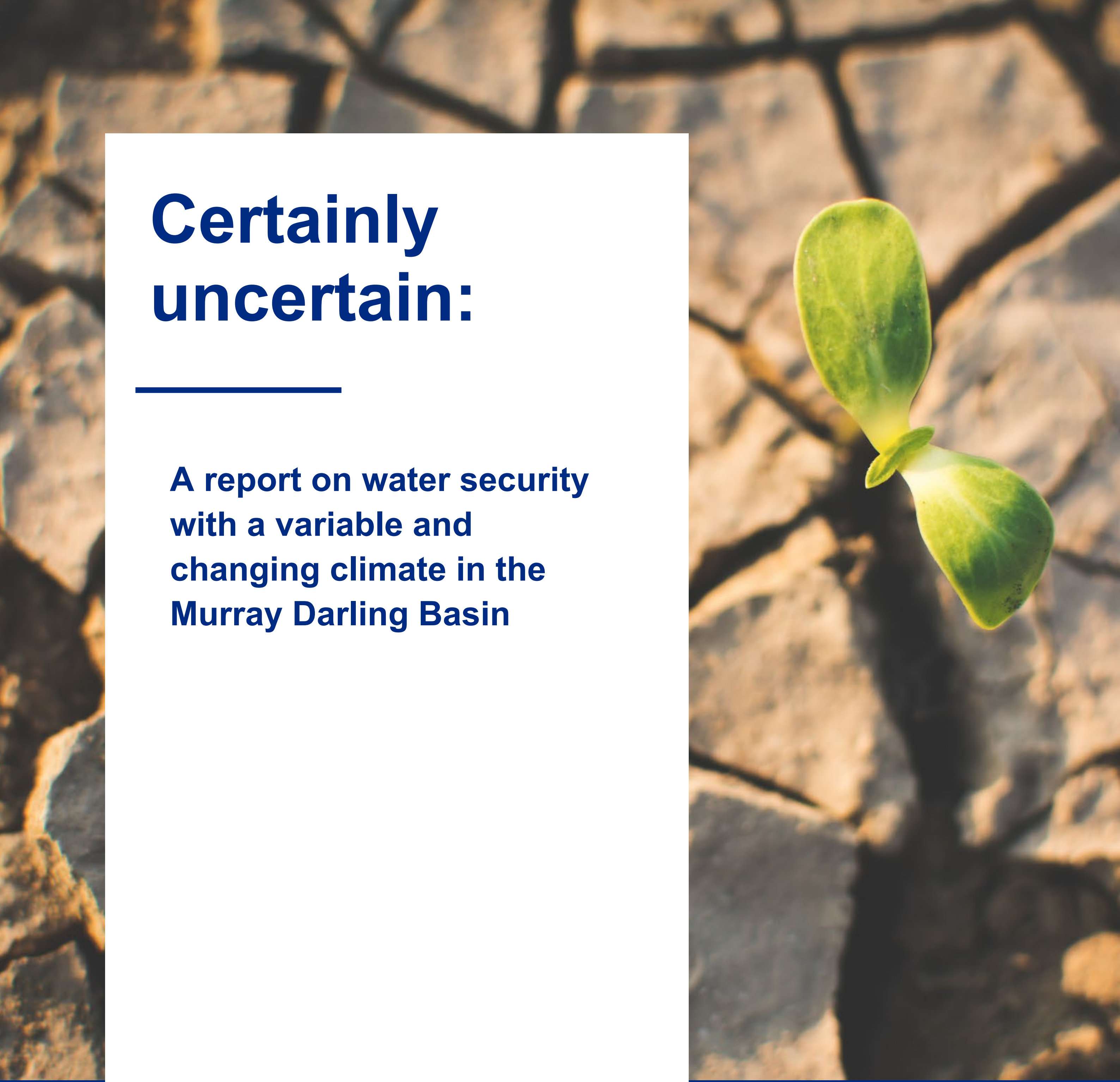

Certainly uncertain:

A report on water security with a variable and changing climate in the Murray Darling Basin

SEPTEMBER 18

National Irrigators' Council

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Executive Summary

Climate variability and any change is factored into current water policy settings in the Murray-Darling Basin (MDB), as well as many other catchments in Australia. In fact, a variable climate is at the heart of the contemporary water management framework in Australia, as envisioned by the National Water Initiative (NWI), and given effect through state-planning arrangements in a variety of ways.

