent businesses backwards in WA, you’d be wrong,” he said (GRDC 2016). This bodes well for a strong and resilient Northern and Yorke region to accommodate future climate shifts while maintaining profitable agriculture enterprise.

With growing season rainfall across both the South Australian and Western Australian grain belts projected to decline further through the coming decades there is a clear need to enhance collaboration, knowledge transfer, and joint research and development between the two regions.

8 PRIORITIES FOR IMPROVING RESILIENCE.

Drought is one of many risks that farm enterprises, communities, regional towns and industries need to manage. Drought does not occur in isolation of other risks, instead it interrelates with factors influencing the economic, social and environmental sustainability of farming enterprises.

Drought can and does exacerbate other risks, particularly related to firstly environmental conditions, then social and economic influences. The impacts of drought extend beyond farm enterprises to agricultural supply chains, regional businesses, communities, individuals, health and finance organisations.

For the purpose of this plan, the key identified resilience themes arising from stakeholder engagement, previous research and plans are as follows:

- Resilient farm enterprises.
- Resilient industries.
- Resilient communities.
- Knowledge and education.
- Research and innovation.

A schematic of the key resilience themes, enablers, priorities and actions of the plan are presented below in Figure 23.

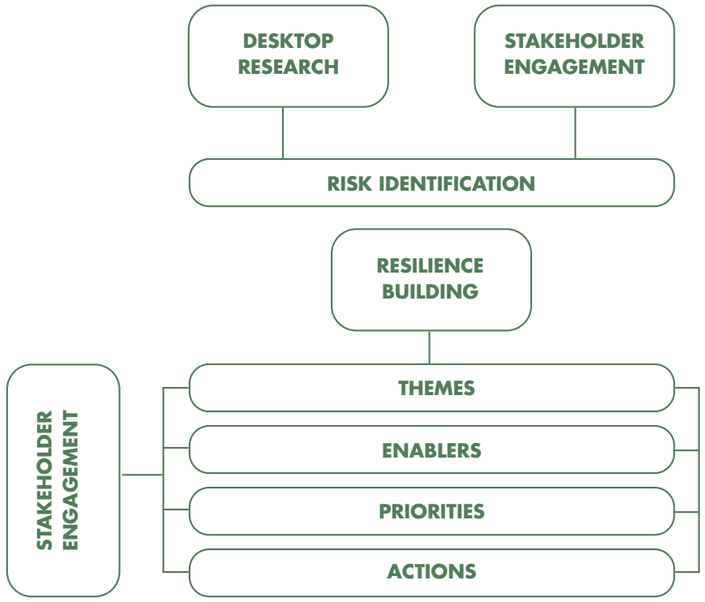


Figure 23. The process of developing drought resilient themes, enablers, priorities and actions.

The enablers of resilience have been grouped into broad categories with key groupings of enablers assigned to each theme (Figure 24).

> **SOIL HEALTH, SOIL BIOLOGY, DROUGHT TOLERANT VARIETIES, INCORPORATING LIVESTOCK INTO THE SYSTEM, KNOWING HOW TO CONFINEMENT FEED...THERE ARE SO MANY.**

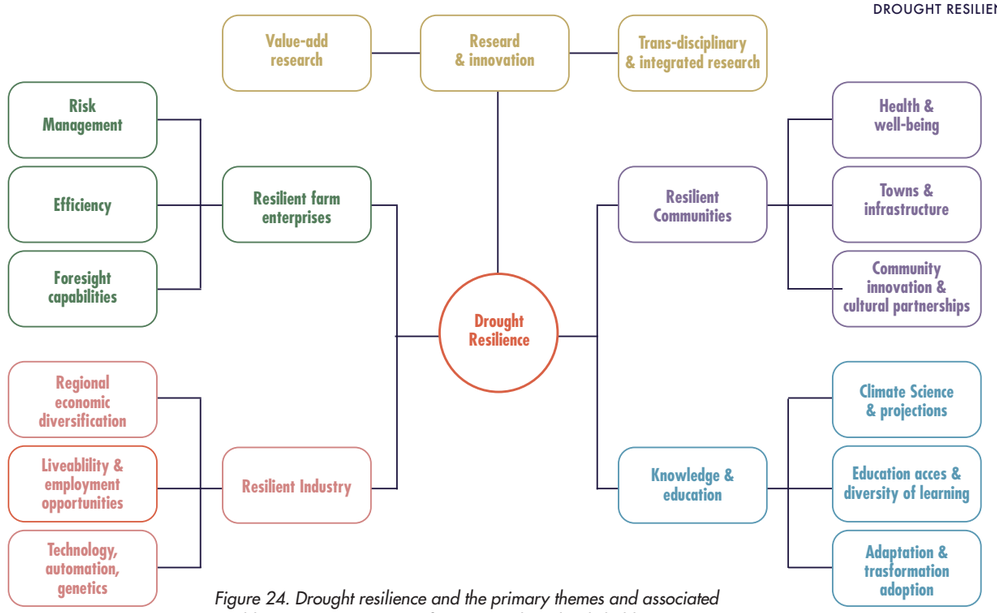


Figure 24. Drought resilience and the primary themes and associated enabler groupings emerging from research and stakeholder engagement

The benefits of participating in the ongoing development of the plans and the actions that are described within the plan include:

- Building knowledge and capacity of individuals, businesses and communities to understand the changing nature of future drought in the region and to prepare for such changes.
- Improved economic, social and environmental outcomes related to the use of water and environmental assets in buffering the effects of drought.
- Improved ability to manage risk through the diversification of farm enterprises and agricultural supply chains towards rainfall independent income streams.
- Ability to access an increasing body of evidence guiding the implementation of drought resilience measures.

The vision to be achieved through the implementation of the plan is a region that has the tools, assets, social capital, skills and knowledge to better prepare for and respond to the impacts of drought.

8.1 Theme 1 - Resilient Farming Enterprises

8.1.1 Overview

Farm enterprises represent 32% of all businesses in the region and in 2020/2021 contributed over $1.7 billion dollars to the state's economy, contributing over 21% of the Gross Regional Product (Profile ID, 2022).

A resilient farm enterprise is one that can withstand or readily bounce back from unforeseen and foreseeable adversity and where required, readily alter systems and processes.

Drought is one of many risks that farmers face. The ability to create and build a resilient farming enterprise is a result of decisions planned for and enacted during times of non-drought, whilst in drought and through drought recovery. Response options to drought also depend on local circumstances, such as soil quality, agronomic patterns, the flexibility of credit providers and taxation systems as well as supply chain partners to support farm enterprises (Meuwissen, et al., 2019). Drought must be contextualised to better understand how drought as a risk interrelates with other farm enterprise risks and can be exacerbated by a combination of risks to a farm business. For example, the capability of animal farm enterprises to withstand the economic impacts of the 2018 drought were mitigated by the high price received for livestock, allowing farmers to purchase feed, contain stock to feed lot arrangements and rest paddocks. This demonstrates that economic sustainability often underpins social and environmental sustainability. This example is in stark contrast to the Millennium Drought, where the price for livestock did not justify the purchase of off-farm feed, in turn causing significant social, environmental and economic stress (Kellock, 2022) (Young, 2022) (Sommerville, 2022).

Farmers are currently facing a range of macroeconomic factors that are influencing the profitability of their business. Key factors identified through stakeholder engagement and desktop research are:

- The region is over-reliant and highly exposed to a reduction in water take from the Murray River, particularly through the viticultural regions of Clare Valley and Barossa Valley.
- Access to a suitable quality and priced water product is the key issue for the horticulture, viticulture and the livestock industries in the Plains and Ranges sub-regional zone.
- The winegrape sector have experienced a reduction of overseas visitors to key wine regions (mainly the Barossa Valley) combined with reduced rainfall, a decrease in demand for wine resulting from trade sanctions with China and a decrease in the price for winegrapes.
- Increasing input costs, in particular diesel and petrol fuel and fertilisers are causing many farmers to either reduce fertiliser usage or allocate greater budgets towards finances for fertilisers.
- The main vegetable, nut and fruit producing regions, located in the plains and ranges zone are exposed to reduced rainfall events, with those growers reliant on mains supply water and groundwater exposed to changes to water take, resulting from government intervention and long-term drought conditions.
- There are various community groups and organisations involved in contributing to a resilient community. The implementation of strategies within this plan will involve the identification of relevant partners. Example regional partners for building resilient communities are summarised in Table 13.

8.1.2 Regional partners

There are various bodies and organisations involved in contributing to resilient farming enterprises. The implementation of strategies within this plan will involve the identification of relevant partners. Example regional partners for building resilient farm enterprises are summarised in Table 13.

	REGIONAL PARTNERS	KEY PLANS AND GUIDING DOCUMENTS
NATIONAL	Department for Agriculture, Water and Environment Grains Research and Development Commission Meat and Livestock Australia National Farmers' Federation Wine Australia The Australian Wine Research Institute	Australian Government – Future Drought Fun Australian Government - National Drought Policy Australian Government – The Water Act The Murray Darling Basin GRDC – Business planning guide for farmers recovering from drought NFF – A National Drought Policy
STATE	Ag Ex Alliance Business SA Department for Environment and Water Department for Primary Industries and Resources SA Grain Producers SA Horticulture Coalition of South Australia Livestock SA Local Government Association Primary Producers SA SA Drought Resilience Adoption and Innovation Hub SA No-till Farming Association SA Water South Australian Grain Industry Trust South Australian Cattle Industry Trust South Australian Sheep Industry Trust Universities	South Australian Government – National Drought Policy SA Government – Water Industry Act 2012 SA Government – Water Security Statement SA Government – South Australian Guide for Drought Assistance GPSA – South Australian Guide for Drought Assistance PIRSA – Drought management and recovery booklet PIRSA – Business planning for farmers recovering from drought South Australia's Disaster Resilience Strategy 2019-2024 SA Drought Resilience Adoption and Innovation Hub – Node Co-design Workshops Report
REGIONAL	Northern and Yorke Landscape Board Legatus Group Regional Development Australia Barossa Gawler Light Adelaide Plains Regional Development Australian Far North Regional Development Australia – Yorke and Mid North	Local Government Emergency Management Framework The Northern and Yorke Regional Climate Adaptation Plan Northern and Yorke Landscapes Board – Annual Business Plan 2021/22
LOCAL	Barossa Australia Barossa Improved Grazing Group Care Valley Wine and Grape Hart Field Day Site Mid North High Rainfall Group Northern Adelaide Plains Food Cluster Northern Sustainable Soils Regional Agricultural Bureaus Regional Landcare and Environment Groups Upper North Farming Systems	Barossa Water Security Strategy Barossa Water Allocation Plan Clare Valley Water Allocation Plan Clare Valley Water Supply Preliminary Business Case Barossa Valley Water Supply Business Case

Table 13. Regional partners for building resilient farm enterprises in the Yorke and Mid North Region

8.1.3 Progress in Region

Farm enterprises have been the backbone of the economy, dominating land use in the region and contributing to state, national and global food production.

Current progress across farm enterprises is as follows:

- A strong history of productivity gains through localised agricultural research and development and implementation.
- Minimising risk through business planning, diversification of properties across different rainfall areas, planting of different crop varieties, accessing alternative water supplies and reducing forward planning.
- Improved soil management and agronomy practices, i.e, no-til farming, precision agriculuture, controlled traffic, use of dung beetles etc.
- There are select examples of on-farm rainfall independent diversification, such as on-farm tourism and renewable energy generation.
- The adoption of farm management deposits.
- Business planning, including off-farm counsel.

8.1.4 Resilient farm enterprises key enabler categories

Three key enablers have been developed for resilient farm enterprises:

1

RISK MANAGEMENT

Drought will increase the exposure of farmers to financial, social and environmental risks. As such, it is critical that risks related to drought are identified and managed.

2

EFFICIENCY

Increasing efficiencies within any business is an important driver of cost savings. Efficiency can take many forms, in this instance, efficiency refers to the ability to do more with reduced available soil moisture.

3

FORESIGHT CAPABILITIES

Key to adaptation and transformation is understanding the impact of a "do nothing" approach compared to the costs and benefits of changing practices and behaviours. It is important that farmers understand and act according to global, national and regional drivers of change, such as supply chain disruptions, increasing global tensions and tribalism, climate change, increasing global population, increasing number of a global middle class (Department of Agriculture, Water and Environment, 2020).

Current progress, key enablers, priorities and actions are outlined in Table 14.

8.1.5 Case study

The case study below tells the story of a farming family in Western Australia who have improved the ability of the soils on their land to store and capture moisture and through this have benefitted from increased pasture retention, erosion control, biodiversity and on-farm productivity.

RETAINING WATER ON THE LAND AT YANGET THROUGH NATURAL SEQUENCE FARMING.

Rod and Bridie O'Bree purchased a property at Yanget, 25 kilometres east of Geraldton in Western Australia in 2008 off the back of two successive drought years. The O'Brees planned to run beef cattle, a horse stud and lambs on the 800 ha property.

The property had undergone hard times, devoid of vegetation to hold the soil together, significant gully erosion was evident across the creek lines and gullies of the property. When the first rains fell, the movement of water across the property took the topsoil with it.

Noting that the average annual rainfall has substantially dropped over the past 30 years (from a mean of 486mm per year to 354mm per year), the O'Bree's needed a plan to transform the property to better utilise the limited rainfall.

The O'Bree's engaged Peter Andrews to guide the implementation of natural sequence farming principles in order to rehydrate the landscape, including :

- constructing earth banks within the creeklines aimed at slowing the movement of water through the landscape.
- re-engineering existing contour banks to hold water and to allow it to exit at strategic points.
- establishing perennial pasture trials in 2009 establishing more perennial pastures on the slopes and flats, including onto heavy soils.
- allowing weeds and invasive species to establish to increase the overall diversity of pastures.
- using mechanical mulching to slash weeds.

Since implementing the changes from 2010 onwards, Rod reflects on what has worked well. Key changes are as follows:

- Grazing capacity has risen and the greatest animal production results were achieved in the last 2 years, despite limited rainfall.
- Groundcover has increased. The perennial pasture species green panic, Bambatsi panic, signal grass, Consol love grass, siratro and lucerne have persisted well.
- Earthworks associated with the NSF approach have slowed the movement of water through the property. Water has left the farm in only 1 year out of the last 4 and that was after 185 mm in 2 weeks after a 10-month dry spell when only 18 mm of rain fell. Now, 25 mm of rain soaks into the broader landscape, compared to the 25 mm in February 2008 that flowed quickly off the property.
- Erosion has significantly reduced and gully-head erosion now doesn't occur. Drainage lines have naturally revegetated and are now stable
- The correct placement of earthworks has resulted in waterholes having more water in them for longer, allowing more grass to grow in flow lines and helping to prevent salinity.

All information contained within this case study has been sourced from The Government of Western Australia, Department of Primary Industries and Regional Development, Regenerative Agricutlure Case studies webpage (Government of Western Australia, 2017).

Above images: Three Creek dam on the O'Bree property in 2009 (left) and again in 2017 (right) (Government of Western Australia, 2017).

THEME #1 RESILIENT FARM ENTERPRISES			
	CURRENT PROGRESS:	**PRIORITIES GOING FORWARD:**	**ACTIONS:**
KEY ENABLERS: RISK MANAGEMENT	• Strong history of productivity gains through localised agricultural research and development. • On-farm rainfall dependent diversification. • Select examples of on-farm rainfall independent diversification. • Farm Management Deposits. • Business Planning, including off-farm counsel.	• Further off-farm diversification. • On-farm rainfall independent diversification. • Forward planning, knowledge of market trends, access to markets and future food demand. • Understanding and acceptance of a new reduced rainfall and increased evaporation scenario. • Reduced reliance on expensive inputs. • Integrated and coordinated mental health system that allows for greater accessibility for farmers, farm families and workers. • Access to rainfall independent water sources for irrigation districts.	• Transition farm operations to carbon nuetral (e.g. electrify machinery, carbon farming etc.) • Increase access to off-farm income sources through further education of the need for off-farm income and increasing access to regionally located education and training services. • Encouraging maximisation of on-farm rainfall independent diversification (tourism, renewable energy etc) through showcasing local rainfall independent business successes from within an outside of the region. • Communicate changes to markets, including market access and future food demands to farmers (currently a significant gap). • Increase access to climate science, meterological information and forecasts, and collaborate with communication specialists to ensure that key messaging cuts through anti-science narrative whilst maintaining the progress, transition and transformation. • Transition to reduced input systems through adoption of new lower input genetic lines, green technology (electric vehicles), on-farm renewable energy, organic fertilisers to reduce operational costs and reliance on traditional farm inputs. • Adopt a coordinated and integrated health system model, as outlined in Table 17. • Investigate options for both regional groundwater and marine desalination plants, specifically for agriculture (water to be treated to fit for purpose standards). • Investigate further aquifer storage and recharge options within the region to capture stormwater during rainfall periods and store for later use. • Improve local grain storage infrastructure to minimise transport expenditure and develop localised seed banks. • Create a consistent framework for drought declaration to ensure support measures can be accessed.
EFFICIENCY	• Information collection and disseminiation by SA Drought Innovation and Adoption Hub. • Continued focus on agricultural research and development has allowed for productivity gains. • High adoption of no-till farming. • Trialling of new precision technologies. • Trialing of new crop and pasture management approaches.	• Allocate further funding for natural resources management as a means of capturing and storing water on land, in soils, aquifers and riparian zones. • Buffer farm animals from the increasing effects of heat through shade cover installation and livestock managemet approaches. • Ensure sustainable use of water, rain and stormwater capture and storage and encourage adoption of water reuse. • Conduct cost-benefit analysis of water reuse schemes. • Research commercial viability of in-region organics processor and distribution centre. • Increase research and development for key climate-environment on-farm risks. • Increase use of native and hardy plant species as grazing fodder in solar farms (solar grazing).	• Increase pasture/ground cover retention in grazing zones. • Conduct further organic fertiliser trials, research and extension to showcase the water storage benefits of short and long-term use of organic fertilisers, clay delving and other water infiltration and soil storage solutions. • Revegetate and restore riparian habitat along key creeks and rivers to clean water, slow water movement and allow for water to soak into soils surrounding riparian zones. • Increase plantings of low rainfall-tolerant plant fodder species (saltbush, bluebush, native grasses)in grazing systems. Showcase benefits of combined grazing renewable energy generation systems. • Plant native species found in drier climatic zones to act as shelter belts, wind breaks and provide shade and shelter for livestock. • Utilise technology and new genetic breeding lines to improve animal and crop resilience to increased heat and drought. • Increase funding and research and development of in-crop frost management and protection. • Investigate options for on-farm stormwater capture and storage in closed systems, that aren't exposed to evaporation, i.e., offer subsidies for on-farm large scale water tanks connected to farm sheds, increased use of aquifer storage and recharge in preference of dams. • Priorities and promote Natural Sequence Farming principles to slow water movement and store water better where it falls. • Partner with existing organics processors and government agencies (GISA, PIRSA, DEW) to assess the economic viability of organics processing in the region. • Target solar grazing for demonstration trials to showcase the benefits of combining the two income streams. Explore key barriers to adoption and develop enablers to overcome barriers.

THEME #1 RESILIENT FARM ENTERPRISES			
	CURRENT PROGRESS:	**PRIORITIES GOING FORWARD:**	**ACTIONS:**
FORESIGHT CAPABILITIES	• CSIRO, ABARES and BOM have developed a suite of resources to better forecast the impact of future drought and weather conditions. • The IPCC and other global bodies have developed a range of tools that demonstrate the impact of climate change. • Climate Change in Australia Climate Analogues and Climate Explorer Tools. • ABARES has developed a future mega-trends analysis for the future of agriculture in Australia. • DEW, SARDI and other state government agencies have a range of resources outlining the projected impacts of climate change for agriculture and regions.	• Boost the number and use of agronomists, specialist farm advisors and direct training to address current and future gaps. • Increase ability of soils to store moisture through directing funding for further research and extension. • Increase access to localised, timely and accurate weather predictions. • Increase communication of projected climate risks and key messages related to adaptation and transformation. • Buffer heat and evaporation through the development of a region-wide greening masterplan. • Target forms of agriculture proven to work in low-rainfall environments.	• Current and projected future skills gaps exist in the farm advisory industry (animal nutrition specialists, pasture research and development, crop frost protection). Direct funding towards or provide incentives for education and encouraging specialisation, mentorships and master/apprentice relationships to build critical skills shortage. • Decreased rainfall and increased evaporation will create the need for greater water efficiency use and the need to increase water soil infiltration and storage. Conduct extensive demonstration trials across the region, including (where feasible) on public land to showcase the benefits of water retention. Combine this with effective communication and messaging regarding projected future climate and the urgent need to plan and act now. • ABARES projects that the average farm profits will reduce by more than 20% by 2030 because of climate change (Department of Agriculture, Water and Environment, 2020). Develop case studies outlining the benefits of on-farm and off-farm rainfall independent income streams. • Liaise directly with BOM and CSIRO to ensure more accurate weather predictions for locations across the region. • Adopt smart irrigation technology within horticulture and viticulture systems. • Liaise with communications specialists to better communicate the projected impacts of near-term climate change and provide avenues of change. • Develop a region-wide greening masterplan, utilising mapping of potential greening sites, incorporate carbon offsetting and biodiversity offsetting projects. • Promote the region as a climate adaptation case study, utilising broad-scale revegetation of low rainfall tolerant native plant species to buffer the impacts of heat and drought. • Target the expansion of reticulated water closed systems and vertical farming for horticulture through the Northern Adelaide Plains. Similar to Sundrop Farms, near Port Augusta.

8.2 Theme 2 - Resilient Industry

8.2.1 Overview

It is well understood that the economic and social impact of drought extends beyond the farm gate to the businesses that directly support farm enterprises and rely on farm business, i.e., the agricultural supply chain. However, it is also the non-farming and supply chain businesses located in the region that are highly reliant on a productive and profitable agriculture industry to support non-agricultural business (Alston, M. & Kent, J., 2004).

A 2018 study found that the loss of services and poor employment outcomes in drought affected areas impact the social and economic well-being of those employed in agriculture and also, albeit to a lesser extent, those not employed in the agriculture sector (Edwards, et al., 2018). As such, the impacts of drought are far reaching.

TRADITIONAL AGRICULTURAL SUPPLY CHAINS INCLUDE TWO PARTS:

1. The purchase of goods and services by farm enterprises, farm workers and farmers (upstream)

2. The production of goods and services by farm enterprises (downstream)

Table 15 lists the key agricultural supply chain partners for the current and future supply chain in the Northern and Yorke region.

The recently released Regional Strengths and Infrastructure Gaps report by Infrastructure Australia highlighted the following sectors as growth areas for the Northern and Yorke region (Infrastructure Australia, 2022):

- Agriculture, forestry and fishing.
- Manufacturing.
- Energy.
- Tourism.