However, these mechanisms are complex and often poorly understood, which has created a false assumption that climate variability and change is not considered at all.

This Report seeks to address that knowledge gap, by outlining the current policy settings to deal with both climate variability and change, and how climate change scenarios are expected to play out under these current settings. This is important to inform an evidence-based understanding of the status quo and make recommendations regarding future evidence gaps.

This Report comes at a critical time with the imminent 2026 Basin Plan Review, and ongoing 2027 Water Act Review, to which climate change is a key statutory consideration.

There is a growing body of work on possible climate change scenarios, but far less on how those scenarios translate through policy settings to actual outcomes. Understanding this science-policy nexus is crucial.

Key findings of this Report include:

- **Climate variability and any change is factored into current water policy settings, at both state and federal levels.** This is reflected in at least five different core measures in Commonwealth and State legislation including: risk-based entitlements, allocation systems, incident response guidelines and extreme measures, and two forms of diversion limits. This excludes localised measures within valley-based Water Sharing Plans (WSP).

  - Policy has an ongoing adaptive mechanism for responding to the real-time actual hydrological consequences of a changing climate, rather than requiring ex ante predictions of water availability decades into the future.

- **The application of climate change scenarios to this existing framework demonstrates how the framework responds to climate variations.**
  - Based on data from the NSW Government, under a dry climate future scenario, with current policy settings, the reliability of water allocations to entitlements will significantly decline.
  - For example, the percentage of the time water allocations reach 100% is expected to drop, from 40% of the time to 6% in the Murrumbidgee, and from 60% of the time to 20% in the NSW Murray.
- **There are parameters of what water *policy* can achieve** (in terms of rules, regulations, legislation), and the role of other *non-policy* interventions (such as infrastructure, alterative water sources, planning requirements, and more). Resilience to climate change will require looking across these multiple levers.
- **In the context of a variable and changing climate, water security as a policy objective is not the absence of variability; it is confidence that variability will be managed** within a durable, robust, transparent and accepted institutional and policy framework. Put simply, certain water policy, to manage for uncertain water availability. For irrigated agriculture, this stability is critical to investment, productive capacity, regional economies and Australia's food security.
- **Understanding possible future climate scenarios is not as simple as "less water", rather, variations in the timing and pattern of water availability -** the science is increasingly consistent on the direction of plausible change, but uncertainty remains and more work is needed to understand the scale, timing and location of potential future impacts on water availability, and how this then translates through current policy settings to produce outcomes.

Greater climate uncertainty increases the importance of policy certainty - it does not diminish it.

Climate Roadmap

Key recommendations from this report include:

Timeframe	Lead	Recommendation
Q4, 2026	MDBA (Basin Plan Review)	1. The MDBA maintain their draft position that "*Given the wide range of plausible climate futures, the Authority is not proposing changes to the SDLs in response to climate change in 2050 through this review.*" 2. The MDBA consider expanding their justification for this position to include the range of existing policy mechanisms in place to manage for climate variability and change.
Q4, 2026	MDBA (Basin Plan Review)	3. The MDBA, as part of the Basin Plan Review: a. include explanation of how actual and permitted levels of take vary based on climate, to improve confidence in the ability of the current system to respond to climate variability and change on an ongoing adaptive basis; b. collate existing policy mechanisms at both a state and federal level to ensure appropriate levels of understanding of the status quo to inform decision-making and stakeholder understanding for upcoming potential reform; c. coordinate work with each jurisdiction to forecast likely reliability impacts to water allocations across entitlement types, in each water source, for various climate scenarios – to understand how climate scenarios will play out based on the status quo of policy settings.
Q4, 2026	MDBA (Basin Plan Review)	4. The MDBA, as part of the Basin Plan Review, maintain recommendations in the Discussion Paper relating to: a. Consideration of realistic and feasible outcomes under climate change; b. Opportunities to optimise management of water for the environment to get better outcomes more efficiently; c. Utilising integrated catchment management or complementary measures to optimise outcomes; d. Addressing infrastructure risks; e. Ongoing science and knowledge generation. 5. The MDBA, as part of the Basin Plan Review, reconsider questions in the Discussion Paper relating to introducing minimum water requirements for critical needs during periods of low water availability, as beyond the role of Basin Plan policy, beyond the scope of what a variable system can deliver, and duplication of existing Incident Response Guide requirements.
2027	CEWH	6. Similar to 3C, the CEWH undertake a program of work to examine reliability trends of water entitlements in their portfolio under various climate change scenarios;

2027	Federal (DCCEEW)	7. The Federal Government, working with States, undertake an audit of critical water infrastructure and supply vulnerabilities - including town water and infrastructure supporting productive water use - and identify investment, alternative supply and other non-policy measures required to improve climate resilience.
Ongoing	States to report, IGWC to audit	8. Governments systematically monitor and report changes in water entitlement reliability over time, distinguishing climate-driven changes from changes arising from government policy, to protect the integrity of the entitlement framework and ensure appropriate application of risk-assignment arrangements.
Ongoing	Federal (BoM)	9. Expand the capabilities of My Climate View and other climate tools to include forecast trends in the reliability of water allocations to water entitlements, to be of increased value for irrigated agriculture and other water entitlement holders.

Contents

Introduction

Climate variability is an inherent feature of Australia hydrology. This means water policy cannot always guarantee fixed volumes of water to all users. In this policy context - *water security* is not the absence of variability; rather, confidence that variability will be managed within a durable, robust, transparent and accepted institutional and policy framework. Put simply, certain water policy, to manage for uncertain water availability.

Fortunately, Australia's water management foundations recognised these factors. Australia's contemporary water management framework **–** as envisioned by the 2004 National Water Initiative (NWI) which lay the blueprint **–** was specifically designed to manage for climate risk and variability**.** This includes through:

- A variable water entitlement system with entitlement categories that represent a share of the resource, based on water availability;
- Risk-based allocation systems that reflect prevailing water availability and prioritise critical needs such as town water supplies and critical/baseline environmental flows for our rivers;
- Water markets enabling water entitlement holders to manage risk, optimise water use, and respond flexibly to changing conditions.

The operationalisation of this framework can be observed through recent droughts – such as the Millenium Drought and Tinderbox Drought – where water allocations for lower-security users (such as farmers irrigating annual crops like rice, cotton, or grains) were zero for many consecutive years, to prioritise critical needs.

However, even with a climate-responsive policy framework, there will always be limitations in what water *policy settings* can achieve under extreme climatic events. Put simply – water policy can only manage and share water when it's available. The paradox is managing an inherently variable water supply, with some users requiring constant demand (such as town water supplies and critical industries), which is a real and important challenge facing Australia. Possible risks to supply have been amplified by more frequent and intense extreme events.

This Report is not to dismiss or belittle the severity of those challenges – rather – to ensure the right solution for the right challenge is used. This requires identifying the parameters of what water *policy* can achieve (in terms of rules, regulations, legislation), and the role of other *non-policy* interventions (such as infrastructure, alterative water sources, planning requirements, and more) which must be considered in this conversation to ensure resilience and climate-readiness.

The adequacy of water policy settings to respond to climate change has formed a key part of ongoing reviews, such as the 2026 Basin Plan Review, and 2027 Water Act Review.

There is an increasing body of work investigating scenarios for climate change impacts on water availability in Australia, particularly in the Murray-Darling Basin (MDB). However, while that work produces important insights into the science (such as rainfall, temperature, soil moisture, evaporation, runoff, streamflow's etc), the flow-on effects for how that then translates through current policy settings is often overlooked. In particular, understanding how potential changes to water availability translates to changes in water allocations to water access entitlements, is the missing piece of the puzzle in policy reviews to date. For policy-makers, scientists and others with an interest in water management in the MDB, this is integral to comprehensively understanding the current baseline or status quo, to which any future vision is based, or any proposed amendments are contemplated.

Understanding this science-policy nexus is paramount. A failure to use the right solution risks:

- Poorly designed policy solutions that are not effective against the intended purpose;
- Pre-emptive, or unnecessary, policy reactions with the subsequent costs, trade-offs and impacts;
- Unnecessary tensions undermined social cohesion, or poor confidence in public water management, through poor water literacy.