Based on the Regional Strengths and Infrastructure Gaps report, stakeholder engagement and further desktop research, supply chain partners from all four above listed categories have been included in Table 15. The supply chain represents organisations that can provide value-add opportunities for goods and services and those who have a vested interest in ensuring the impact of drought is buffered and minimised through drought resilience capacity building.

8.2.2 Regional partners

There are various bodies and organisations involved in contributing to resilient farming enterprises. The implementation of strategies within this plan will involve the identification of relevant partners. Example regional partners for building resilient industry are summarised in Table 15.

	KEY AGRICULTURAL SUPPLY CHAIN PARTNERS		**KEY PLANS & GUIDING DOCUMENTS**
INTERNATIONAL	Accolade Wines Australian Grain Technology Bayer Glencore Graincorp Grainflow Incitec Pivot JBS Foods Australia	Neoen Nutrien Orora Pernod Ricard Treasury Wine Estates Syngenta	Not found
NATIONAL	AGL Australian Export Grains Innovation Centre Australian Industry Group Department of Agriculture, Water and Environment Elders Landmark	Manufacturing Australia National Farmers' Federation Tilt Renewables Tourism Australia Wine Australia	Australian Government – Future Drought Fun Australian Government - National Drought Policy Australian Government – The Water Act The Murray Darling Basin NFF – A National Drought Policy
STATE	Ag Ex Alliance Business SA Department for Primary Industries and Resources SA Primary Producers SA Grain Producers SA Livestock SA	SA Water South Australian Grain Industry Trust Local Government Association South Australian Cattle Industry Trust South Australian Sheep Industry Trust Tourism SA	SA Government – Water Security Statement SA Government – South Australian Guide for Drought Assistance GPSA – South Australian Guide for Drought Assistance PIRSA – Drought management and recovery booklet PIRSA – Business planning for farmers recovering from drought SA Drought Resilience Adoption and Innovation Hub – Node Co-design Workshops Report South Australia's Disaster Resilience Strategy 2019-2024
REGIONAL	Northern and Yorke Landscape Board Legatus Group Regional Development Australia Barossa Gawler Light Adelaide Plains Regional Development Australian Far North Regional Development Australia Yorke and Mid North		Local Government Emergency Management Framework The Northern and Yorke Regional Climate Adaptation Plan Northern and Yorke Landscapes Board – Annual Business Plan 2021/22
LOCAL	AW Vater Barossa Australia Barossa Improved Grazing Group Barossa Infrastructure Limited Bunyip Scheme Care Valley Wine and Grape Dublin Sale Yards E.E. Muir Farmer Johns Hart Field Day Site Kelly Tillage Kerin Agencies	Mid North High Rainfall Group Northern Adelaide Plains Food Cluster Northern Sustainable Soils Nutrien Ag Pinion Advisory Pringles Crouch Rocky River Ag Services Rural Solutions Upper North Farming Systems Vennings YP Ag	Not found

Table 15. Key Agricultural supply chain partners

8.2.3 Progress in the Region

The region has many assets that it can build on and enhance.

The region has taken advantage of the following:

- Capitalised on the growth in intrastate and interstate tourism, as an alternative economic driver to agriculture.
- Invested in access to freight routes, ports and Adelaide.
- Taken advantage of the availability of both sun and wind to build large scale wind and solar projects, with more planned over the coming years.
- Continues to adapt agricultural techniques to produce high quality and high yielding products.
- Established community collectives encouraging local entrepreneurism and place-making.
- In some circumstances, invested in infrastructure to increase the aesthetics of towns.

8.2.4 Resilient industry key enablers categories

The identified key enabler categories captured through this plan are as follows:

- Increase regional economic diversification – Increase the diversification of the economy in the region, to reduce risks of agricultural productivity and profitability loss and to increase alternative income sources for all.
- Increase the liveability and employment opportunities available in the region – Create more liveable towns and regional centres through providing the services required and wanted by residents and harnessing opportunities for growth.
- Technology, automation, genetics – Trial and adopt novel and emerging technology that can help to create efficiencies in business operations, improve decision making and reduce labour costs.

The resilient industry current progress, key enablers, priorities and action are presented in Table 16.

THEME #2 RESILIENT INDUSTRY

	CURRENT PROGRESS:	PRIORITIES GOING FORWARD:	ACTIONS:
KEY ENABLERS: INCREASE REGIONAL ECONOMIC DIVERSIFICATION	• Sound access to freight routes, ports and Adelaide. • Large scale solar and wind energy projects across the region due to high exposure to both sun and wind. • Historically, a profitable and productive farming region, providing a significant proportion of South Australia's agricultural produce and exports. • Increase in tourism resulting from COVID-19 through many districts and towns has provided economic benefits. • Community collectives encouraging local entrepreneurism and place-making.	• Regional diversification in industry form and function. • Value add to existing regionally produced agricultural commodities. • Increasing understanding of market access and development. • Define, measure and report regional industry resilience. • Take advantage of existing South Australian future target industries. • Encourage business investment in the carbon offset market for locations where farming viability is reduced. • Provide non-farming enterprises with a template and training for the development of business resilience plans (especially related to drought).	• Investigate options for regional diversification linked to the South Australian Government future industries. Define the value-add opportunities for the region based on current regional economic strengths and growth areas and the South Australian Government economic growth priorities. • Continue to build upon a growing and significant tourism industry across the food, wine, outdoor adventure and caravanning sectors. • Implement regional tourism strategies to better define target markets and opportunities for expansion. • Fund an economic diversification study to ascertain value-add opportunities for goods and services produced in the region. • Create better connections between goods produced and customer demands. • Where advantageous, introduce block chain technology to supply chains to take advantage of the clean and green image of SA produced produce. • Develop a communications plan outlining a strategy to provide climate information to alter practices and create the transitional and transformational change required. • It is essential that the levers that allow for spending and decision-making track and support climate impacts, mitigation, and adaptation measures. Capture and integrate costs of climate change and adaptation measures across long-term financial planning at the council and regional scale. • Develop and implement a regional carbon farming plan to assist willing farmers to transition parcels of land to the offset market. • Non-farming businesses are also affected by drought, supply chain disruptions and other interruptions.Develop a business resilience plan template and training program for non-farming businesses to access. • Establish regional partnerships and collaborative groups consisting of representatives of farm enterprises and agricultural supply chains to plan for greater systems resilience.

> **COMMUNITIES NEED TO BE PREPARED FOR DROUGHT, WE NEED EDUCATION, SKILLS AND KNOWLEDGE... AS WELL AS COLLABORATION, STAYING POSITIVE**

THEME #2 RESILIENT INDUSTRY

	CURRENT PROGRESS:	PRIORITIES GOING FORWARD:	ACTIONS:
INCREASE THE LIVEABILITY AND EMPLOYMENT OPPORTUNITIES AVAILABLE IN THE REGION	• Relatively more affordable housing and land (compared to Adelaide). • Good accessibility to nature. • Select councils are actively marketing the lifestyle benefits of a regional lifestyle, aiming to attract new residents. • Increased opportunities for community connection. • Significant projections of increased population growth through Northern Adelaide Plains and Barossa.	• Increase the housing stock in the region through strategic expansion of townships in select locations to attract and retain workers from rainfall independent industries. • Maximise proximity to Adelaide for population growth, lifestyle opportunities. • Increase digital access across the region. • Increase access to health services. • Ensure sustainable use of water, including water reuse. • Support the development of strategic community infrastructure to enhance social and recreational wellbeing of local communities. • Increase living infrastructure in towns. • Improve critical town infrastructure, i.e., main streets aesthetics, access and resources.	• Define barriers to township growth and collaborate with the state government to remove barriers for select townships, i.e., areas where demand outstrips housing supply. • Demonstrate that a restriction in housing supply is linked with reduced access to labour in the region. • Conduct research related to regional town centres that have grown in South Australia, interstate and overseas. Determine the key enablers of population growth. • Capitalise on the work from home culture to attract high skill-high income residents to move to the region. Target select lifestyle destinations capable of accommodating residential growth. • Seek federal and state government funding for main street upgrades for towns identified as growth areas. • Ensure towns have services available (e.g. childcare, co-working space) that enable off-farm employment. • Collaborate with state government and telcos to provide greater digital access across the region. Investigate new and emerging technologies (Starlink) for such purposes. • Increase access to health services (see Table 17). • Incorporate Water sensitive urban design (WSUD) into future town main street planning. • Plant street trees that can withstand future climate conditions. Support street trees and other living infrastructure with WSUD measures. • Target growth town main streets for infrastructure upgrades and beautification.
TECHNOLOGY, AUTOMATION, GENETICS.	• Multiple agri-business tech start-ups operating in the region. • Strong history of technological advancement and adoption across the agriculture sector. • Multiple agricultural research and development organisations operating in the region, providing locally relevant information to farmers.	• Maximise real time data technology emerging in the ag tech and manufacturing sectors. • Develop a regional economic development strategy to deliberately target and attract key technology sectors (space, defence, hi-tech, digital, energy sectors). • Develop multiple demonstration sites showcasing and trialling use of precision agriculture, new crop genetic lines and options for agriculture and value-adding processes. • Adopt needed and innovative transitionary and transformation land management methods and systems. • Maximise accessibility to sun and wind energy to create and store localised electricity for town use (community owned renewable energy).	• Adopt agriculture and manufacturing digital technology and data capture and sharing platforms to maximise efficiencies across logistics and supply chains. • Establish partnerships between the region and local and interstate manufacturing and agtech communities. • Seek to develop an MOU or equivalent partnership with Lot14 and emerging industries for opportunities for the region. • Develop a technology specific regional development strategy to identify potential partnerships and opportunities for improvement. • Create multiple demonstration sites showcasing innovative processes, technologies, emerging genetics and integrated and modern agricultural systems that demonstrate transitional and transformational resilience building techniques. Sites should focus on benefits to soils, crops, livestock, native vegetation etc. • Transformational change is required across the landscape. Trial emerging and untried methods of groundcover retention, mass revegetation and water infiltration into soils. Seek and incorporate new processes and Aboriginal knowledge and apply to land management. • Towns reliant on grid electricity are exposed to price increases and market volatility. Given the access to renewable energy sources (sun, wind), there is a significant opportunity to utilise combined battery and renewable energy sources to capture and store energy on site in local towns, reducing costs for local residents associated with electricity consumption. • Investigate options for embedded networks of electricity. i.e., Target specific areas of land for commercial renewable energy export. Export power to inner city councils.

8.1.5 Case study

Presented below is a case study of Sundrop Farms, a vertical farming operation, located near Port Augusta, South Australia, that has successfully utilised technology and natural resources to create a rainfall independent agricultural operation in desert conditions.

CASE STUDY

SUNDROP FARMS.

Located less than 10 kilometres to the east of the Northern and Yorke region, Sundrop Farms are pioneers in the sustainable agriculture and fresh produce sector.

The farm operations harness solar energy to desalinate sea water for the irrigation of tomatoes for Coles Supermarkets nationwide.

Despite operating in an environment of 218mm of rainfall per year, Sundrop Farms has successfully established a vertical greenhouse farming operation (Bueau of Meteorology, 2022). The site close to Port Augusta was deliberately chosen due to the abundance of solar energy and the ability to extract water from Spencer Gulf.

Sundrop Farms note that they are "breaking farming dependency on finite resources using nature" (Sundrop Farms, 2020).

Utilising a range of technology, the company has reduced the need for expensive ongoing input and output costs through the implementation of the following technologies (KBSS Engineering, 2020):

POWER ISLAND

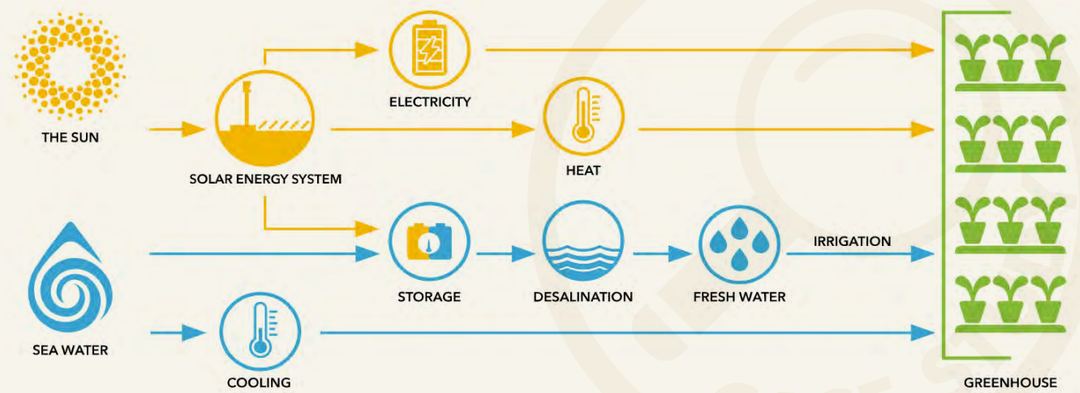
15 Hectares of mirrors (23,000 individual mirrors) focused on a 126 metre tall solar concentrator tower.

The tower feeds super-heated steam to 3 places – multi effect desalination plant (MED), bypass condenser which maintains the 95 degree water stored in the two thermal storage units, and finally to the 1.5MW steam turbine to develop power for the site.

FARM

20 Hectares of greenhouses (4 even sized houses) where hot water passes through approximately 50km of heating pipes for the winter and evaporative cooling in hotter months via cardboard paneling with sea water passing over them.

3 ponds – fresh, sea and brine. Fresh water 100% sealed with floating roof to maintain cleanliness of water and prevent evaporation.



Above image: A model showcasing the use of sun and seawater to create electricity, heating and where necessary cooling and fit for purpose water for production of tomatoes (Sundrop Farms, 2020).

8.3 Theme 3 - Resilient Communities

8.3.1 Overview

A resilient community has capacity to deal with change, move forward and adapt to minimise the impact of adverse events. Events such as drought will affect a community on a social, economic and environmental level and its impacts will extend to all areas of a community including farms, businesses and individual community members.

A resilient community is one that can learn from the experience and adapt or better yet, prevent it from happening again.

The community's resilience is linked to their health and wellbeing meaning that when one is reduced, so is the other and vice versa. The determinants that contribute to poor health status are similar to those associated with vulnerability, so a community with large concentrations of vulnerable populations will be less resilient (Institute of Medicine, 2015). Aiming to improve the underlying population health status of a community is a means of achieving community resilience.

Farmers, agribusinesses and surrounding communities are an integral part of the Northern and Yorke region's way of life. Agriculture has been important in forming the regions identiy as the States key areas for agriculture and wine and has helped showcase the region's diversity. Agricuture is particularly important as it creates essential jobs in the region and supports jobs in other industries (for example, tourism and hospitality), and supporting thriving regional towns. The region's communities rely on agriculture for their economic prosperity and drought will directly affect people working in the agricultural sector. There are substantial flow on effects on other groups as economic stress spreads across the local economy (P. Dibben, per. comm 2022) which have both direct and indirect impacts on the health and wellbeing of the people in the region. These impacts can then potentially lead to depopulation of townships creating workforce retention stress on essential health and social services.

Drought will also have cultural resilience implications for the region. Consultation with Aboriginal stakeholders revealed the cultural impact on Aboriginal communities can cause a loss of cultural connectivity to land, water and country as a result of altered landscape conditions. The link between aspects of the environment - the indigenous grasses, insects, reptiles, birds and animals, and the importance of each aspect to cultural markers and stories is broken when any one of these is missing (as happens in times of drought). An opportunity exists to engage with Traditional Owners and Aborignal Communities to learn about what can be achieved through long-term planning and educating people as to better ways to manage the landscape through integrating knowledge of the relationships between climate, people and natural resources.

Overall, drought is tough for those in the agricultural sector (financially and mentally), but regional communities are resilient, at least in terms of social cohesion. This is partly due to a high level of community and social cohesion which allows residents to pull together in times of crisis.

Key factors influencing community resilience identified through stakeholder engagement and desktop research are:

- The impact of drought on health and wellbeing. Regional and rural communities tend to suffer from higher incidence of mental illness which is exacerbated by effects of drought.
- Maintaining social networks and connections. These connections allow residents to cope better with adversities.
- Access to quality natural spaces and sustainable resource use.
- Increases in cost of living including fuel, housing and services.
- Cultural impacts such as interruption of ancient trading routes and water courses by open road networks.
- Small towns are highly economically reliant on farming enterprises. The region would benefit from economic diversification especially to industries that are not dependant on rainfall.

Studies indicate that water sensitive urban design measures increase the greening and cooling of urban areas (Broadbent, et al., 2018). Water shortages are a significant stressor on the lives and wellbeing of drought affected people and communities (Schwartz & McRae-Williams, 2009). As such, the capture, storage and reuse of water should be a key focus for the Northern and Yorke region. The benefits of the capture, storage and reuse of water can apply to both agriculture, urban greening, street tree development and contribute to the cooling, aesthetics and longer-term viability of living assets. The benefits of green spaces extend beyond amenity and aesthetics and are linked to both social well-being and economic prosperity (Schwartz & McRae-Williams, 2009). Through the course of stakeholder engagement multiple farmers and agricultural body representatives listed high quality greenspace as an important asset to the community.

> **GREEN IS IMPORTANT TO PEOPLE – NEED TO GO INTO TOWN AND SEE GREEN LAWN FOR MORALE**
>
> J. TILLEY, CHAIR MID NORTH HIGH RAINFALL GROUP

> **COMMUNITIES NEED TO BE PREPARED FOR DROUGHT, WE NEED EDUCATION, SKILLS AND KNOWLEDGE... AS WELL AS COLLABORATION, STAYING POSITIVE**

8.3.2 Regional Partners

There are various community groups and organisations involved in contributing to a resilient community. The implementation of strategies within this plan will involve the identification of relevant partners. Example regional partners for building resilient communities are summarised in Table 11.

	REGIONAL PARTNERS	KEY PLANS & GUIDING DOCUMENTS
STATE	Department for Primary Industries and Resources SA Department for Premier and Cabinet Wellbeing SA Department of Human Services Local Government Association	South Australian Government – National Drought Policy SA Government – Water Industry Act 2012 SA Government – Water Security Statement SA Government – South Australian Guide for Drought Assistance PIRSA – Drought management and recovery booklet PIRSA – Business planning for farmers recovering from drought South Australia's Disaster Resilience Strategy 2019-2024 SA Drought Resilience Adoption and Innovation Hub – Node Co-design Workshops Report South Australia's Health and Well-being Strategy 2020-2025
REGIONAL	Regional Development Australia Barossa Gawler, Light and Adelaide Plains; Regional Development Australia Far North Regional Development Australia Yorke and Mid North, Legatus Group Northern and Yorke Landscape Board SA Health – Local Health Networks Social Service and Not for Profit Organisations including Red Cross, Lifeline Country to Coast, Primary Health Networks.	Northern Areas Council Public Health Plan Regional Public Health & Wellbeing Plan for the Northern Group of Council Regional Public Health Plan Yorke Peninsula Alliance
LOCAL	Local Government Community Incorporated Associations Indigenous Business Enterprises and Incorporations Business Associations	The Barossa Council Public Health and Wellbeing Plan Various Local Health Networks

Progress or enablers of resilience can be broadly categorised across the following categories:

HEALTH AND WELLBEING

- Various community initiatives, training and programs to support farmer health and wellbeing. Examples include PIRSA's FAB Mentor Program, Wellbeing SA's Healthy Workers programs and the work of various community organisations such as Fat Farmers, I Farm Well, Lifeline, Rural and Remote Mental Health and many others (note: SC feedback welcome here)
- Grass roots community grants initiatives delivered through State and regional bodies such as Wellbeing SA, Landscapes SA, the RDA and Rural Aid.
- Council's have developed Community Health and Wellbeing Plans for their regions either through planning together at a regional level or for their own Council area. There are seven Regional Public Health Plans across the region.
- Legatus is exploring regional partnerships for mental health and wellbeing on a centralised model and has established an MoU with Lifeline Country to Coast to replicate to other parts of the region their Community Connect program which has commenced out of Clare.

TOWNS AND INFRASTRUCTURE

- Some councils are embracing water sensitive urban design principles to promote urban amenity and reduce water consumption. There is a regional forum in place for Community Wastewater Management through the Legatus Group.
- Some Councils have commenced projects such as the SA Water Smart Irrigation and Space Down Unders Storm Water harvesting Projects.
- The recently release Legatus Group Waste Resource and Recovery Strategy and Action Plan is investigating regional compost sites for the use of food and green orgnaics to assist with soil quality and water retention.

COMMUNITY INNOVATION AND CULTURAL PARTNERSHIPS AND INVESTMENTS

- There are examples of place-based approaches to building community. The Orrorroo 5431 Community Collective is an example of a not-for-profit enterprise providing rural creators with links to a platform to grow & showcase locally made quality products and services.
- The trialling of native bush foods on select properties (Sommerville, 2022)

8.3.4 Resilient community's enabler categories

Assisting the Northern and Yorke community to build resilience capacity are the following enabler categories:

- Health and well-being – a healthy community has greater capacity of resilience and can more easily build resilience.
- Towns and infrastructure – Evidence shows that investment in towns and infrastructure can assist with improving resilience of a community through the creation of employment opportunities, economic activity and sense of place Invalid source specified.
- Community innovation and cultural partnerships - Involving the community in decision making processes can improve the feeling of empowerment and provide new layers of knowledge to solve problems. There are significant opportunities to increase community voice, in particular through greater empowerment of Aboriginal communities.

The resilient communities current progress, key enablers, priorities and actions are outlined in Table 18.

A HEALTHY COMMUNITY HAS GREATER CAPACITY OF RESILIENCE AND CAN MORE EASILY BUILD RESILIENCE.