The challenge, therefore, for this period of water-reviews and potential reform is not just identifying the possible scenarios for climate and water, but:

- Understanding how those scenarios will play out with current policy-settings (such as through current water allocation processes);
- The role of various policy instruments for managing variable climate and extreme events (such as the separate roles and functions of the Commonwealth and States and Local Government);
- The extent to which policy (in terms of rules of access, water sharing arrangements and diversion limits) can achieve the desired outcomes (and what policy-alone cannot achieve);

- The availability of emergency interventions if required, and appropriate levels of risk-appetite;
- To the extent that any policy changes are being considered, the feasibility of objectives being sought under climate change scenarios and understanding the trade-offs of those objectives;
- The timeframes for decision-points, including the recognized the time-lag for environmental objectives to respond to significant reforms from the Basin Plan.

This Report seeks to contribute to closing that gap, to ensure any future policy decisions are based on evidence-based and informed understanding of the water policy framework. Specifically, this Report contains three parts:

1. A brief overview of the **science-landscape** as context;
2. A comprehensive look at the **policy-landscape**;
3. Analysis of the **science-policy nexus** – including available analysis of how various climate change scenarios will play out via these existing settings, to identify the actual expected outcomes of these scenarios;
4. **Discussion** of ways forward, including the role and limitations of policy and non-policy interventions in managing for water security with inherently variable water supply; and unpacking what water security can mean conceptually in such a climate as a policy objective.

Note: with water management being a matter for state jurisdictions in Australia, most climate-responsive policy settings occur at a state-level. This report uses NSW as the primary case-study (as a state that has invested substantially in climate change and water research and thus has greater publicly available data resources), with four specific case-study valleys to provide a broad cross-section: NSW Murray, Murrumbidgee, Macquarie-Castlereagh and Gwydir.

The science landscape

This section provides a brief overview of the science landscape to provide context.

There are a range of publications looking at climate change scenarios for water availability in Australia, particularly the MDB:

- *The future of climate and water availability in the Murray–Darling Basin – Sustainable Yields Report* (MDBA, 2025)[1]
- *Assessing the sensitivity of water resources in the Murray Darling to fire and climate change* (CSIRO, 2023)[2]
- *Values and vulnerability of the Murray-Darling Basin - Basin wide rapid assessment* (CSIRO, 2023)[3]
- *Synthesis of indirect impacts of climate change in the Murray-Darling Basin* (CSIRO, 2021)[4]
- *National Climate Risk Assessment*.

Common findings among these publications include:

- Temperatures across Australia are now 1.5 °C hotter (on average) relative to 1910, and hotter conditions are modelled to continue to increase.
- Extreme events such as storms, droughts and floods are becoming more frequent and intense.
- Changes in rainfall patterns are modelled to occur across much of the Basin, with average declines the Southern Basin, and small average increases in the Northern Basin.
- This will impact total water availability, including runoff, streamflow's and water in storages.

However, while work to date has focused on impacts to rainfall, runoff, soil moisture, streamflow's, inflows, and drought frequency – the impacts on water allocations are often absent from these same reports. This makes it difficult to gauge a comprehensive picture of how climate modelling will play out with current policy settings.

A specific example from the My Climate View as a case study is shown below.

Case study: My Climate View

This section looks at the My Climate View, developed by the CSIRO and the Bureau of Meteorology.

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[1] The future of climate and water availability in the Murray–Darling Basin

[2] https://www.mdba.gov.au/sites/default/files/publications/assessing-the-sensitivity-of-water-resources-in-the-murray-darling-to-fire-and-climate-change.pdf

[3] https://www.mdba.gov.au/sites/default/files/publications/values-and-vulnerabilities-murray-darling-basin-rapid-assessment.pdf

[4] https://www.mdba.gov.au/sites/default/files/publications/synthesis-of-indirect-impacts-of-climate-change-in-the-murray-darling-basin.pdf

For this case study, a town is selected from each of the case study valleys explore, being:

- Moree – Gwydir
- Dubbo – Macquarie
- Griffith – Murrumbidgee
- Deniliquin – NSW Murray.

The specific data for each town is shown in **Appendix 1.**

Methodology notes
The time period shows both past and future rainfall (1966-2085), using a medium global emissions scenario (RCP4.5). Total rainfall is defined as the total rainfall between 1 January and 31 December.
Time spent in drought is defined as the total number of months in drought across each 30-year historical and future period. Any period of three months or longer when rainfall remains below decile 3 relative to the baseline conditions is considered a drought. Baseline conditions are calculated using the historical rainfall from 1986 to 2005. The drought is considered to be over when monthly rainfall exceeds decile 5 (the median).