THEME #3 RESILIENT COMMUNITY	CURRENT PROGRESS:	PRIORITIES GOING FORWARD:	ACTIONS:
KEY ENABLERS: HEALTH AND WELLBEING	• Initiatives and programs for farmer health and wellbeing: Fat Farmers, I Farm Well and PIRSA's FAB Mentor Program. • Community Grants programs. • 7 Regional Public Health Plans across the region. • Community Connect model .	• Improve capacity for mental health support. • A better connected and integrated community. • Better access to health and wellbeing services. • Maintain access to healthy natural environments. • Coordinated approach to mental health services. • Community involved in decision making.	• Coordinate and expand Community-Led Mental Health and Wellbeing Support Initiatives (e.g. Lifeline Country to Coast initiative). • Establish an Online Hub/Community for promotion and awareness of mental health supports and case studies. • Advocate for visiting and outreach mental health services. • Prepare for acute mental health resources under drought conditions. • Support suicide prevention programs favouring a self-determination /community-led approach. • Ongoing support and access to health and community services for at risk sectors with priority being mental health services. • Support community leaders and community resilience coordinators to help promote drought resilience programs. • Education programs to fight stigma around mental health issues.
TOWNS AND INFRASTRUCTURE	• Water sensitive urban design. • Water recycling. • Smart irrigation technology.	• Manage natural environments in urban areas for drought resilience. • Ensure sustainable use of water. • Support the development of strategic community infrastructure to enhance social and recreational wellbeing of local communities.	• Integrate planing for risk of drought within regional health service and infrastructure planning. • Assess current reliance of health, aged care, housing, industry and social infrastructure on rainwater. • Investigate and exapnd recycled water use for irrigation region wide. • Assist with development and/or funding of community projects, programs and infrastructure. • Integrate WSUDs in asset planning. • Investigate opportunities for urban cooling as part of all major Council place-making, urban development and infrastructure upgrade projects. • Develop regional compost sites for use of waste. • Incorporate drought management/resilience as part of Council environmental management plans. • Encourage use of indigenous/drought tolerant plants in public and private spaces. • Support and encourage walkable neighbourhood design, physical activity and community use in town planning.
COMMUNITY INNOVATION AND CULTURAL PARTNERSHIPS	• Community collectives encouraging local entrepreneurism and place-making. • Existing cultural partnerships through Landscapes SA and the five Aboriginal nations of the Northern and Yorke region.	• Incorporation of Aboriginal knowledge and perspectives into planning and decision-making processes to increase drought resilience. • Build the capacity of Aboriginal controlled and operated organisations to be involved in sustainable project delivery across the long-term. • Build more sustainable and realistic relationships with farmers and other stakeholders to enhance and optimise land management. • Boost the capacity and project-readiness of existing community incorporated associations.	• Ensure appropriate and meaningful engagement with Prescribed Body Corporates on funded projects. • Partner with indigenous groups to develop and deliver training and education of the increased use of drought resistant native vegetation, improved water management and the importance of wildlife corridors for animals. • Support the capacity for community groups to apply for grants. • Review grant application process to improve the accessibility and user-friendliness of grants processes for grass-roots community groups. • Develop 'place based' models for promoting economic diversification, local entrepreneurship and town vibrancy.

8.4 Case studies

Presented below are two case studies of a community-led health initiative and urban infrastructure projects delivered by the City of Mitcham, a leader in council water sensitive urban design

FAT FARMERS: COMMUNITY-DRIVEN HEALTH INITIATIVE.

The "Fat Farmers" Regional Health Initiative was founded in 2010 by a group of grain producers who, recognising their growing waistlines and declining health, gathered in their local gym in Yorke Peninsula, South Australia to become fitter and to train for the annual Adelaide to Glenelg City-Bay Fun Run.

Industrialised farming has led to many farmers experiencing high levels of sedentary work, just as urbanised populations do. The Country South Australia Primary Health Network has been identified as the most overweight and obese in the nation, with 73% of residents now identified as either obese or overweight (AIHW, 2016). With leadership from several new Team Coordinators and support from the Healthy Farmers Adviser based at Primary Producers SA, Fat Farmers teams have now spread to seven locations and approximately 120 farmers across SA. It's politically incorrect name and bottom-up approach "cuts through" in a nation which has become blasé about obesity and its impact on health and wellbeing.

The outcomes of the "Fat Farmers" initiative thus far has been:

- Building leadership and capacity. Both male and female farmers (Team Coordinators) have been good advocates for the importance of health for business productivity and are talking about this with other farmers proactively via traditional media, social media and their own farming and community networks.
- Many farmers who had previously been doing little exercise and/or never attempted a fun run before have started exercising with the "Fat Farmers" groups. Some groups which have been established for several years report that the gym training sessions they participate in have become a strong community social event and is becoming more popular than going to the pub
- Establishing the strong partnership with AIMHS which will provide opportunity for "Fat Farmers" to continue in the future (beyond government funded support) and to ensure that the linkages between physical and mental health are promoted.

The support of a Health Promotion professional with knowledge of the farming community and effective health promotion and community development principles has added value to the efforts of the Team Coordinators to make a model which is sustainable and which has the potential to grow in the future.

For further information, see **www.fatfarmers.com**

TREENET INLET CITY OF MITCHAM.

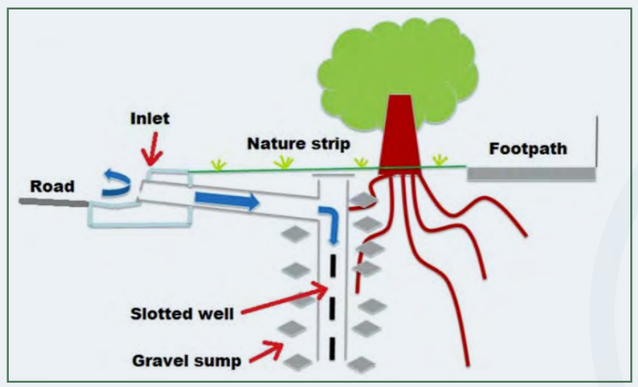
The City of Mitcham is pioneering the use of the TREENET Inlet designed by Space Down Under, (pictured below) which allows for water travelling along the street water table (gutter) to enter the soil surrounding a street tree via an inlet (Johnson, 2022)

Water from the water table is gravity fed into a plastic tube that deposits the water into a slotted vertical pipe that allows water to move from the pipe into the street verge soil. Water percolates into the gravel medium surrounding the vertical pipe and then into the soil of the street verge, providing a street tree with captured rainwater (Johnson, 2022).

This system captures stormwater that would otherwise be destined for the sea, and in the process provides street trees with much needed water.

Research currently being conducted indicates that trees with access to stormwater via a TREENET Inlet system have thicker canopy with a higher leaf area index providing greater shade, higher rates of sap flow and create a cooler microclimate through evapotranspiration (Johnson, 2022).

Above images: A TREENET Inlet (pictured above) designed by Space Down Under delivers water to the soil of the street verge (nature strip), providing added water supply for street trees (Johnson, 2022)



Above image: A cross section diagram of a TREENET Inlet.

PERMEABLE PAVEMENT CITY OF MITCHAM.

Adelaide is experiencing the loss of green space and the loss of permeable surfaces. That is, surfaces that allow water to enter the soil.

With an increase in impermeable surfaces, such as roofs, driveways, courtyards, roads and footpaths, the City of Mitcham is trialling the use of permeable pavement on some footpaths and roads within the council area (Johnson, 2022).

Permeable pavement allows for the movement of water into the soil medium, providing street trees with additional and much needed water.

The rainwater tanks in the image below have been photoshopped into the image to demonstrate the incredible water storage capacity of soils (Johnson, 2022). The light grey coloured paving surrounding each of the immature street trees, in the image below, is permeable pavement. Based on an average annual rainfall of 500mm, each of these street trees can access an additional 4000 litres of water per annum. This is based on the 8m2 of permeable pavement surrounding the tree (Johnson, 2022).

Capturing rainwater where it falls and utilising the water for street tree growth, diverts water from aging stormwater infrastructure networks and allows street trees to access more water throughout the year. Recent studies indicate that the use of permeable pavement allows water to percolate further into the soil medium. This encourages tree roots to grow deeper to access water that is deeper in the soil. Tree roots can cause uplifting of traditional footpath pavement types and the remediation of this is an added cost for councils.

Above image: The rainwater tanks represent the annual amount of water (4000 litres) delivered to the soil through 8m2 of permeable pavement. Photograph taken 29 October 2010 (Johnson, 2022).

8.5 Theme 4 – Knowledge and Education

> **AT A BASIC LEVEL, THE MORE EDUCATED A COMMUNITY IS, THE MORE RESILIENT THE COMMUNITY IS. AN EDUCATED COMMUNITY IS ABLE TO FIND ALTERNATIVE INNOVATION**
>
> ANITA KUSS, UNIHUB SPENCER GULF

The United Nations Convention to Combat Desertification (UNCCD), promotes that a proactive approach for enhancing drought resilience and to mitigate drought risks is composed of **three important pillars:**

At the national and state level, drought preparedness and resilience can be strengthened through knowledge and early warning systems of climatic conditions and the effective communication of this knowledge with communities (understanding climate projections and science).

Community engagement across the Northern and Yorke region reflected that knowledge and improved forecasting of weather conditions is a priority for drought resilience. Improved climatic forecasting would allow farmers to better plan for the expected conditions to reduce farming inputs and enable more informed farm business decision making. The instability and variability in the seasons is increasing the complexity of farm planning.

IMPROVED CLIMATIC FORECASTING WOULD ALLOW FARMERS TO BETTER PLAN FOR THE EXPECTED CONDITIONS TO REDUCE FARMING INPUTS AND ENABLE MORE INFORMED FARM BUSINESS DECISION MAKING.

Consultation in the region highlighted the opportunity to build the capacity of the community and farm management boards to prepare to prepare for drought resilience at a community service, business and farm management level.

There is strong desire for strengthened education systems at the local level from school age through to tertiary training and workplace apprenticeships. There is concern that education has become more 'city centric' leading to gaps in regional knowledge. 'Education in place' to support local knowledge and jobs is considered essential for strengthening regional communities and hence support resilience (NYRDA Drought Resilience Community Workshops, 2022).

> **STOP TRYING TO COMMUNICATE SCIENCE TO FARMERS, AGROS (AGRONOMISTS) ARE THE INFLUENCERS. PROVIDE THE DATA TO THE AGRONOMISTS**

8.5.1 Regional Partners

There are various community groups and organisations involved in contributing to enhanced knowledge in the region. These are presented below in Table 19

	KNOWLEDGE AND EDUCATION PARTNERS		KEY PLANS AND GUIDING DOCUMENTS
NATIONAL	Australian Centre for International Agricultural Research CRC for High Performance Soils CSIRO Bureau of Meteorology Fight Food Waste CRC Food Agility CRC	Future Food Systems CRC Grains Research and Development Corporation The University of Adelaide The University of South Australia Flinders University	Australian Government – Future Drought Fun Australian Government - National Drought Policy Australian Government – The Water Act The Murray Darling Basin GRDC – Business planning guide for farmers recovering from drought NFF – A National Drought Policy
STATE	Department for Primary Industries and Regions SA Department for Premier and Cabinet Department for Environment and Water Wellbeing SA Department of Human Services SA Local Government Association SA Water Primary Producers SA	Conservation Council of SA First Nations of SA Ag Excellence Alliance Ag Bureau of SA SA Nature Alliance Friends of Parks SA Landcare Association of SA Premier's Climate Change Council	South Australian Government – National Drought Policy SA Government – Water Industry Act 2012 SA Government – Water Security Statement SA Government – South Australian Guide for Drought Assistance GPSA – South Australian Guide for Drought Assistance PIRSA – Drought management and recovery booklet PIRSA – Business planning for farmers recovering from drought SA Drought Resilience Adoption and Innovation Hub – Node Co-design Workshops Report
REGIONAL	Regional Development Australia Yorke and Mid North Regional Development Australia Barossa Gawler Light Adelaide Plains Regional Development Australia Far North Legatus Group Northern and Yorke Landscape Board	SA Health – Local Health Networks SA Drought Innovation and Adoption Hub Social Service and Not for Profit Organisations Spencer Gulf Uni Hub TAFE SA	Local Government Emergency Management Framework The Northern and Yorke Regional Climate Adaptation Plan Northern and Yorke Landscapes Board – Annual Business Plan 2021/22
LOCAL	Local Councils Community Incorporated Associations Indigenous Business Enterprises and Incorporations Business Associations Barossa Australia Barossa Improved Grazing Group Care Valley Wine and Grape Hart Field Day Site	Mid North High Rainfall Group Northern Adelaide Plains Food Cluster Northern Sustainable Soils Regional Agricultural Bureaus Upper North Farming Systems	Barossa Water Security Strategy Barossa Water Allocation Plan Clare Valley Water Allocation Plan Clare Valley Water Supply Preliminary Business Case Barossa Valley Water Supply Business Case

Table 19. Knowledge and Education partners

8.5.2 Progress in Region

- The SA Drought Resilience Adoption and Innovation Hub is one of eight Hubs established across the nation through the Australian Government's Future Drought Fund, includes a regional node within the region in Orrorroo within the Upper North and Eastern sub-regional zone and the hub located at Roseworthy within the Plains and Ranges sub-regional zone. The Node is a shopfront where farmers and community members can connect with drought resilience expertise.
- Northern and Yorke Landscape Board provides industry and farming system groups with support, advice, capacity building and help with funding applications for sustainable agriculture and biodiversity improvement initiatives in the region.
- The Northern and Yorke Lanscape Board Goyder's Line project will deliver a range of extension and on-ground activities aimed at increasing farmers' ability to manage their land, their stock and their businesses, through changing times.
- The Ag Excellence Alliance hosts the Regional Agricultural Landcare Facilitator (RALF) for the Northern and Yorke region. The facilitator works with landholders, farming systems and landcare groups, Landscape Board and RDC's to identify and address sustainable agriculture initiatives.
- The Goyder Institute for Water Research, as part of the SA Climate Ready Project, released the most comprehensive set of downscaled climate projections data ever available in South Australia in 2015. This data complements the national scale projections produced by the CSIRO and the Bureau of Meteorology. Downscales climate projections utilise complex climate information (from the past and the projected future) to produce finer resolution climate information to better account for regional climatic influences, such as local topography. (Climate Change in Australia, 2020).
- The Future Drought Fund's Climate Services for Agriculture (CSA) tool is also operational and provides users with location specific information on seasonal and monthly rainfall outlooks, and medium and longer term climate projections for rainfall and temperature.
- RDA Yorke and Mid North has established a central online platform for community engagement and information delivery on the Northern and Yorke Drought Resilience Plan - www.droughtresilientny.com.au..

8.5.3 Key enabler categories

The following represent the key knowledge and education enabler categories:

- Understanding climate projections and science - In order to adapt to the future projected impacts of drought, individuals, businesses and the community will benefit from understanding the future climate projections for the region and acting to reduce the impacts through implementing change.
- Greater access to education and diversity and styles of learning - increasing access to relevant and timely information to inform decision making and behaviour and the tailoring of information to accommodate multiple and diverse learning styles.
- Adoption of proven international, national and regional drought adaptation and transformation techniques – learning from others, across Australia and the world who have greater adaptation and drought knowledge

The knowledge and education current progress, key enablers, priorities and actions are presented in Table 20.

THEME #4 KNOWLEDGE AND EDUCATION

	CURRENT PROGRESS:	PRIORITIES GOING FORWARD:	ACTIONS:
KEY ENABLERS: UNDERSTANDING CLIMATE PROJECTIONS AND SCIENCE	• Recognition of changes to weather patterns over time by many farmers and farming groups • Significant work conducted by DEW and SARDI to quantify projected impacts of climate change on available soil moisture and agricultural systems.	• Develop appropriate communication materials to suit varied learning styles and educational levels. • Co-develop materials with and for farmers, supply chains and rural communities. • Effectively communicate the opportunities and need for rainfall independent income and revenue required for future farming enterprises. • Connect community leaders who have experience of drought to the Drought Leaders Mentoring Program	• Engage both communications, researchers and educational specialists to work with farmers, argonomists, supply chain stakeholders and the broader community to understand barriers to understanding and acceptance of climate change. • Develop communication materials based on findings from the stakeholder engagement and co-design process. Ensure the focus is on actions required and taken, rather than climate data. • Engage trusted community leaders within the co-design process and promote messaging related to climate change projections. • Develop case studies of farmers gaining income through rainfall independent systems. • Take advantage of the Drought Leaders Mentoring Program to ensure knowledge and skills transfer from farming districts with experience of drought to farming districts where drought management skills and knowledge are low. • Build a longtitudinal data set (via survey or standing reference group) to obtain information required to avoid consultation fatigue. • Develop a personal climate change checklist to allow farmers to identify if climate chnage is affecting their entreprise (e.g. business plan, soil moisture, evaporation rates, changes to growing season).
GREATER ACCESS TO EDUCATION AND DIVERSITY AND STYLES OF LEARNING	• Regional based TAFE tertiary centres based in Nurioopta, Port Pirie, Point Pearce and Kadina. • Uni Hub Spencer Gulf centres located in Port Pirie and Kadina. • University of Adelaide campus located at Roseworthy offers agricultural science courses. • Many forms of informal and short-course education offered by regionally based and extra-regional organisations.	• Education is a key enabler of drought resilience. Liaise with primary, secondary and tertiary education sectors to increase knowledge of climate science, adaptation and transformation. • Incorporate resilience training models across the education sector through a train the trainer model. • Education extends beyond formal institutions. Upskill farmers, agricultural supply chain stakeholders and regional business owners through increased community engagement, social media and targeted workshops. • Accommodate for a diverse range of learning styles and inequitable digital access and literacy.	• Local agricultural R&D networks play a key role in providing relevant and trusted information through extension. Utilise these existing networks through providing direct funding for drought resilience initiatives, that extend beyond agricultural R&D. • Where feasible, facilitate partnerships with trusted agricultural organisations and education, health and financial organisations to deliver more holistic farm management and drought resilience training. • Develop a skillset approach to training that provides transferable skills for off-farm employment. • Integrate resilience training, knowledge of climate science, adaptation and transformation across primary, secondary and tertiary studies. • Utilise problem-based and inquiry-based experiential learning to better engage children and adults in transformative thinking and behaviour. • Liaise with SA Health and SAHMRI to develop models of resilience training for teachers and educators, through a train the trainer model. • Roll out pilot training in select trial locations, seek feedback, improve training based on feedback and deliver the improved model regionally. • Liaise and partner with other drought affected regions to create economies of scale training programs. • Increase climate projection information, including evidence and examples of past, current and planned future incremental, transitional, and transformational change to localised farming organisations through crop walks, demonstration trials, drought working groups, field days, workshops, conferences etc. • Seek to influence and partner with both state and regional agricultural bodies to design programs and information targeted at farmers. • Deliver information through a range of media, i.e., through direct engagement and delivery, social media, websites, paper-based information, informal conversations and demonstration sites. • Seek and access funding for drought specific research and development and extension.

“NORTHERN AND YORKE LANDSCAPE BOARD PROVIDES INDUSTRY AND FARMING SYSTEM GROUPS WITH SUPPORT, ADVICE, CAPACITY BUILDING AND HELP WITH FUNDING APPLICATIONS FOR SUSTAINABLE AGRICULTURE AND BIODIVERSITY IMPROVEMENT INITIATIVES IN THE REGION.”

THEME #4 KNOWLEDGE AND EDUCATION			
	CURRENT PROGRESS:	**PRIORITIES GOING FORWARD:**	**ACTIONS:**
ADOPTION OF PROVEN INTERNATIONAL, NATIONAL AND REGIONAL DROUGHT ADAPTATION AND TRANSFORMATION TECHNIQUES	• Agricultural productivity gains across the region demonstrate how advances in technology, genetics and management practices have already increased resilience to multiple farming stressors, including drought. • High adoption of no-till farming. • High adoption of containment feeding during dry times and drought. • Use of localised aquifer storage and recharge through the Clare Valley wine region. • Development of alternative water and reuse schemes, particularly through the Northern Adelaide Plains and Barossa.	• Incorporation of Aboriginal knowledge and perspectives into planning and decision-making processes to increase drought resilience • Build the capacity of Aboriginal controlled and operated organisations to be involved in sustainable project delivery across the long-term • Build more sustainable and realistic relationships with farmers and other stakeholders to change perspectives on land management • Develop partnerships with locations that have experienced conditions the Northern and Yorke Region will experience by 2030 • Develop information sharing partnerships with drought prone regions across the world (Israel, Saudi Arabia, Western USA, Southern Africa, Chile, Argentina).	• Ensure appropriate and meaningful engagement with Prescribed Body Corporates on funded projects. • Long-term funding in place to support positions. • Partner with indigenous groups to develop and deliver training and education of the increased use of drought resistant native vegetation, improved water management and the importance of wildlife corridors for animals. • Form information sharing partnership agreements with regional locations that have experience of drought transition, adaptation, and transformation. Target locations with greater experience and knowledge of drought. • Utilise these agreements to target funding towards gaps in research and utilise the partnerships to ensure data, stories and progress reports are shared between regions. For example, the WA Wheat Belt is experiencing conditions that the N&Y region are projected to experience in 2030. What can N&Y learn from the WA Wheat Belt in terms of adaptation and transformation? • Target further research and development of transformational systems and changes. Showcase transformational systems through demonstration trials.

8.5.4 Case study

The following case study relates to a disaster risk reduction and resilience program run by UNESCO.

CASE STUDY

UNESCO DISASTER RISK REDUCTION.

The United Nations Educational, Scientific and Cultural organisation (UNESCO) has developed a series of resources and targeted programs to assist children to better understand, prepare for and build resilience to natural disasters (UNESCO, 2018).

The key finding of the program is that the more eduction, the less risk of post disaster shock (UNESCO, 2018). If children are informed about, prepared for and know what to do in the event of a disaster and post disaster, resilience can be built through skills and knowledge.

As part of the educational program, UNESCO developed a technical guidance document for integrating disaster risk reduction in the school curriculum (UNESCO, 2018).

A separate program has been run through schools in regional South America. UNESCO is working with policy-makers, universities and young people to increase the resilience of educational institutions and local communities in at-risk regions (UNESCO, 2018).

The program has three pillars (UNESCO, 2018):

1. Support to regional, national and local authorities to lead and implement the Comprehensive School Safety Framework.
2. Strengthen the role of universities in risk management, reaching local and educational communities.
3. Facilitate activities led by girls, boys and young people that aim to reduce vulnerability and increase the resilience of educational institutions and local communities, underlining rights and protection principles.

8.6 Resilience Theme #5 – Research and Innovation

8.6.1 Overview

Research and innovation has long been at the heart of Australian agriculture. Over time, Australian farmers have altered practices, management decisions and adopted new technologies and genetics to improve productivity and profitability.

The need to invest in and continually improve over time is required, especially given the global, national and regional drivers of change, one of which is an increase in the severity, duration and frequency of drought.

There are limitations to productivity gains and adaptation in a scenario where rainfall is projected to reduce over time and evaporation is projected to increase (Hope, 2015). As such, there is a need to extend research and development beyond what is provided in the agriculture sphere and to integrate other research and development into agricultural systems and supply chains.

There is also a need to invest in research and innovation beyond farming systems, including increasing the value of a good or service produced in the region.

Research is also required at the regional scale to determine methods of increasing regional populations, increasing employment opportunities, housing stock and creating a critical number of people to support further development of health, aged care and child care services.

> **MORE SERVICES WHICH SUPPORT LANDHOLDERS TO CONFIDENTLY DIVERSIFY FROM RAINFALL DEPENDENT SYSTEMS TO OTHER MORE DROUGHT RESILIENT PRODUCTION SYSTEMS.**

8.6.2 Progress in the region

Research and innovation related to drought has primarily been through proven improvements in agricultural productivity, return on investment and profitability. Further advancements relate to efficiencies and making farmers lives easier.

ALL OF THE AFOREMENTIONED ARE CATEGORISED ACROSS THE FOLLOWING AREAS:

8.6.3 Regional partners

Research and Innovation partners are identified in Table 21.

	RESEARCH AND INNOVATION PARTNERS		KEY PLANS AND GUIDING DOCUMENTS
NATIONAL	Australian Centre for International Agricultural Research CRC for High Performance Soils CSIRO Bureau of Meteorology Fight Food Waste CRC Food Agility CRC Future Food Systems CRC	The University of Adelaide The University of South Australia Flinders University Carnegie Melon University	Australian Government – Future Drought Fun Australian Government - National Drought Policy Australian Government – The Water Act The Murray Darling Basin GRDC – Business planning guide for farmers recovering from drought NFF – A National Drought Policy
STATE	Department for Primary Industries and Regions SA Department for Premier and Cabinet Department for Environment and Water Wellbeing SA Department of Human Services SA Drought Resilience Adoption and Innovation Hub SA Local Government Association SA Water Primary Producers SA	Conservation Council of SA First Nations of SA Ag Excellence Alliance Ag Bureau of SA SA Nature Alliance Friends of Parks SA Landcare Association of SA Premier's Climate Change Council TAFE SA	South Australian Government – National Drought Policy SA Government – Water Industry Act 2012 SA Government – Water Security Statement SA Government – South Australian Guide for Drought Assistance GPSA – South Australian Guide for Drought Assistance PIRSA – Drought management and recovery booklet PIRSA – Business planning for farmers recovering from drought SA Drought Resilience Adoption and Innovation Hub – Node Co-design Workshops Report
REGIONAL	Regional Development Australia Yorke and Mid North Regional Development Australia Barossa Gawler Light Adelaide Plains Regional Development Australia Far North Legatus Group Northern and Yorke Landscape Management Board	SA Health – Local Health Networks SA Drought Innovation and Adoption Hub Social Service and Not for Profit Organisations Spencer Gulf Uni Hub	Local Government Emergency Management Framework The Northern and Yorke Regional Climate Adaptation Plan Northern and Yorke Landscapes Board – Annual Business Plan 2021/22
LOCAL	Local Government Community Incorporated Associations Indigenous Business Enterprises and Incorporations Business Associations Barossa Australia Barossa Improved Grazing Group	Clare Valley Wine and Grape Association Hart Field Day Site Mid North High Rainfall Group Northern Adelaide Plains Food Cluster Northern Sustainable Soils Regional Agricultural Bureaus Upper North Farming Systems	Barossa Water Security Strategy Barossa Water Allocation Plan Clare Valley Water Allocation Plan Clare Valley Water Supply Preliminary Business Case Barossa Valley Water Supply Business Case

Table 21. Research and Innovation partners

8.6.4 Progress in the region

Local, regional and state and nationally funded research and development occurs through trial and demonstration sites across the region. Research and innovation has traditionally been focused on:

- Education and skill development offered locally (workshops, events, field days, crop walks)
- Indirect education provided (web or paper based) - Fact Sheets, data, videos, podcasts, links to funding, other resources.
- Collaboration between multiple farming organisations.

Research, innovation and extension has taken the form of:

- Agronomic advances through:
  - > Improved soils and crop/animal nutrition.
  - > Improved crop and pasture protection.
  - > Water quality.
  - > Pest and disease management.
  - > Tillage practices and time of sowing (grain and break crops only).
- Business support/financial planning.
- Weather and/or soil moisture data.
- Farm planning support and training.
- Health, WHS and wellbeing.
- On-farm risk management.
- Helps farmers and communities respond to the impacts of drought
- Prepares farmers and communities for the Impacts of a changing climate

8.6.5 Key enabler categories

The following represent the key research and innovation enabler categories:

- Value-add – Research and innovation designed to increase the value of goods and services produced in the Northern and Yorke region.
- Inter-disciplinary and integrated research – Research and innovation that take a systems approach to improving outcomes, such as research options for an entire supply chain or seeks to incorporate efficiencies through the value-add process.

The research and innovation current progress, key enablers, priorities and actions are presented in Table 22.

THEME #5 RESEARCH AND INNOVATION			
	CURRENT PROGRESS:	**PRIORITIES GOING FORWARD:**	**ACTIONS:**
KEY ENABLERS: VALUE-ADD	• Particular areas, such as the Barossa Valley have successfully built on the wine region brand to create a range of businesses that value-add to agricultural commodities. • Paddock to plate enterprises. • Strong food and wine tourism has allowed for value-add processes.	• Maximise the spike in tourism to offer locally produced goods through bricks and mortar shops. • Investigate options for digital marketplaces and online sales of locally produced goods. • Increase variety of paddock to plate, farm tourism, stays and events. • Identify current assets and strengths and build upon these. • Develop a longitudinal data set to assess change in stakeholder drought resilience perspectives over time.	• Research successful industries and regions increasing the value of products and services in regional locations, within Australia and globally. • Fund a value-add opportunities report for the region based on this research and inter-regional research, establishing the key barriers and enablers to increasing economic diversity through value-adding and on-selling products both within the region, extra-regionally and online. • Invest in options for native Australian foods and support Aboriginal enterprises to develop this market. • Investigate options for solar farms and wind farms. • Ensure investment in local infrastructure supports value-add ventures. • Determine options for further diversifying tourism in the region. • Determine options for utilising the Regional Wellbeing Survey and other ABARES surveys to capture changes in perspectives over time.
TRANS-DISCIPLINARY AND INTEGRATED RESEARCH	• Unknown	• Research options for creating efficiencies across supply chains, considering the needs of global customers. • Investigate options for manufacturing of agricultural goods produced locally. • Build off the momentum of state government space, defence, hi-tech and digital foci. • Examine the role that education can play in creating resilience across key regional industries. • Determine the in-region educational programs that can seek to further diversify the regional economy.	• Determine the global mega-drivers of change. • Establish partnerships between the region and local and interstate manufacturing and agtech communities. • Seek to develop an MOU or equivalent partnership with Lot14 and emerging industries for opportunities for the region. • Develop a technology specific regional development strategy to identify potential partnerships and opportunities for improvement. • Engage the education sector in design-thinking programs to assist in improving economic diversity through integrating a range of industry sectors.

Table 22. Research and Innovation current progress, key enablers, priorities and actions

Case study

TOTALLY RENEWABLE YACKANDANDAH.

Yackandanah is located in Victoria, 27 kilometres south of the Victorian and New South Wales border (Google maps, 2022). In 2014, a community group formed with the goal of establishing a microgrid powered by 100% renewable energy (Totally Renewable Yackandandah, 2021).

Microgrids are small, localised networks that share energy from interconnected small-scale technologies like solar and batteries with small communities (Australian Renewable Energy Agency, 2021).

As well as improving energy independence for isolated populations, they offer a way to accelerate the shift to locally-deployed renewable energy (Australian Renewable Energy Agency, 2021).

While microgrids are not new, the falling cost of solar, batteries and energy management technology is making them a viable option for more regions that struggle with expensive, polluting and unreliable electricity supplies (Australian Renewable Energy Agency, 2021).

In Yackandandah a combination of rooftop solar PV panels and battery storage systems have been utilised to capture and store solar energy.

All told, Totally Renewable Yackandandah has developed three functioning microgrids, a 10-building virtual power plant made of solar and behind-the-meter battery storage, and driven the uptake of rooftop solar on 60% of buildings in the Yack valley.

HOW DOES SOURCING RENEWABLE ENERGY ASSIST IN BUILDING DROUGHT RESILIENCE?

- Drought places financial strain on individuals, organisations and businesses. Independent energy allows communities to reduce the ongoing costs of electricity. This reduces the costs of living and allows for money to be spent on other goods and services throughout the community.
- The Northern and Yorke region has an abundance of sun filled days. Why not take advantage of this? Utilising and capturing solar energy, can help businesses, families and individuals to reduce the cost of living.
- Microgrids are dependable, not reliant on centralized networks like the National Electricity Market. In the event of a state shortfall in electricity, microgrids can provide an alternative energy source.
- Microgrids increase resilience to natural disasters, such as bushfires. During times when communities may be cut-off from the "outside world", microgrids allow for key services to continue.
- Community owned microgrids, not only reduce power bills but can be used to earn income. This income can be used for other public good measures.

In the case of Yackandandah, the community saw many reasons to develop a community owned microgrid.

$160 MILLION

"LEAVES OUR REGION EVERY YEAR IN ELECTRICITY BILLS. IT'S HARD TO KNOW WHAT A POST-COVID PHASE WILL LOOK LIKE, BUT IF WE CAN START KEEPING THAT IN OUR COMMUNITY, IT GOES TO LOCAL JOBS AND INVESTMENT, AND UPSKILLING. IT'S A CIRCULAR ECONOMY. WE'VE CREATED AN ENVIRONMENT NOW WHERE THESE PROJECTS CAN GET UP."

CAM KLOSE, TOTALLY RENEWABLE YACKANDANDAH (PATAGONIA, 2020)

9. PLAN IMPLEMENTATION FRAMEWORK.

The successful implementation of the Plan will be founded on continued partnership across the Northern and Yorke Regional Alliance stakeholders and building the drought resilience capacity of community groups, local businesses, industry groups and farm management boards in the region.

This Plan identifies a number of potential stakeholders to deliver on the five priority themes of: Resilient Farming Enterprises, Resilient Industry, Resilient Communities, Knowledge and Education and Research and Innovation. However, there is no limit to the community stakeholders who may be involved in resilience actions and the Alliance encourages all sectors of the community to engage in the Plan implementation. The Regional Alliance is committed to both:

- Integrating these plan priorities within relevant stakeholder planning frameworks to ensure that drought risk is assessed and considered across social, economic and environmental planning for the region; and
- Supporting grass-roots capacity of local industry and community groups in the region in drought resilience project identification, grant proposals and project management.

The NYRDP Steering Committee will steer Plan finalisation and awareness raising of the Plan, in accordance with the Commonwealth funding agreement, up until December 2022. Plan implementation monitoring and longer-term evaluation will be undertaken through the Northern and Yorke Alliance partners.

The Plan Implementation Framework is shown in Figure 25.

GOVERNANCE.

Ongoing governance of the Plan will be administered via the Northern and Yorke Alliance (the Alliance) as a standing agenda item (alongside Climate Change Sector Agreement).

Each Alliance member is an incorporated regional based organisation that works with local government, businesses, community groups and other organisations across the region.

The Alliance seeks to drive better outcomes for local communities through better land management, governance and administration, and regional development activities that grow the capacity of the region and the quality of life for people living and working in the Norther and Yorke region.

The processes and administrative arrangements for the Alliance are set out in the Terms of Reference for the Alliance administered by each of the Alliance members in rotation.

Implementation

The implementation of the Plan will be managed at a sub-regional level by Alliance members as part of their business-as-usual activities (including their strategic and business planning activities), working closely with local farm and supply chain businesses, communities and stakeholders on the ground to deliver the priority actions needed to build drought resilience.

The importance of regional partners and stakeholders in implementing the Plan

To ensure the Plan achieves its purpose in building drought resilience throughout the region, it is critical that regional partners continue to own the Plan beyond the co-design phase, and work collaboratively in implementing the Plan.

This requires regional partners (farm businesses, supply chain businesses, local communities, local government) and other stakeholders to understand the Plan, have a sense of ownership of it, and possess the knowledge, skills and resources to delivery priority actions and learn from experience as they go.

Regional partners' role(s) in implementing the Plan

Regional partners are those actors 'on the ground' in the region who are undertaking the day-to-day activities impacted by drought conditions, as well as those activities that can best build drought resilience.

Key roles to be played by regional stakeholders in implementing and maintaining the Plan include:

- Drawing on the Plan as an input to other planning activities to ensure priority actions are incorporated into their wider activities.
- Delivering projects and initiatives that align with the priority actions identified in the Plan- these forming the adoption pathways through which material changes to operations, practices and decision making occur which then improve drought resilience.
- Engaging with Alliance members to learn about drought resilience activities being planned or underway elsewhere, and other forms of new knowledge to help refine and inform drought resilience activities locally. This adaptive learning process will enable lessons to be incorporated into future planning and prioritisation activities to make subsequent drought resilience activities more impactful and effective.

Benefits to regional partners

- (Where the Plan is implemented successfully) reduced exposure to the negative impacts of drought, leading to:
  - > Avoided losses to production (sales) and higher inputs costs which lead to corresponding financial hardships.
  - > Avoided environmental losses and damages through better management of natural environments and water resources
  - > Avoided losses to social capital, cultural connectivity and community cohesion through better management of the connections that bind these communities of interest, and better management of the physical environments that play a role in enabling these communities to come together and undertake culturally significant activities.
- Access to funding opportunities via the Future Drought Fund to deliver projects that enhance drought resilience – projects that will contribute towards other positive outcomes including stronger profitability within businesses, better risk management (and reduced financial exposure), and better quality amenities for regional communities.

Empowering regional partners to own the Plan

The co-design process by which the Plan has been developed does not end with the publication of a document. Rather, regional partners are being empowered to own the Plan going forwards, working to implement and refine priority actions as progress is made on different aspects of drought resilience, new information and funding becomes available and circumstances change in the Plan region.

Key to ongoing ownership and maintenance of the Plan by regional partners will be an adaptive learning process whereby learnings from the implementation of the Plan (and delivery of priority actions across the Plan region) and drought resilience activities more broadly are shared with regional partners to help them adapt their approach to building drought resilience as knowledge grows and circumstances change.

This adaptive learning process will be facilitated by Alliance members as part of the ongoing governance of the Plan.

Activities that will be undertaken by Alliance members in enabling activities by stakeholders in implementing the NYRDRP will include:

- Promoting the NYRDRP to regional partners and other stakeholders to encourage them to incorporate/reflect on priority actions when undertaking their strategic and business planning;
- Encouraging regional partners and stakeholders to engage with Future Drought Fund programs to support the delivery of priority actions from the NYRDRP;
- Monitoring regional partners and stakeholders' strategic planning and project delivery activities to identify whereas activities align with relevant NYRDRP priority actions;
- Engaging with regional partners and stakeholders to understand learnings from resilience activities being undertaken in sub region, and where priorities may be changing;
- Identifying and incorporating new data and information relating to scenario forecasting into the MEL Framework process and information sharing with regional partners and stakeholders to ensure decision makers and partners have access to current data and information, to aid in decision making around drought resilience activities;
- Engaging with stakeholders (both in-region and from relevant communities of practice) to share new knowledge and insights to building resilience to drought and in delivering priority activities addressed in the NYRDRP, to enable adaptive learning to occur, and;
- Reprioritising the priority actions for the sub-region annually, using the MCA developed by Edge Environment, updated to reflect new priorities or redundant actions for omission.

IDENTIFYING AND INCORPORATING NEW DATA AND INFORMATION

Notional allocations of responsibility for each of the sub-regions are as follows:

> Upper North and East - Legatus

> Mid North - RDAYMN

> Yorke Peninsula - NYLB

> Plains and Ranges - RDABGLAP

Activities being undertaken or planned at the regional level, or by Alliance members, will be monitored through the Alliance. New information, in terms of research, knowledge or funding opportunities, are also be to shared between Alliance members to enable this information to be shared with the relevant sub-region.

Engagement with regional partners (as referenced in chapter 8 of the Plan) identified at the national, state and regional levels will occur through the Alliance; engagement with regional partners will occur via the relevant Alliance member responsible for that sub-region.

Alongside these core delivery and implementation actities, the Alliance will oversee an ongoing monitoring, evaluation and learning (MEL) framework to ensure adaptive learning informs the maintenance of the Plan going forwards.

MONITORING, EVALUATION AND LEARNING (MEL) FRAMEWORK

Progress made against the NYRDRP, changes to priority actions under the NYRDRP, and insights and learnings obtained through the MEL framework are to be captured and documented in the form of Table 24 below.

A summary of the insights obtained through the MEL framework will be published through the Alliance annually to inform and enable the adaptive learning process, and aid in the dissemination of new insights and learnings.

This information should form a key input to the annual reprioritisation of the priority action list at the sub-regional level.

Future updates of the plans will develop multiple plausible scenarios with active stakeholder participation to consider how intervertion options develop over time, considering shocks and drivers of regional change and drought and other stresses.

NYRDRP MEL TEMPLATE.

The proposed template for implementing the MEL framework is featured below at Table 24. This template includes a live example in Legatus' Northern and Yorke Community Continuity Planning for Disasters project for illustrative purposes.

VISION

A FUTURE WHERE, DESPITE THE ENDURING AND INCREASING RISKS ASSOCIATED WITH DROUGHT, CLIMATE CHANGE AND ASSOCIATED SHIFTS IN RAINFALL AND MOISTURE AVAILABILITY, COMMUNITIES IN THE NORTHERN AND YORKE REGION ARE ABLE TO WITHSTAND THE ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF DROUGHT IN ORDER TO FLOURISH AND PROSPER.

STAKEHOLDER	ACTIVITY	ALIGNMENT	THEORY OF CHANGE	INDICATOR(S)	IMPACT(S)	LEARNINGS
Entity undertaking activity	(Planning, project or core/BAU activities being undertaken pertaining to drought resilience and related issues)	(Alignment of the activity against domain(s) of resilience (economic, environmental and social) specific NYRDRP themes, enablers and priority actions)	What risks(s) are being addressed through what mechanism(s) to improve which domain(s) of resilience)	(Measures of outcomes being achieved in respect of those objectives being pursued, defined in reference to impacts identified in chapter 3 of the Plan)	(Observed outcomes in respect of those indicators)	(Success and detracting factors observed; new knowledge created; lessons taken from activity; opportunities to share these learnings)
Legatus	Northern and Yorke Community Continuity Planning for Disasters	Domain: Social resilience Theme: Resilient Communities Enabler: Health and Wellbeing	Improving community members' awareness of risks to mental wellbeing, and the services available, will provide them with a better understanding of risk factors and opportunities for managing risks. This improved awareness will increase utilisation of services, producing better mental health outcomes which in turn remove a barrier to participation	• Quality of mental health outcomes • Prevalence of health conditions and co-morbidities • Incidence of suicide • Rates of volunteering within the community	[To be measured during and post implementation]	[To be captured during and post implementation]

Table 24: An example of NYRDRP Activities, Monitoring, Evaluation and Learning Framework

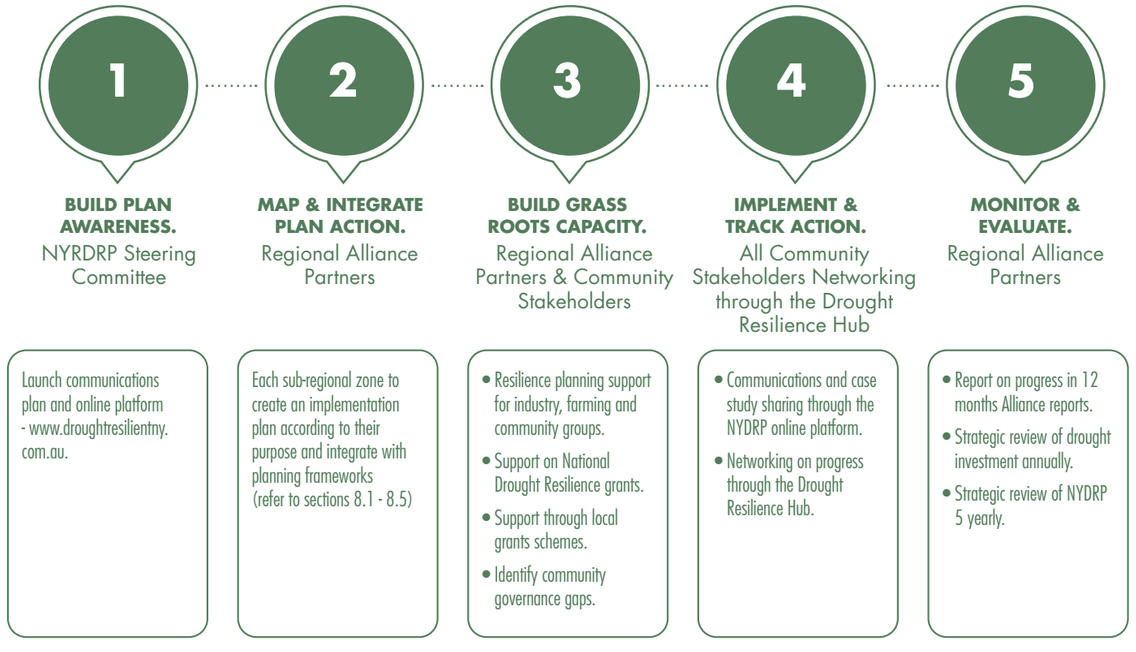


Figure 25. The Northern and Yorke Regional Drought Resilience Plan implementation framework

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APPENDIX A: CLIMATE ANALOGUES.

Identification of areas that experience similar climatic conditions, but which may be separated in space or time (i.e. with past or future climates) can be helpful when starting to consider adaptation strategies to a changing climate. Locating areas where the current climate is similar to the projected future climate of a place of interest is a simple method for visualising and communicating the impact of projected changes.