This resource does provide data on implications across a range of agricultural commodities, such as for rainfall and time in drought. However, a gap in this data is on water allocations for irrigation, which is perhaps the largest determiner of water security for farmers of irrigated agricultural commodities (alongside water prices). It is important to note that rainfall is not a sole indicator of water availability – as the timing and location of rainfall (i.e. if above storages), as well as evaporation (amongst other factors) are also important factors in determining the availability of that water. The largest determiner for water availability for irrigation is how that water availability then flows through the policy framework, to result in allocations.

However, rainfall does show a general indicator of climate conditions, and general trends for changes to water availability across key regions, including the conclusiveness of data.

Key findings

- **For all four case study towns, the 'time spent in drought' was found to be inconclusive, meaning** "there is no clear change between the recent (1996–2025) and modelled future climate (2050s) averages**".**

- **For all four case study towns, total rainfall change was found to be inconclusive, meaning** "there is no clear change between the recent (1996–2025) and modelled future climate (2050s) averages**".**
- **For all four case study towns, there were changes to the patterns of rainfall, including:**
    - **Increases:**
        - Summer rainfall for Moree
        - Summer rainfall for Dubbo
        - Winter and Summer rainfall for Griffith
        - Winter and Summer rainfall for Deniliquin
    - **Decreases:**
        - Spring rainfall for Moree
        - Autumn and Spring rainfall for Dubbo
        - Spring rainfall for Griffith
        - Autumn and Spring rainfall for Deniliquin.
    - Inconclusive for all other months.

The significance of these findings is:

- Understanding possible future climate change scenarios is not as simple as "less water", rather, variations in the timing and pattern of water availability (as well as other contributing factors such as temperature);
- There remains a lot of uncertainty in understanding future climate change scenarios, with substantial findings being inconclusive;
- Changes in water availability span both wetter and drier conditions.

However, most significantly, is the clear ongoing limitation that data to-date does not provide information on projected water allocations (or equivalent access opportunities) to water users within these areas. For irrigated agriculture, reliability of water allocations is a determiner of water security - which is not only shaped by climatic drivers, but by policy and regulatory settings, and infrastructure. For water management generally, this science-policy nexus remains a critical piece of the puzzle when seeking to understand future water realities, and implications for the system

The policy landscape

This section provides a detailed account of the policy landscape, as designed by the 2004 National Water Initiative (NWI), which serves as the blueprint to Australian water management as a system to respond to this climate variability. The NWI outlines:

"Australia's water resources are highly variable, reflecting the range of climatic conditions and terrain nationally."

"The objective of the Parties in implementing this Agreement is to provide greater certainty for investment and the environment, and underpin the capacity of Australia's water management regimes to deal with change responsively and fairly."

The primary mechanism to do this, as envisioned by the NWI, is by establishing a variable entitlement-based system:
"The consumptive use of water will require a water access entitlement, separate from land, to be described as a perpetual or open-ended share of the consumptive pool of a specified water resource,"

This is not a fixed volume of water, rather a share of the water that is available. This system is designed to be flexible and dynamic, in response to water availability.

With water management a matter for state jurisdictions in Australia, most of these mechanisms occur at a state-level. As above, this report uses NSW as the primary case-study (as a state that has invested substantially in climate change and water research and thus has greater publicly available data resources), with four specific case-study valleys to provide a broad cross-section: NSW Murray, Murrumbidgee, Macquarie-Castlereagh and Gwydir.

Variable entitlements with adjustments via water allocations

The amount of water allocated to a water access entitlement varies, based on water availability, known as a 'water allocation' or 'Available Water Determination (AWD)'.[5] This is because a water access entitlement is to a defined share of the available water volume in a water year, not a fixed volume. Simply, a 10 ML general-security water access entitlement may be allocated 10 ML in a wet season where allocations are 100%, but in a drier season allocations may only be 20% (so 2 ML), or in a very dry season 0% (so 0

[5] Note: As this process occurs at a state-level, this paper will refer to NSW as a case study, noting similar processes in other state jurisdictions.

ML). This dynamic, climate-adjusting system means the volume of water used varies in relation to the amount of water available.