Clare

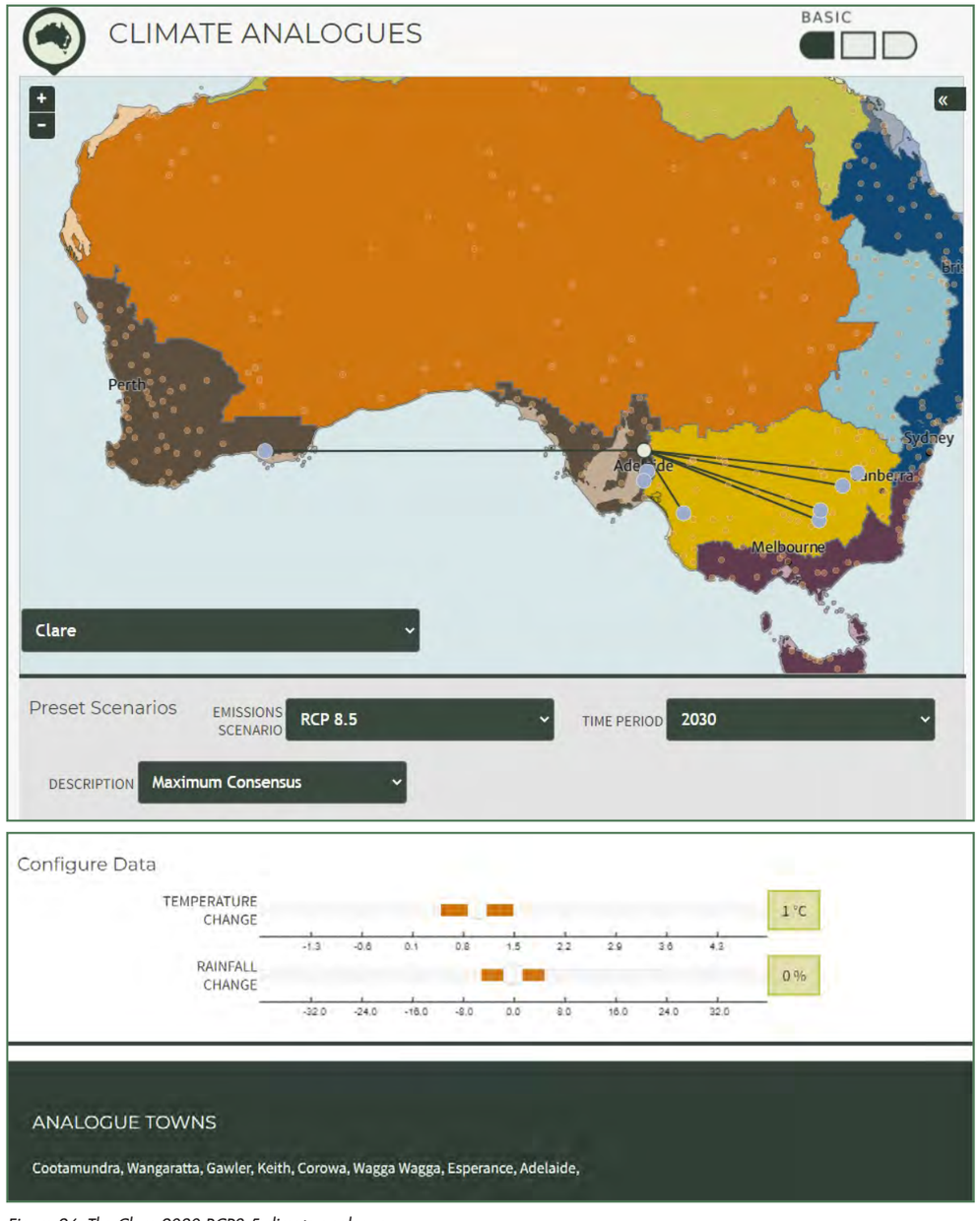


Figure 26. The Clare 2030 RCP8.5 climate analogue

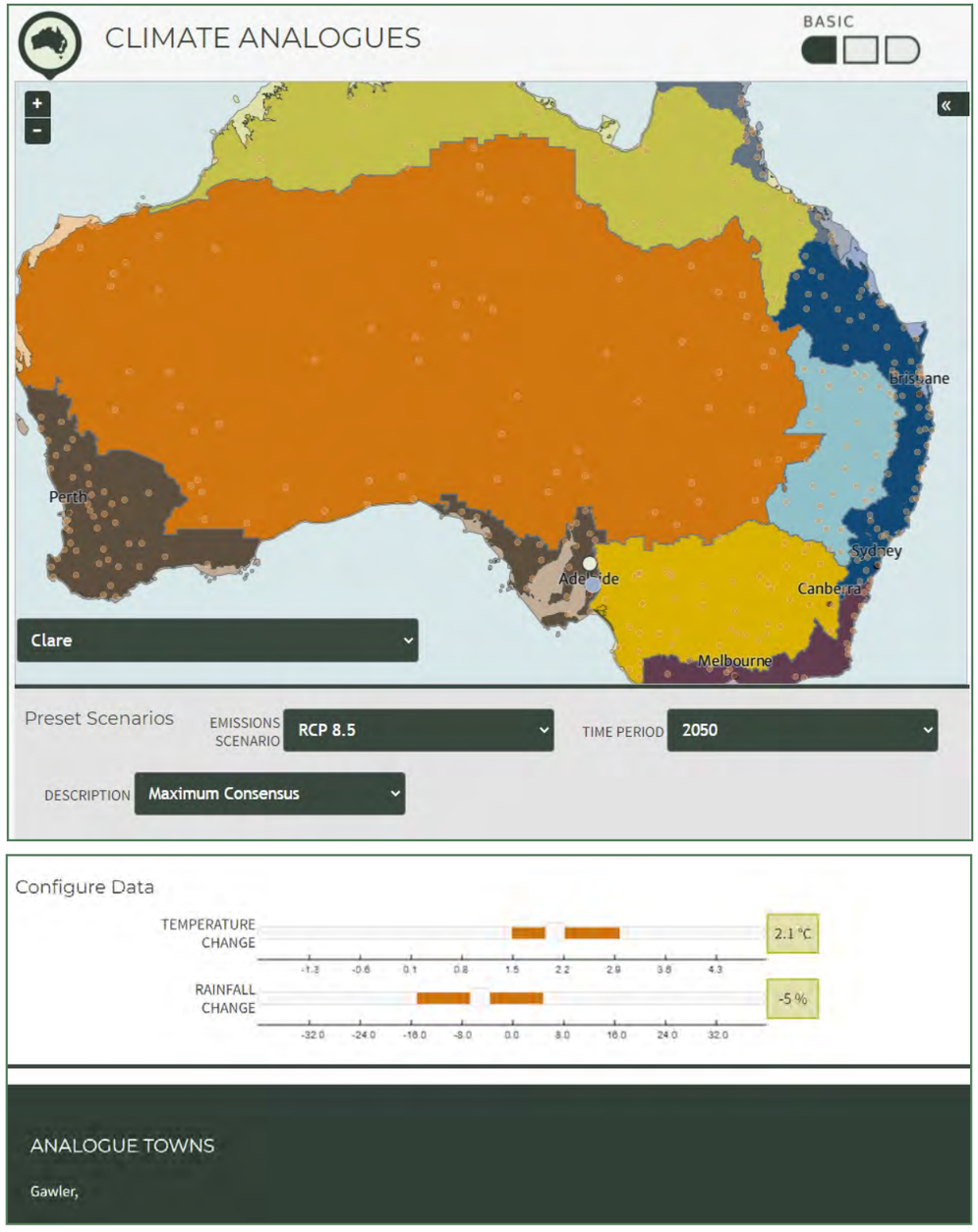


Figure 27. The Clare 2050 RCP8.5 climate analogues scenario

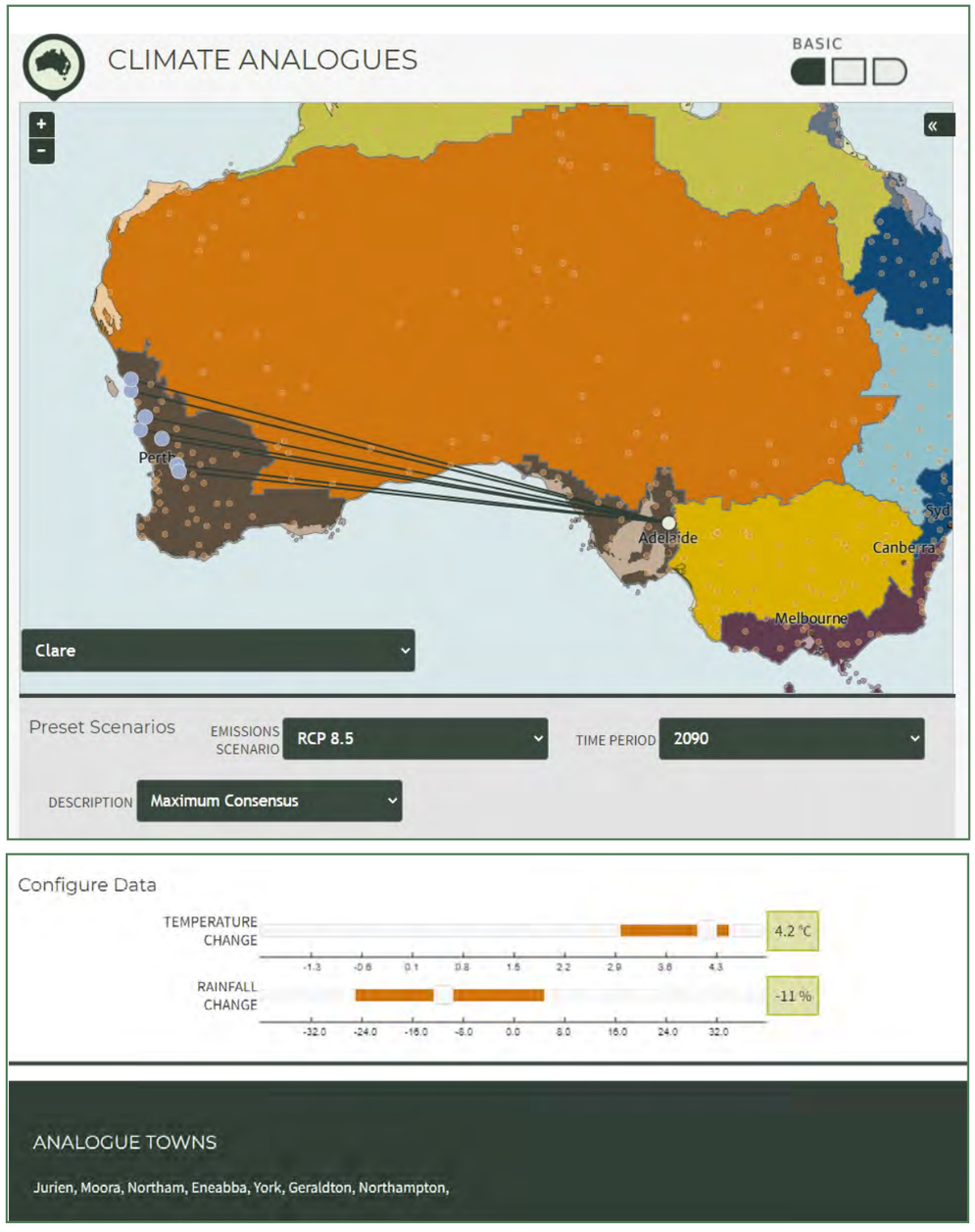


Figure 28. The Clare 2090 RCP8.5 Climate analogue

Kadina

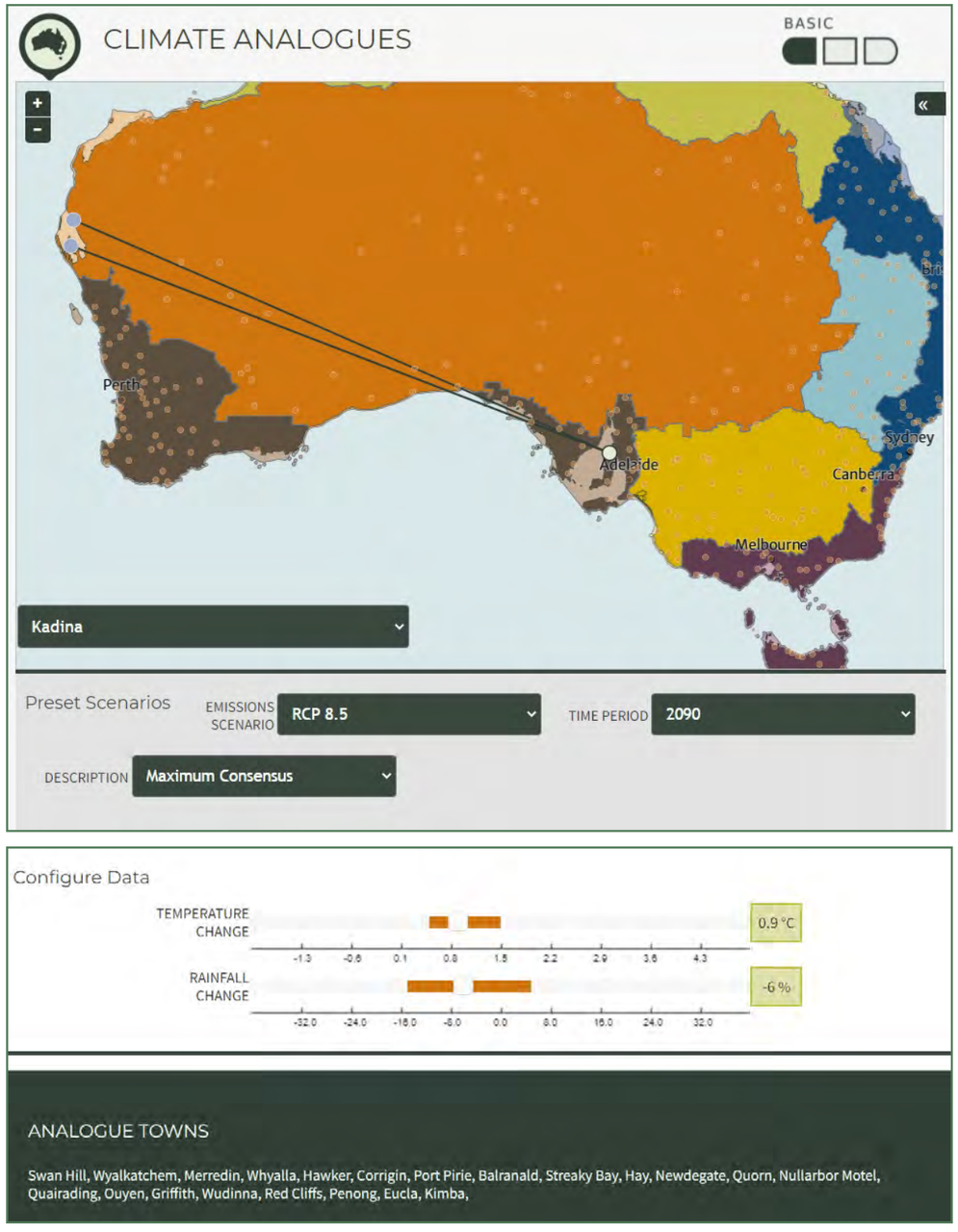


Figure 29. The Kadina 2030 RCP8.5 Climate analogue

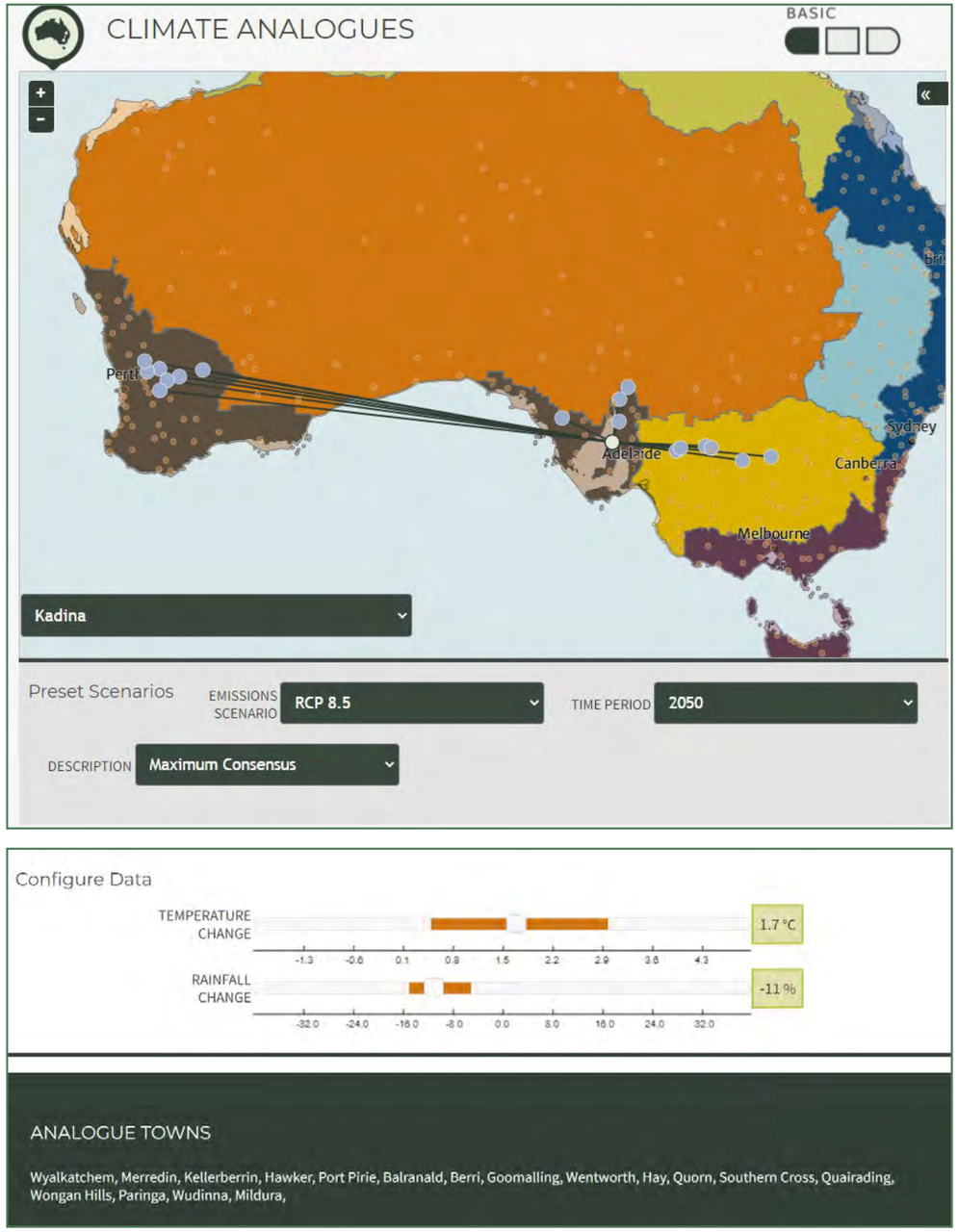


Figure 30. The Kadina 2050 RCP8.5 Climate analogue

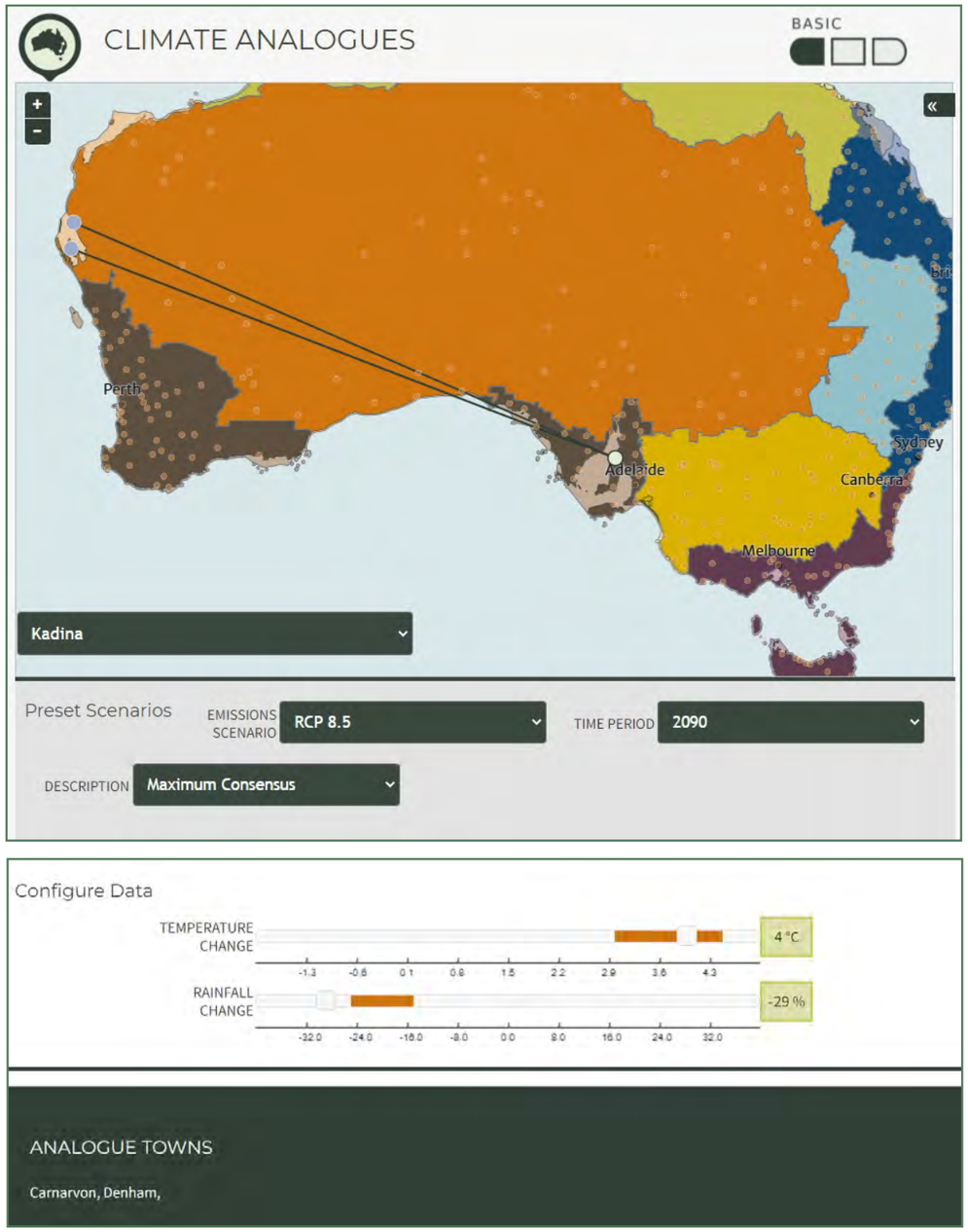


Figure 31. The Kadina 2090 RCP8.5 climate analogue

Nuriootpa

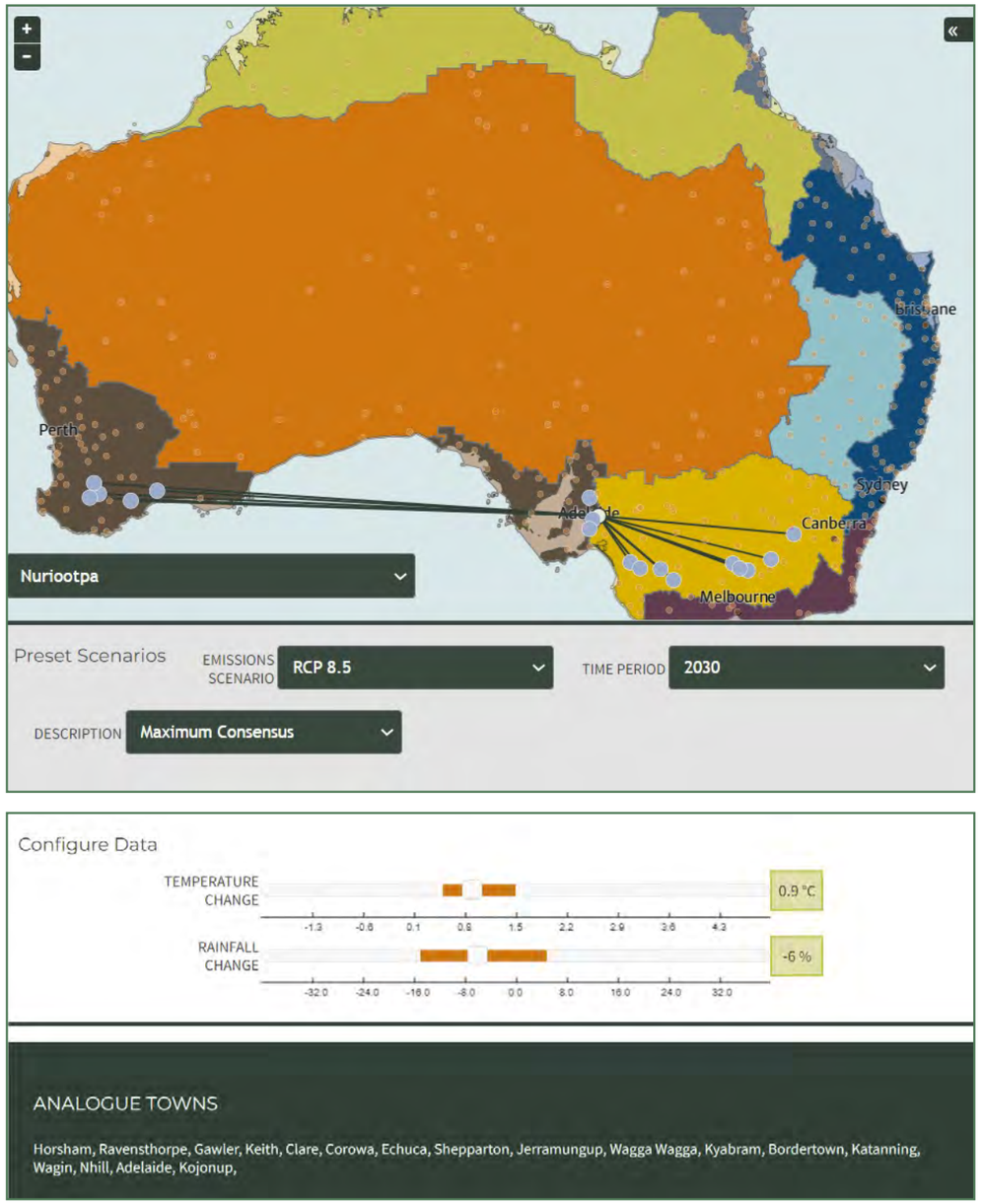


Figure 32. The Nuriootpa 2030 RCP8.5 Climate Analogue

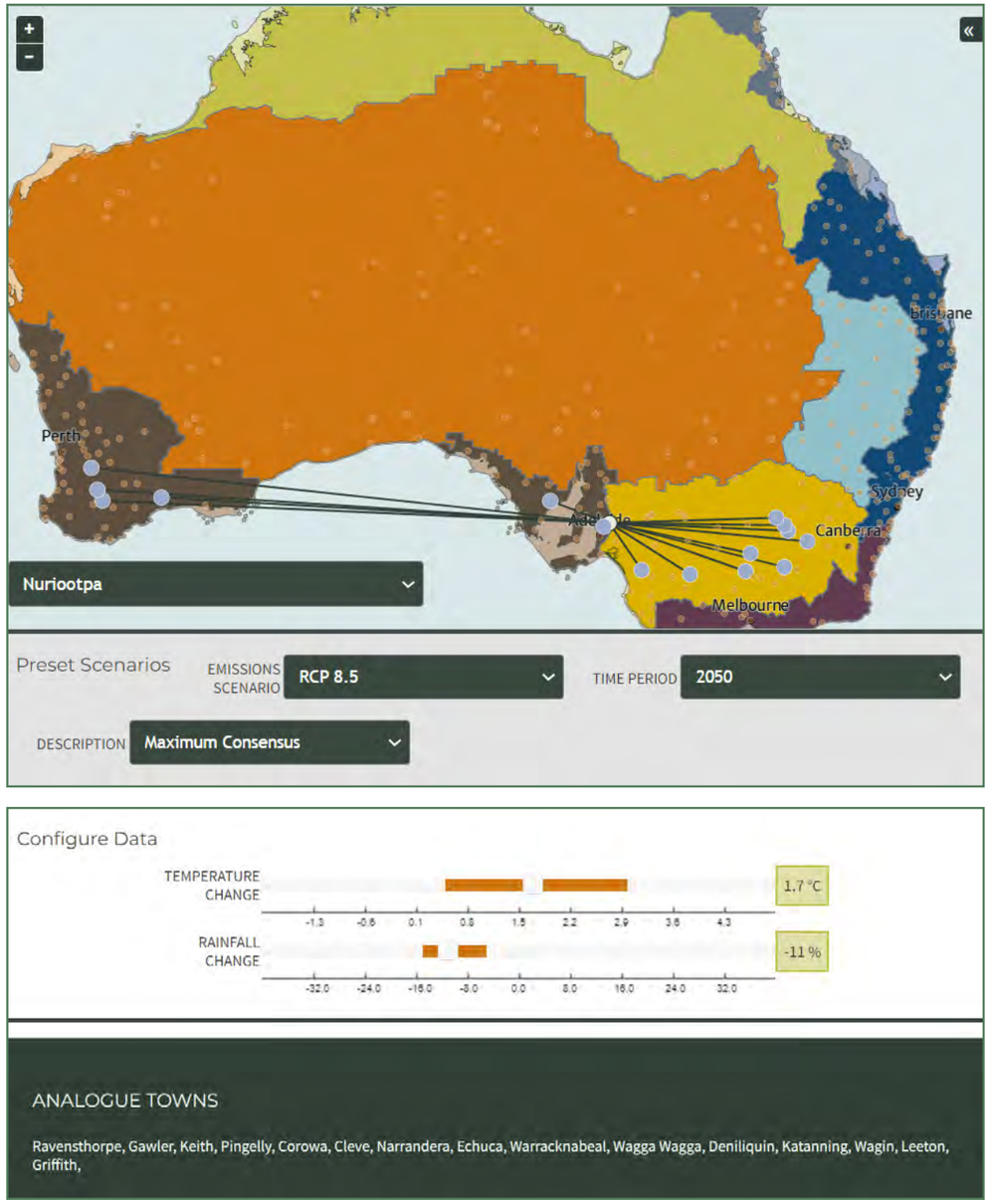


Figure 33. The Nuriootpa 2050 RCP8.5 Climate Analogue

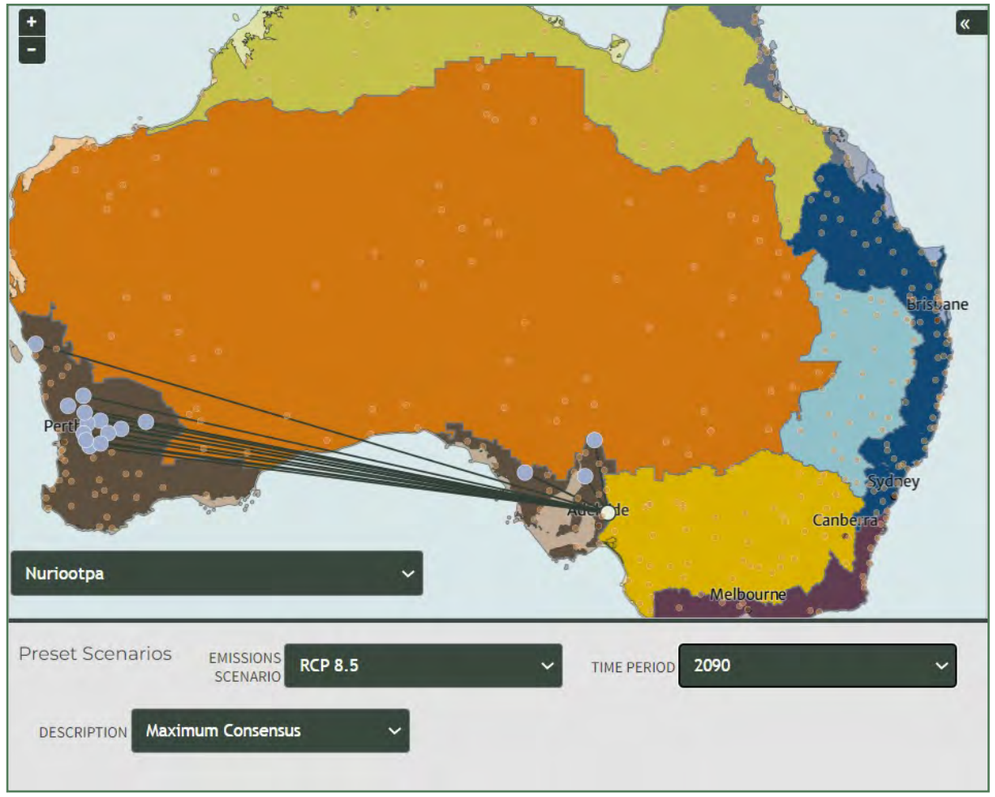


Figure 34. The Nuriootpa 2090 RCP8.5 Climate Analogue

Orroroo

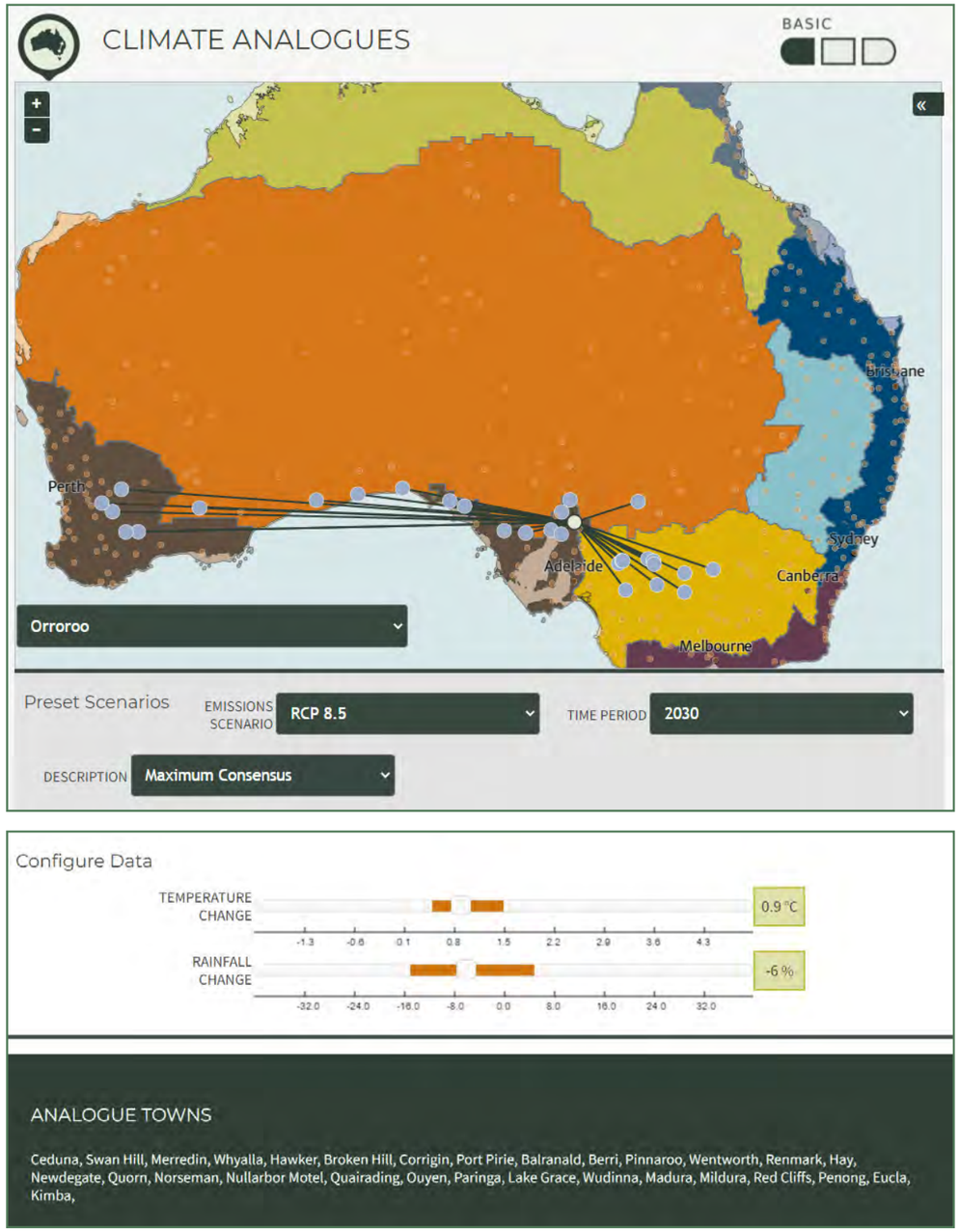


Figure 35. The Orroroo 2030 RCP8.5 Climate Analogue

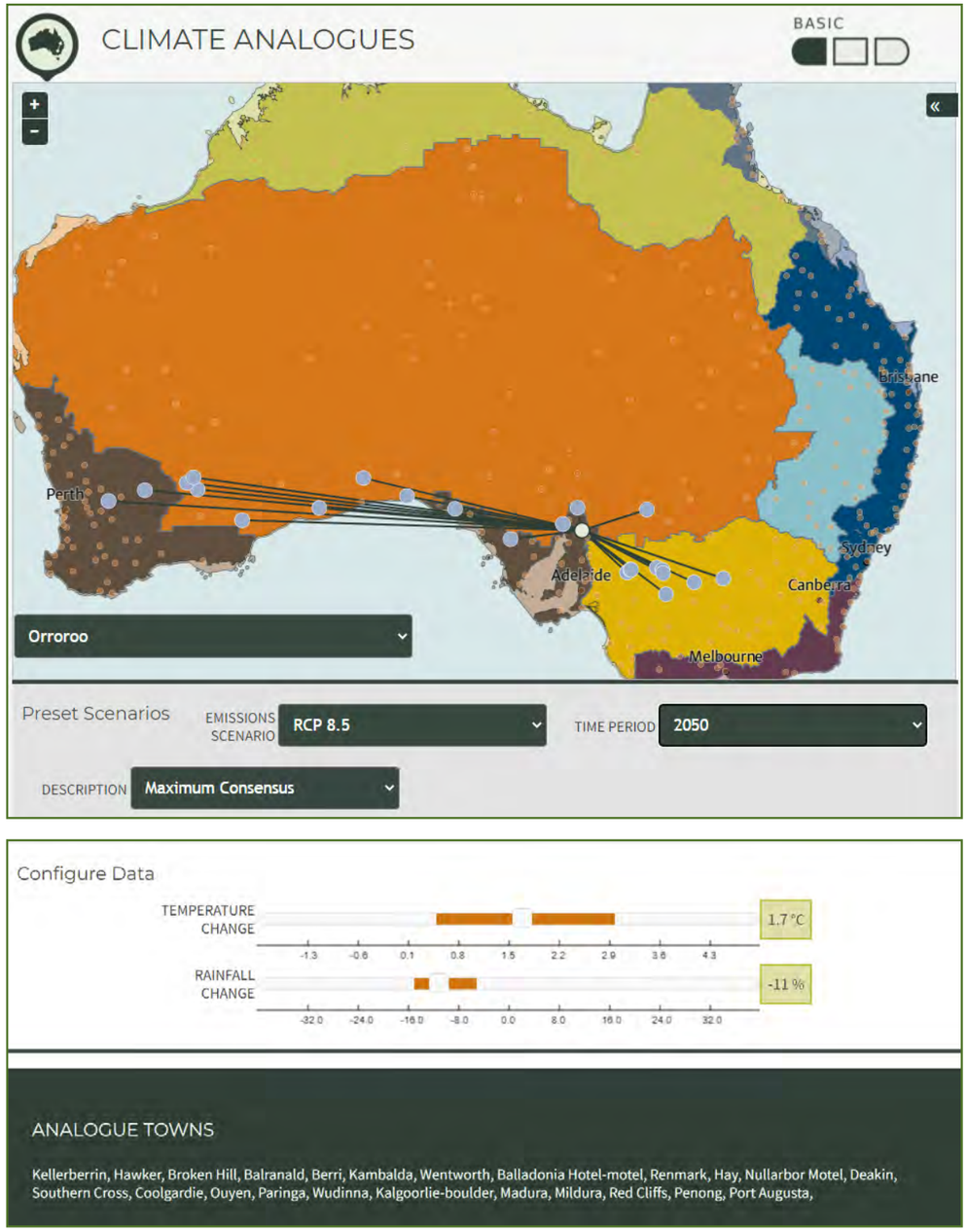


Figure 36. The Orroroo 2050 RCP8.5 climate analogue

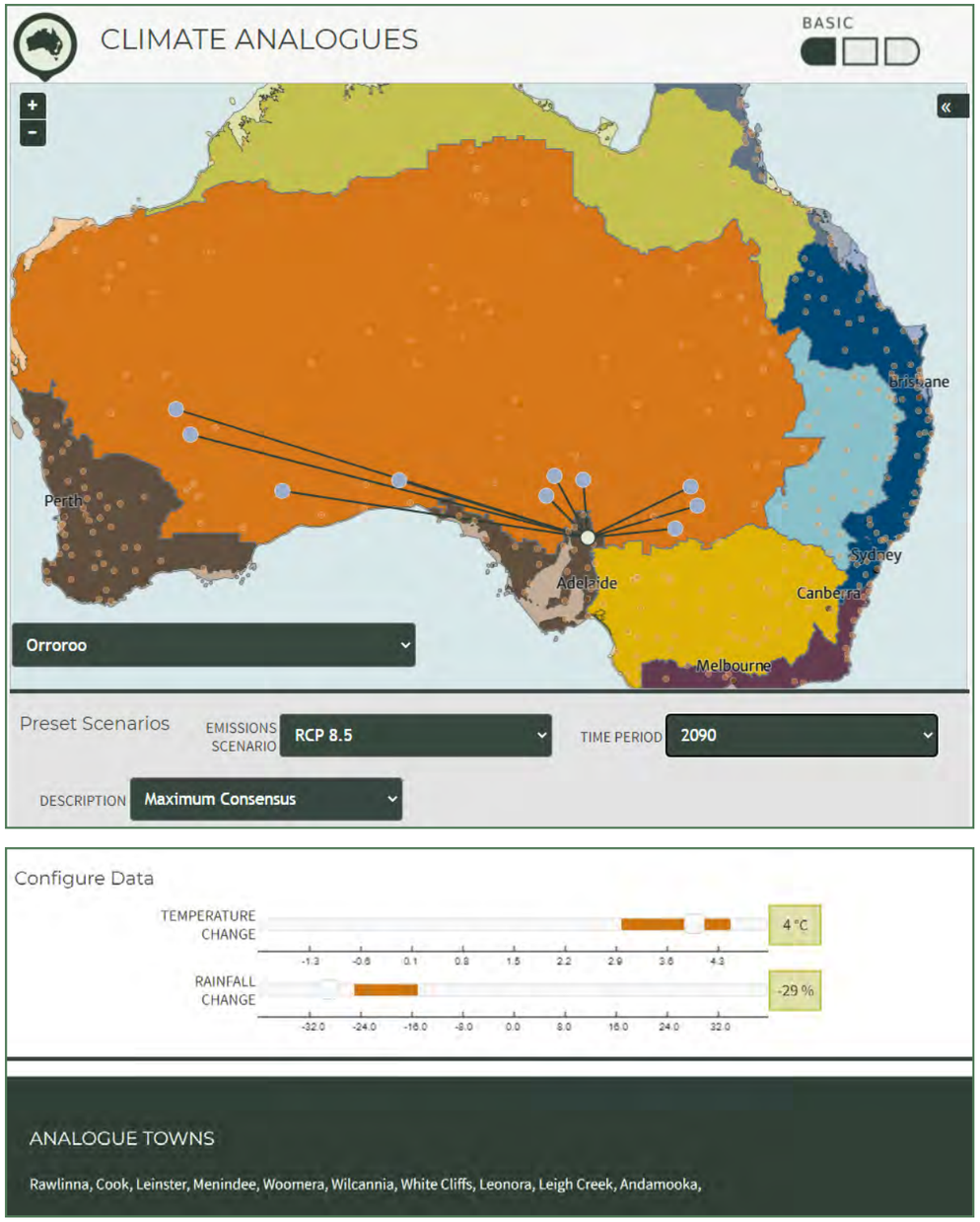


Figure 37. The Orroroo 2090 RCP8.5 climate analogue

Port Pirie

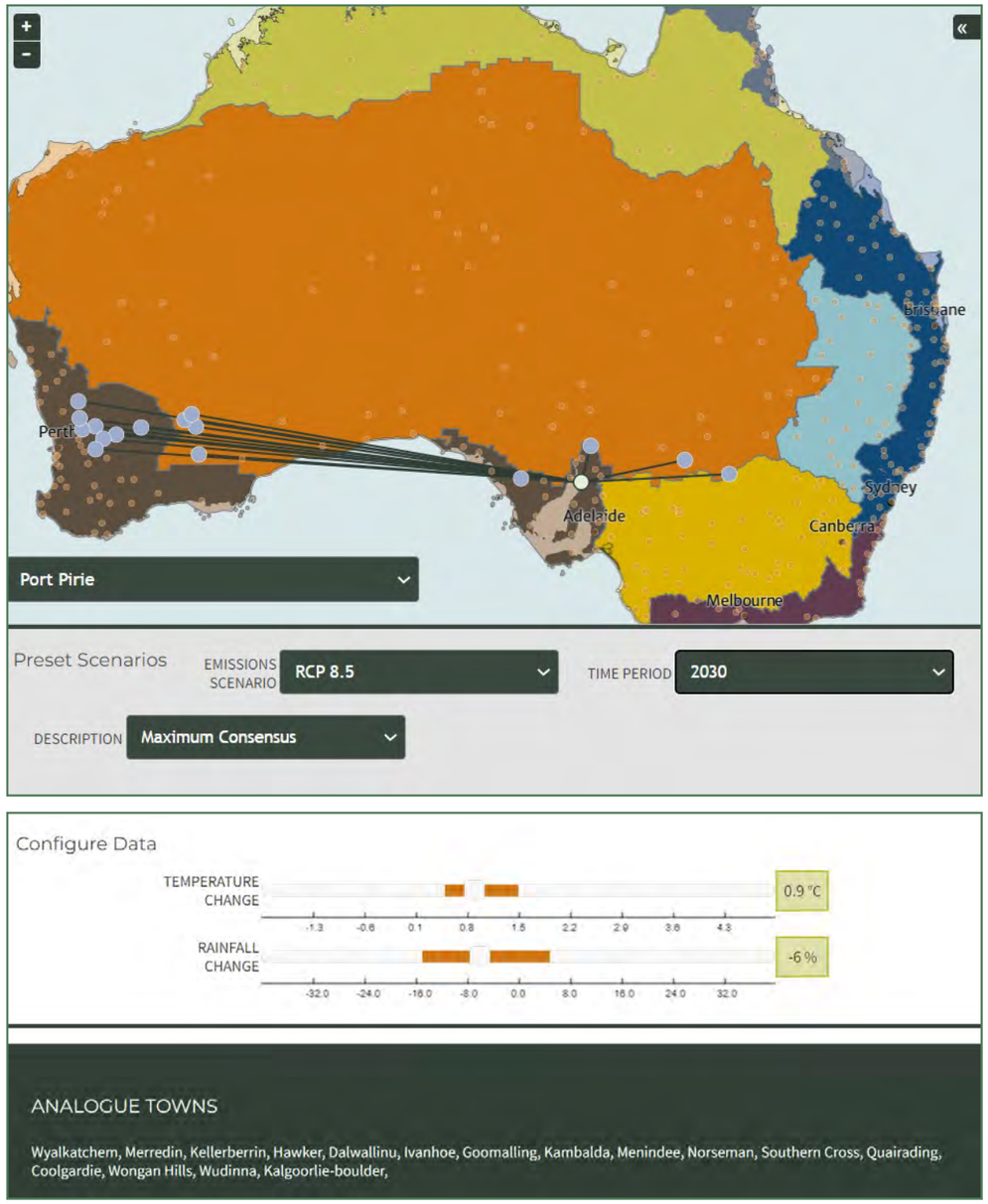


Figure 38. The Port Pirie 2030 RCP8.5 Climate Analogue

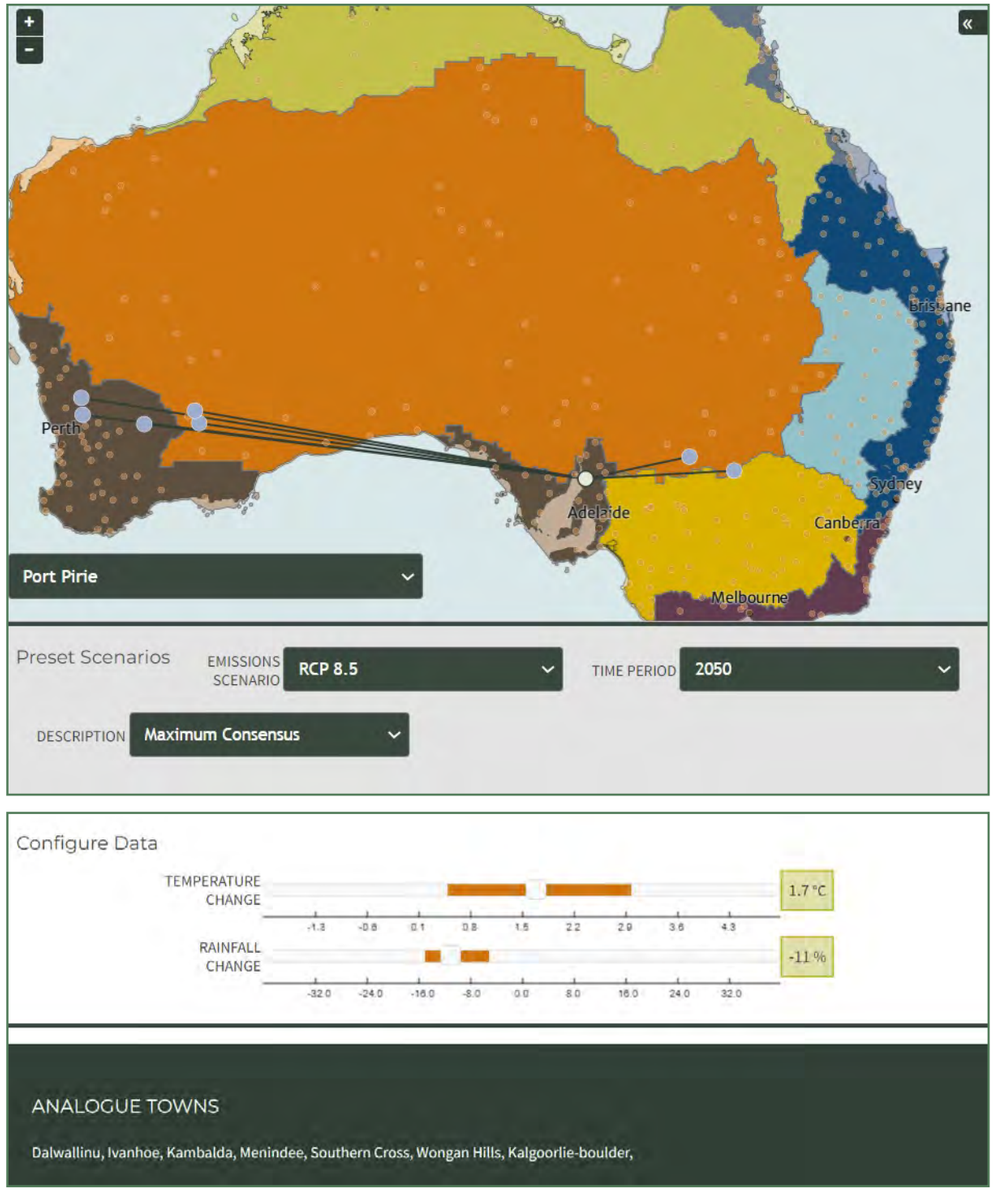


Figure 39. The Port Pirie 2050 RCP8.5 Climate Analogue

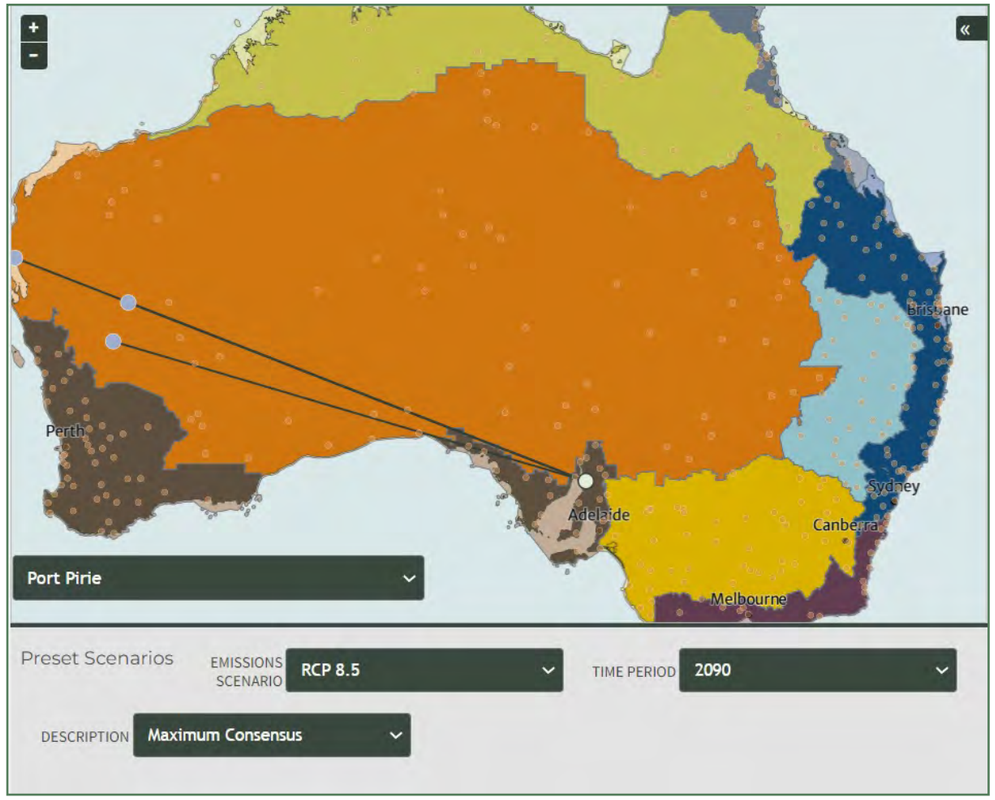


Figure 40. The Port Pirie RCP8.5 2090 Climate Analogue

Quorn

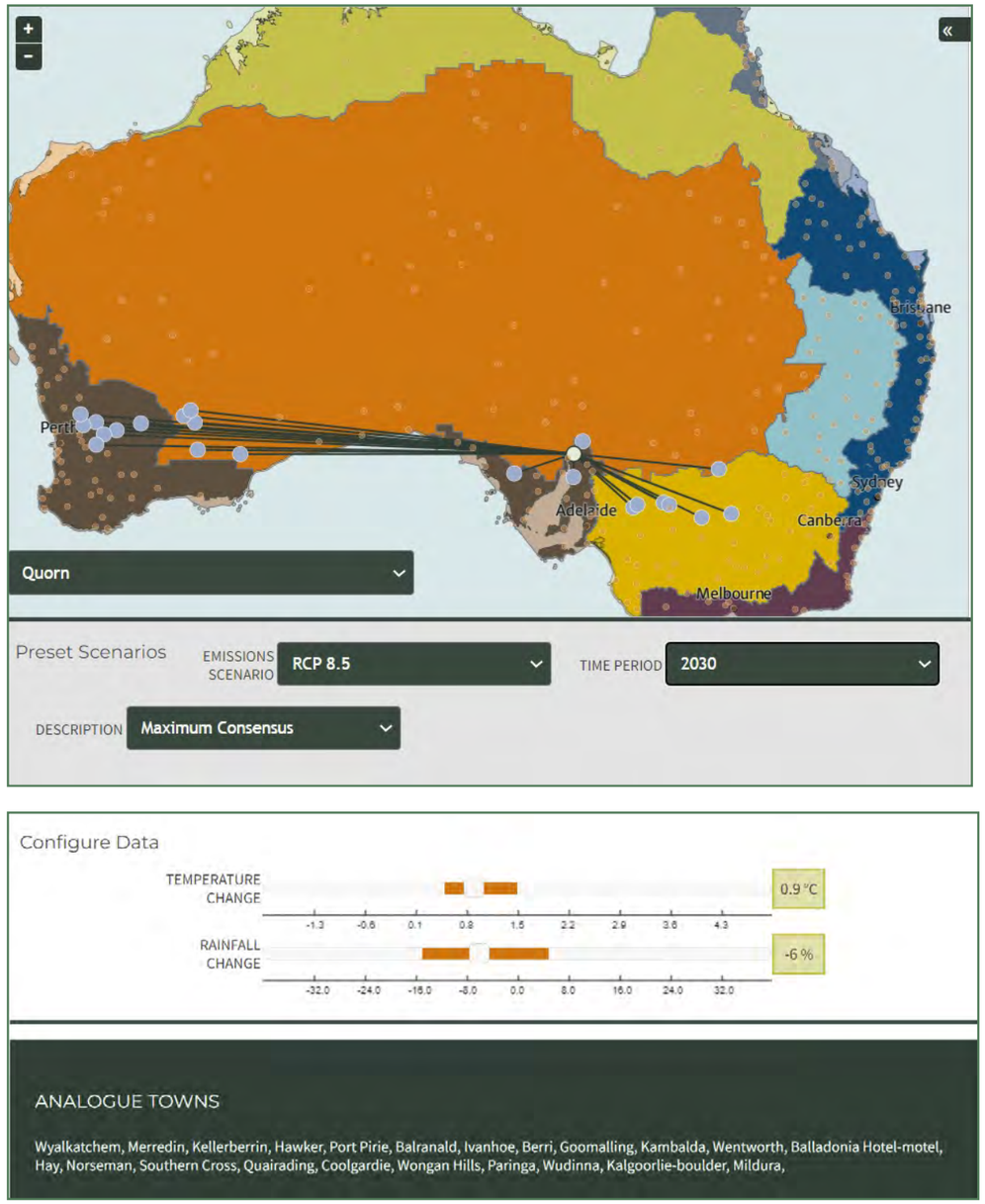


Figure 41. The Quorn 2030 RCP8.5 Climate Analogue

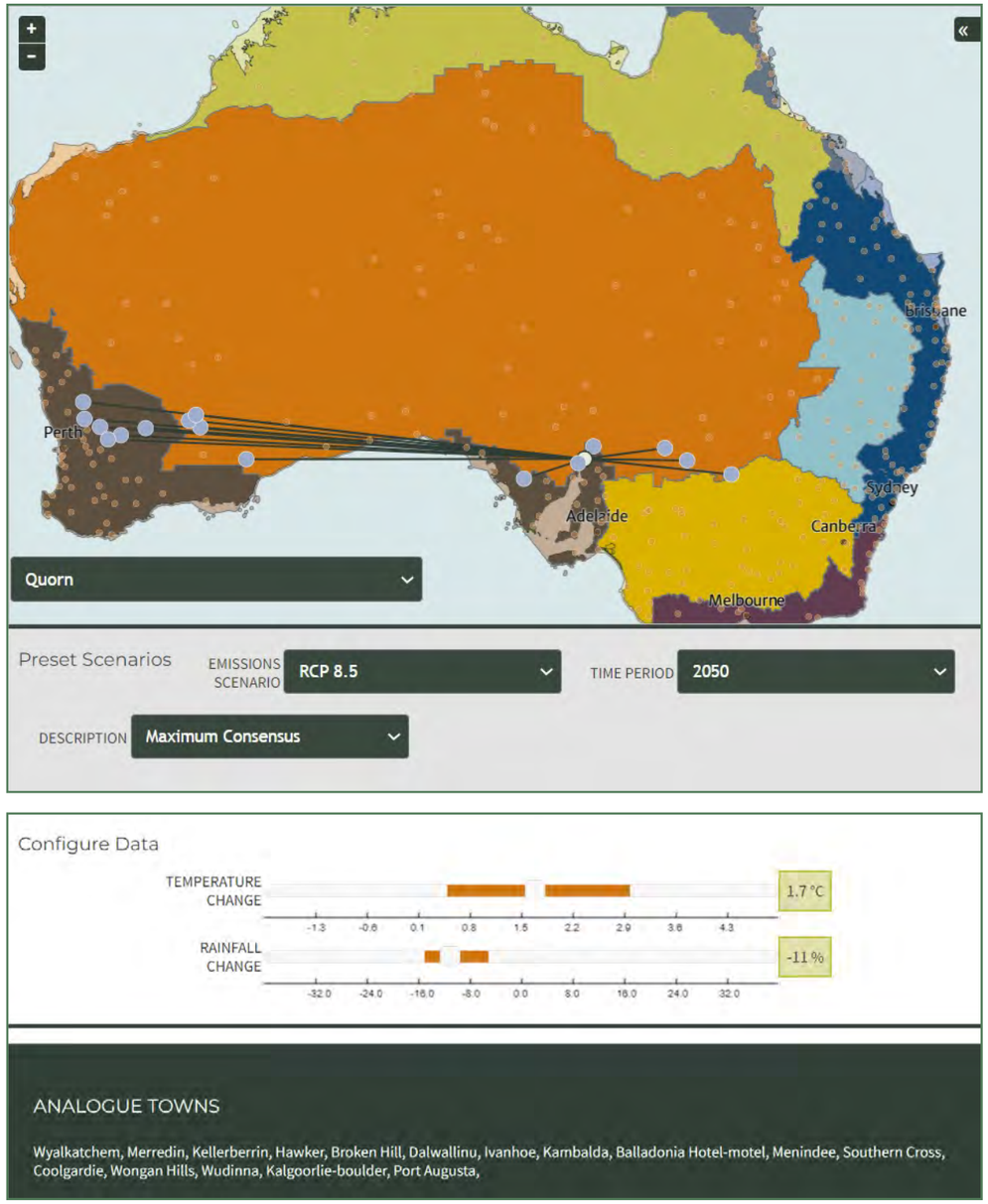


Figure 42. The Quote 2050 RCP8.5 Climate Analogue

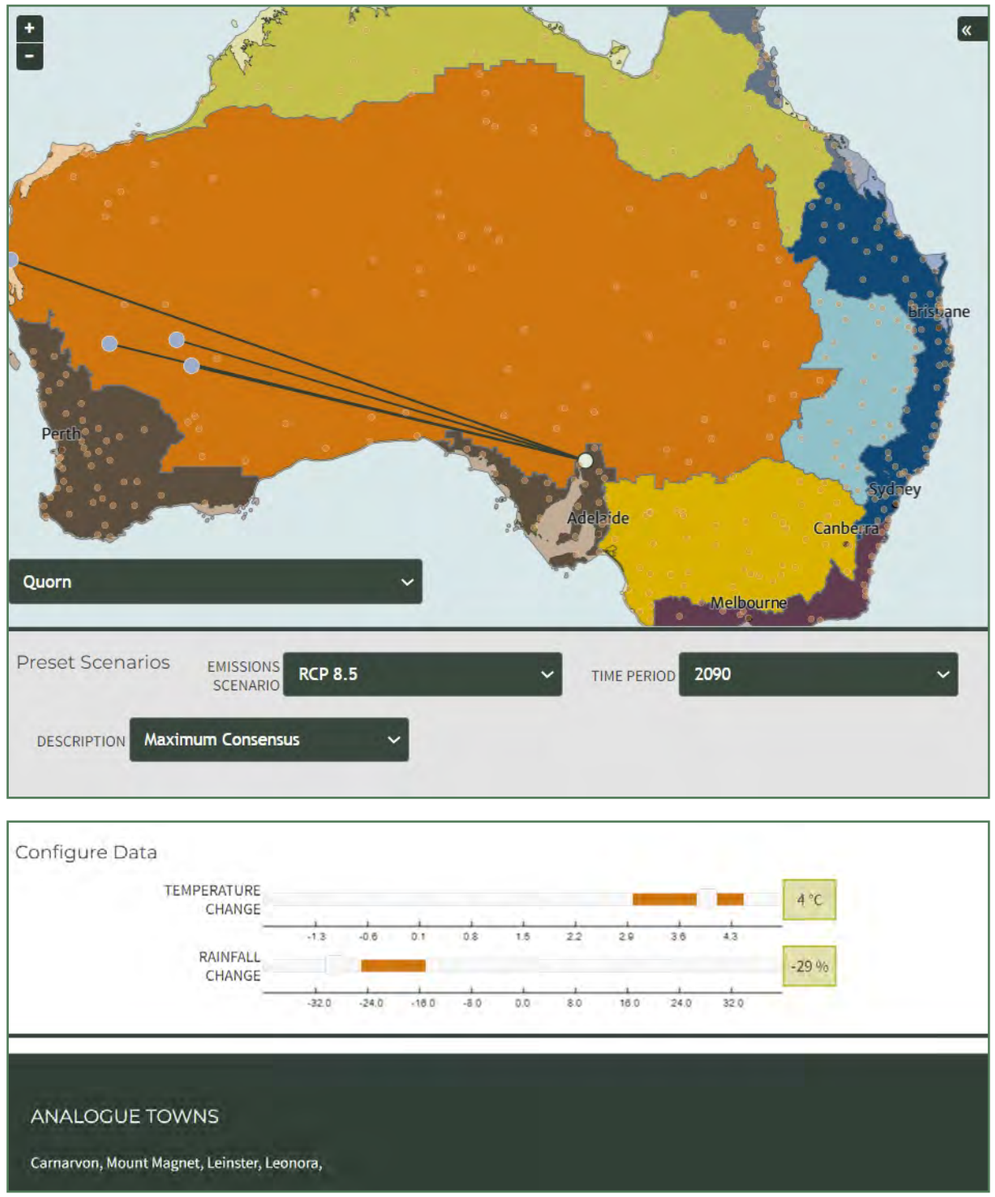


Figure 43. The Quorn 2090 RCP8.5 Climate Analogue

APPENDIX B: SOUTH AUSTRALIAN SOIL GROUPS.

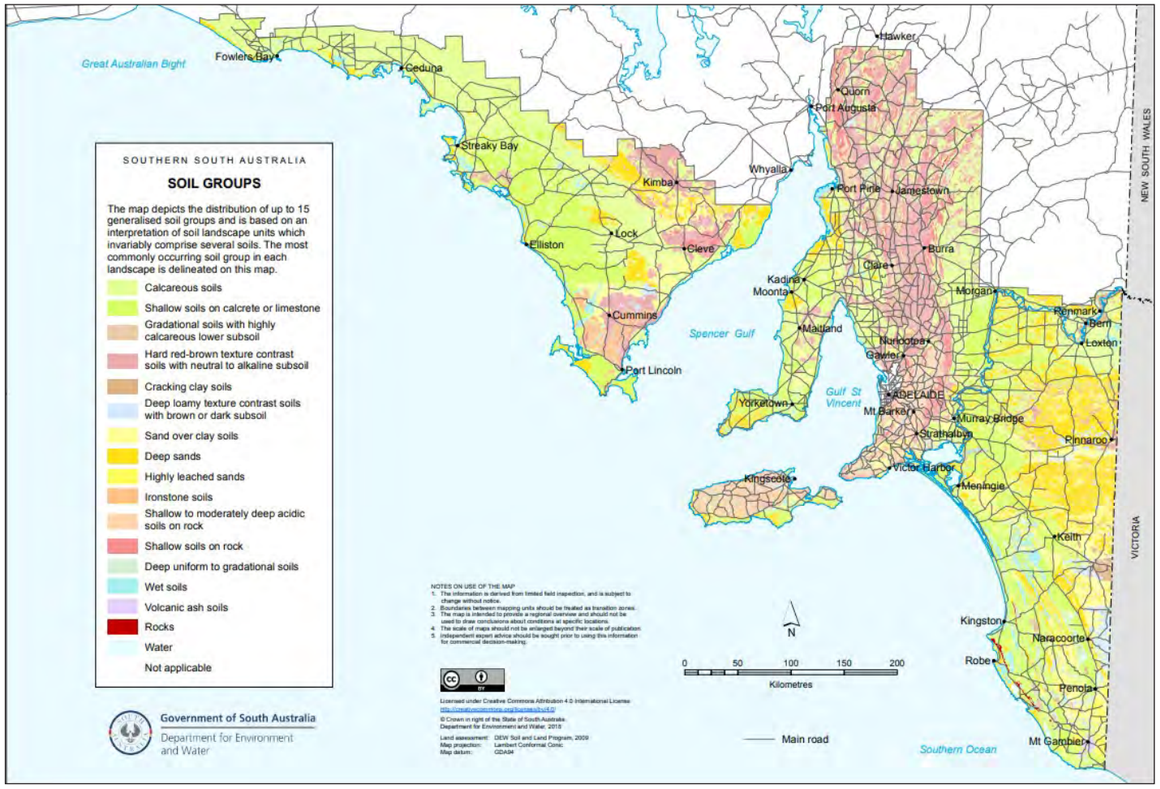


Figure 44. Southern South Australia Soil Groups (Department for Environment and Water, 2018).

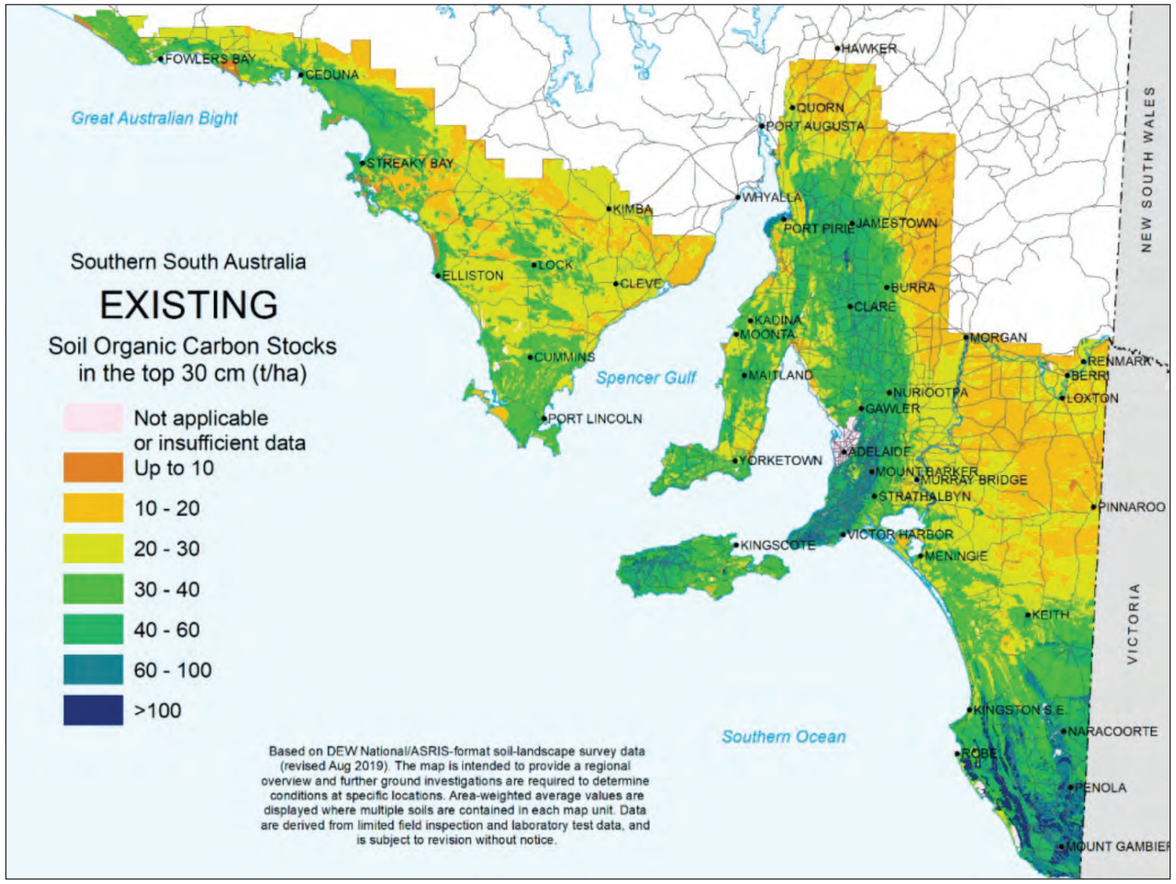


Figure 45. Southern SA existing soil organic carbon stocks 1990-2000 (Department for Environment and Water, 2021)

APPENDIX C: CONSULTATION SUMMARY.

A wide range of consultation methods were undertaken in the development of this Plan including face to face and online interviews, regional and key stakeholder workshops. From these interviews, the project team have taken notes of discussions and analysed for prominent themes. Prominent themes presented in this appendix are Resilient Farming Enterprises, Resilient Industry, Resilient Communities, Knowledge and Education, and Research and Innovation. Beneath each key theme are subthemes with examples of input from consultation which informed the strategic priorities.

Key Theme 1: Resilient Farming Enterprises

1) Risk Management
   a) Off farm diversification
      i) Off-farm income is needed (Interview, Women in Ag president)
      ii) Orroroo took 10 years to get back after drought - has to rely on off farm income (Interview, Regional Landscapes Facilitator AgEx Alliance)
   b) On farm diversification
      i) More of a focus on mixed farming systems (Interview, Regional Landscapes Facilitator AgEx Alliance)
      ii) Some farmers are diversifying by buying land in different regions (Interview, Chair Mid North High Rainfall Group)
   c) Forward Planning
      i) Looking at what science business/farmers/etc need to help them understand risk going forward (Interview, Manager Climate Change Policy and Strategy, DEW)
   d) Understanding and acceptance of a new reduced rainfall and increased evaporation scenario
      i) Potential evaporation is increasing in the subtropics and southern Australia. This means the atmosphere is sucking harder on whatever moisture is in the soil and this increases the chances of rapid drying and flash droughts (Interview, ANU)
   e) Reduced reliance on expensive inputs
      i) Water is twice as expensive (Interview, Viticultural Development Manager - Barossa Australia)
      ii) Rising costs of higher fertilisers (Interview, Northern Sustainable Soils / Agronomist)
   f) Integrated and coordinated mental health system
      i) There's need for a more coordinated approach to mental health services in the region (Interview, Legatus Group)
      ii) There are existing initiatives and programs for farmer health and wellbeing. Examples include: Fat Farmers, I Farm Well and PIRSA's FAB Mentor Program (Interview, Wellbeing SA)
2) Efficiency – doing more with less
   a) Allocate further funding for natural resources management as a means of capturing and storing water
      i) Lack of understanding of how catchment conditions such as soil processes and groundwater respond to and recover from acute and chronic drought (Interview, BOM)
   b) Ensure sustainable use of water
      i) Tapping into -waste water, mains water, reclaimed water (Mallala Workshop)
      ii) Capture more stormwater (Eudunda workshop)
   c) Conduct cost-benefit analysis of water reuse schemes.
      i) Targeted impactful R&D – water re-use (Mallala workshop)
   d) Increase research and development for key climate-environment on-farm risks
      i) develop more drought and frost resilient cereal varieties (Orroroo workshop)
3) Foresight Capabilities
   a) Boost the number of agronomists, specialist farm advisors and direct training to address current and future gaps.
      i) Over 70% of farmers use an agronomist (Interview, AgCommunicators)
   b) Increase ability of soils to store moisture through directing funding for further research and extension.
      i) Need more work on soils, how to store moisture in the soils (Interview, Women in Ag)
      ii) water stays in the paddocks when residues and soil structure are retained (Interview, SANTFA)
   c) Increase access to localised, timely and accurate weather predictions.
      i) Weather forecasts give 50% accuracy. Improved weather forecasting would greatly support the industry (Maitland workshop)
   d) Increase communication of projected climate risks and key messages related to adaptation and transformation.
      i) Focus on making sure the science is coming through all levels of education
   e) Buffer heat and evaporation through the development of a region-wide greening masterplan.
      i) Need funding for green areas (spaces – in the community/ towns) (Interview, Agrilink)
      ii) Targeted impactful R&D, Urban greening (Mallala workshop)
   f) Target forms of agriculture proven to work in low-rainfall environments.
      i) more drought tolerant varieties - low rainfall legume (Interview, AgCommunicators)
      ii) develop more drought and frost resilient cereal varieties (Orroroo workshop)

Key Theme 2: Resilient Industry

1) Increase regional economic diversification
   a) Regional diversification in industry form and function.
      i) Geographic and industry diversification to reduce risk on sector (Interview, Financial Services SA)
   b) Value add to existing regionally produced agricultural commodities.
      i) Value add to a product - rather than selling wheat - manufacturing - food innovation - add value to something that are growing
   c) Increasing understanding of market access and development.
      i) Understand global market and global economy - Global market volatility will amplify climate risks and opportunities both in terms of input costs and commodity prices (Interview, National Broadacre Manager, AgXtra)
   d) Encourage business investment in the carbon offset market for locations where farming viability is reduced.
      i) helping the farmer, looking at projects that helps resilience, e.g. how do we manage our soils, how do we engage in new world of carbon farming, e.g. looking to get funding to trial, extend (Interview AgEx Alliance)
   e) Provide non-farming enterprises with a template and training for the development of business resilience plans (especially related to drought).
      i) Gaps in business plan - accommodate for drought (Interview, AgCommunicators)
2) Increase the liveability and employment opportunities available in the region
   a) Increase the housing stock in the region through strategic expansion of townships in select locations.
      i) have to move to areas where housing is available and more affordable (Interview, Women in Ag)
   b) Increase digital access across the region.
      i) Those who have reliable access to phone and internet continue to move ahead of those who do not (Interview, DC Goyder)
   c) Increase access to health services.
      i) Access to mental health services (Interview, AgCommunicators)
   d) Ensure sustainable use of water, including water reuse.
      i) Water is the greatest sustainability issue for the valley (Interview, Barossa Council)
      ii) Capture more stormwater (Eudunda workshop)
   e) Support the development of strategic community infrastructure to enhance social and recreational wellbeing of local communities.
      i) Tourism cycling trails/Art. Infrastructure aquifers. Promote our natural scenery walking, cycling, horse trails (Eudunda Workshop)
3) Technology, automation, genetics.
   a) Develop multiple demonstration sites showcasing and trialling use of precision agriculture, new crop genetic lines and options for agriculture and value-adding processes.
      i) Drought results in reduced input spending - chemical companies don't have money - don't invest in trials (Interview AgXtra)
   b) Adopt needed and innovative transitionary and transformation land management methods and systems.
      i) Using containment areas for land management and and protection, native plans come back faster (Interview, Barossa Improved Grazing Group)
      ii) The land is looking far better in these last few droughts - farmers have adopted good land management practices (Interview, PIRSA)
   c) Maximise accessibility to sun and wind energy to create and store localised electricity for town use (community owned renewable energy).
      i) Huge investment- Wind farms – solar farms on marginal land (farmers can be targeted) (Eudunda workshop)

Key Theme 3: Resilient Communities

1) Health and Wellbeing
   a) Improve capacity for mental health support
      i) There is an increase in suicidal ideation and mental health issues when communities are faced with drought (Interview, LHN)
   b) A better connected and integrated community
      i) Community based programs vital for resilient communities (Interview, Wellbeing SA)
   c) Better access to health and wellbeing services
      i) There's need for a more coordinated approach to mental health services in the region (Interview, Legatus).
      ii) Need more outreach services to allow everyone to have access (Wellbeing SA)
   d) Maintain access to healthy natural environments
      i) need funding for green areas (spaces – in the community/ towns) because green is important to people – "Need to go into town and see green lawn for morale"
      ii) Focussed on making the landscape of the town and surrounds into a more people friendly landscape (Interview, ANU)
   e) Community involved in decision making
      i) Involvement from community - Resilience in having farmer meetings and catchups (Interview, Barossa Improved Grazing Group)
2) Towns and Infrastructure
   a) Manage natural environments in urban areas for drought resilience
      i) Focussed on making the landscape of the town and surrounds into a more people friendly landscape (Interview, ANU)

b) Ensure sustainable use of water

i) Long term planning to bring back, restructure water courses and use water for environmental purposes to build up and sustain the landscape so that it can survive ongoing drought conditions (Aboriginal engagement, Yaran).

c) Support the development of strategic community infrastructure to enhance social and recreational wellbeing of local communities

i) Tourism cycling trails/Art. Infrastructure aquifers. Promote our natural scenery walking, cycling, horse trails (Eudunda Workshop)

3) Community Innovation and Cultural Partnerships

a) Incorporation of Aboriginal knowledge and perspectives into planning and decision-making processes to increase drought resilience

i) Knowledge will diminish if not involved (Aboriginal Engagement, Yaran)

ii) Controlled vegetation burnings using traditional methods to mitigate the risk associated with the unsustainable hot burns that appear to occur more often during droughts (Aboriginal engagement, Yaran)

b) Build the capacity of Aboriginal controlled and operated organisations to be involved in sustainable project delivery across the long-term

i) Work with partners to restore sustainable cultural and environmental water flows to revive creeks and riparian zones (Aboriginal engagement, Yaran).

c) Build more sustainable and realistic relationships with farmers and other stakeholders to enhance and optimise land management

i) Wholistic approach to resilience planning i.e. consider all community members, industries, utilise bottom up AND top down approach (Wellbeing SA))

d) Boost the capacity and project-readiness of existing community incorporated associations

i) Community based programs vital for resilient communities – streamline grants process (Interview, Wellbeing SA)

ii) Coordination of resources to help community (Lifeline BHC2C)

Key Theme 4: Knowledge and Education

1) Understanding climate projections and science

a) Develop appropriate communication materials to suit varied learning styles and educational levels.

i) Education and information provision – diversify training systems for different learning styles (Orroroo workshop)

b) Co-develop materials with and for farmers, supply chains and rural communities.

i) Recognise acknowledge and include experience of elders in accumulation of knowledge share information (Orroroo workshop)

c) Effectively communicate the opportunities and need for rainfall independent income and revenue required for future farming enterprises.

i) Farmers do change if the technology is effective (Orroroo workshop)

ii) Since we started no till - systems have become farm more robust - extract more income from those dry years (Interview, SAGIT)

d) Connect community leaders who have experience of drought to the Drought Leaders Mentoring Program

i) Best to engage successful farmers in more marginal, high risk environments to share learnings and demonstrate risk management to landholders in closer to the coast where risks are emerging and increasing (Interview, ANU)

2) Greater access to education and diversity and styles of learning

a) Liaise with primary, secondary and tertiary education sectors to increase knowledge of climate science, adaptation and transformation.

i) Access to training TAFE (Mallala workshop)

ii) Focus on making sure the science is coming through all levels of education (Interview, AgXtra)

b) Incorporate resilience training models across the education sector through a train the trainer model.

i) Farmers determining education needs and on ground training (Orroroo workshop)

ii) Education is vital for a resilient community (Interview, UniHub)

c) Upskill farmers, agricultural supply chain stakeholders and regional business owners through increased community engagement, social media and targeted workshops.

i) Ran drought management workshops; decision of buying in grain or livestock (Interview, Barossa Improved Grazing Group)

d) Accommodate for a diverse range of learning styles and inequitable digital access and literacy.

i) Education and information provision – diversify training systems for different learning styles (Orroroo workshop)

3) Adoption of proven international, national and regional drought adaptation and transformation techniques

a) Incorporation of Aboriginal knowledge and perspectives into planning and decision-making processes to increase drought resilience

i) Long term planning to bring back, restructure water courses and use water for environmental purposes to build up and sustain the landscape so that it can survive ongoing drought conditions (Aboriginal engagement, Yaran).

ii) Controlled vegetation burnings using traditional methods to mitigate the risk associated with the unsustainable hot burns that appear to occur more often during droughts (Aboriginal engagement, Yaran)

b) Build the capacity of Aboriginal controlled and operated organisations to be involved in sustainable project delivery across the long-term

i) Work with partners to restore sustainable cultural and environmental water flows to revive creeks and riparian zones (Aboriginal engagement, Yaran).

c) Build more sustainable and realistic relationships with farmers and other stakeholders to change perspectives on land management

i) Wholistic approach to resilience planning i.e. consider all community members, industries, utilise bottom up AND top down approach (Wellbeing SA))

d) Develop partnerships with locations that have experienced conditions the Northern and Yorke Region will experience by 2030

i) Best to engage successful farmers in more marginal, high risk environments to share learnings and demonstrate risk management to landholders in closer to the coast where risks are emerging and increasing (Interview, ANU)

e) Develop information sharing partnerships with drought prone regions across the world (Israel, Saudi Arabia, Western USA, Southern Africa, Chile, Argentina)

i) In some areas around the world agricultural production has reduced by 40% despite CO2 fertilisation this may test the coping capacities and require transformative action rather than incremental change (Interview, ANU)

Key Theme 5: Research and Innovation

1) Value add

a) Maximise the spike in tourism to offer locally produced goods through bricks and mortar shops.

i) Working on experiences at the wineries – helicopters, knife making (Interview, Barossa Australia).

b) Investigate options for digital marketplaces and online sales of locally produced goods.

i) Needs to be a focus on transitional process that lead away or are separate from farming/industry diversification (UniSA)

c) Increase variety of paddock to plate, farm tourism, stays and events.

i) Keep promoting and developing tourism farm stays (Orroroo workshop)

d) Identify current assets and strengths and build upon these

i) Affordability, lifestyle, tree change (Eudunda workshop)

ii) Many lifestyle benefits of living in the region (Maitland workshop)

2) Trans-disciplinary and integrated research

a) Research options for creating efficiencies across supply chains, considering the needs of global customers.

i) GPS and auto steer – impact on efficiency (Maitland workshop)

b) Investigate options for manufacturing of agricultural goods produced locally.

i) Develop a rural industry locally (Orroroo workshop)

ii) No food processing – what opportunities exist (Maitland workshop)

c) Examine the role that education can play in creating resilience across key regional industries.

i) Education - Regional resilience must be talked about separately or outside of crisis (UniSA)

ii) Education is vital for a resilient community (UniHub)

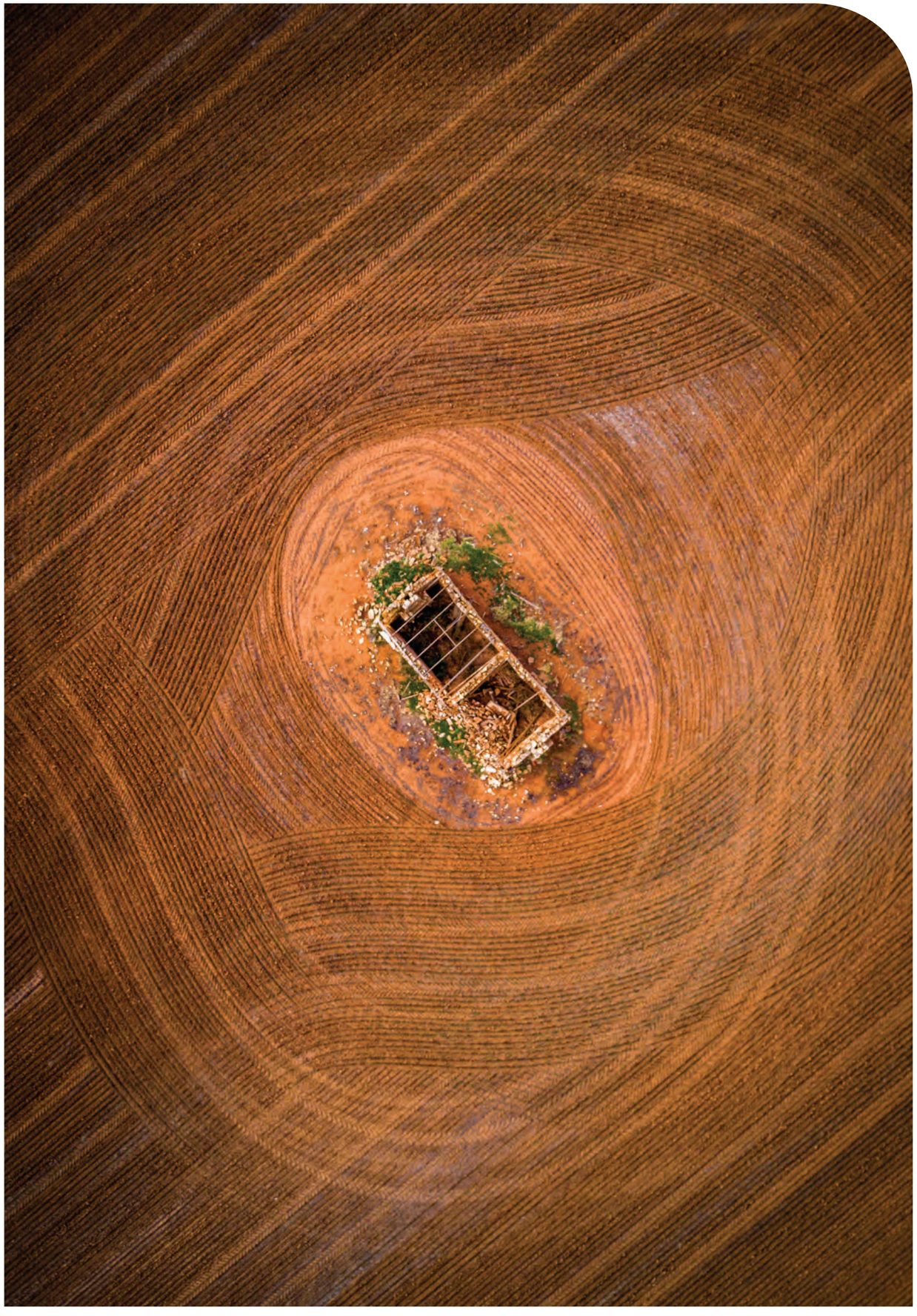
d) Determine the in-region educational programs that can seek to further diversify the regional economy.

i) Off-farm income is needed, better manage risk through education, decision making, choose when to sow / when not to sow (Women in Ag).

APPENDIX D: SOUTH AUSTRALIAN FARM MANAGEMENT DEPOSITS.

YEAR ON YEAR MARCH QUARTER VALUES HELD IN SA FARM MANAGEMENT DEPOSITS ($'000)					
	2018	2019	2020	2021	2022
CROPS	$29,526	`$27,231	$32,684	$30,888	$32,244
GRAIN	$309,571	$306,266	$298,312	$275,705	$251,308
GRAIN-SHEEP-BEEF	$268,275	$254,789	$269,551	$239,070	$213,097
SHEEP-BEEF	$53,362	$57,543	$68,369	$66,135	$69,689
SHEEP	$46,742	$54,102	$60,345	$53,664	$57,719
BEEF	$44,318	$45,210	$40,699	$37,514	$37,200

Table 23. Year on ear March quarter values held in South Australian (SA) Farm Management Deposits ($'000) by select agriculture sector (Department of Agriculture, Water and the Environment, 2018-2022)



Australian Government

Future Drought Fund

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Regional Development Australia YORKE AND MID NORTH

Regional Development Australia BAROSSA·GAWLER·LIGHT·ADELAIDE PLAINS

Regional Development Australia FAR NORTH SA

LANDSCAPE SOUTH AUSTRALIA NORTHERN AND YORKE

LEGATUS GROUP