The AWD is calculated based on factors such as: (i) the condition of the catchment and river system river (wet/dry) and forecast inflows; (ii) dam storage levels, including how much unused water from previous years is carried over in public storages; (iii) the estimated volume required to run the river, including end of system flows, transmission losses and evaporation losses; and, (iv) other requirements, such as storage reserves and environmental water allowances.[6]

Under legislation (i.e. the *NSW Water Management Act 2000*[7]), the allocation of water when water is available, is made based on a hierarchy or order of priority of water users. Under normal circumstances, this order of priority is:

- needs of the environment;
- basic landholder rights;
- town water supply and stock & domestic licenses;
- high security water licenses (typically used for permanent plantings such as orchards or vineyards); and finally,
- lower security licenses such as general-security then supplementary (which are typically used for opportunistic/ annual crops like cotton or rice).[8]

During a declared 'extreme event' (such as droughts) critical human water needs (e.g. water for drinking) becomes highest priority.[9] Note: if these consumptive water licences are purchased by the Government, for the environment, they maintain their allocation characteristics (i.e. only receive water when the farmer otherwise would have).

The impacts of climate variability on water allocations against water access entitlements is clearly observable. This can be shown from data on the NSW Government Water Allocation Dashboard[10]. To demonstrate, the below case

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[6] NSW Government, 'Principles for allocating regulated river water in NSW' *Allocations and availability* (online, 2025) < https://www.dpie.nsw.gov.au/water/our-work/allocations-availability/allocations/how-water-is-allocated/principles-for-allocating-regulated-river-water-in-nsw>.

[7] Water Management Act 2000 (NSW), 60.

[8] Note: Where a water access licence is 'bought back' by the Government for the environment (called Held Environmental Water) it maintains the characteristics of the original licence as if used for diversions. This is in addition to the water for the environment that is not the subject of a water access entitlement for diversions.

[9] Water Management Act 2000 (NSW), 60 3(A).

[10] NSW Government, 'Allocations Dashboard' *Allocations and availability* (online, 2025) <https://water.dpie.nsw.gov.au/our-work/allocations-availability/allocations/allocations-dashboard>.

study water sources are selected as a representative sample from across the NSW MDB (NSW Murray, Murrumbidgee, Gwydir and Macquarie)[11], examining general-security allocation data[12] from 2004-05 to present (2024-25). New allocation is shown in blue, whereas carryover of previously unused allocation is shown in orange.

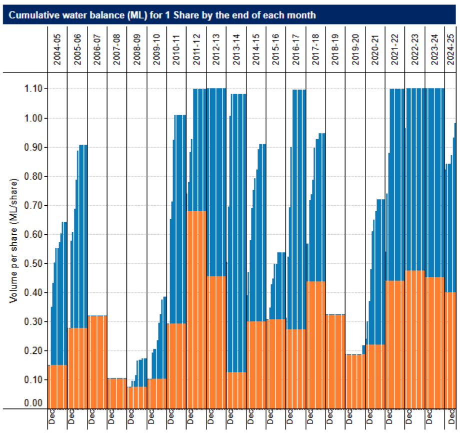


Figure 1 NSW Murray Regulated River Water Source (Reg river, GS)

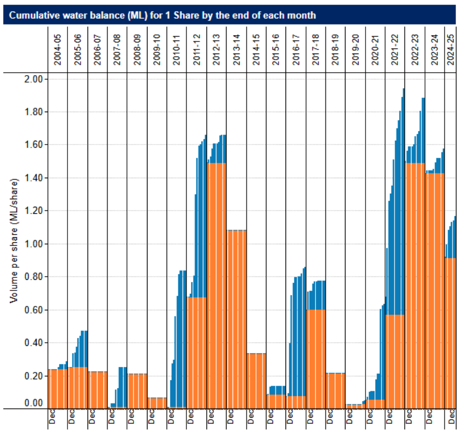


Figure 3 Gwydir Regulated River Water Source (Reg river, GS)

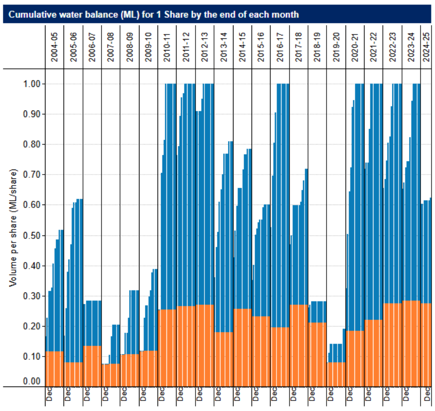


Figure 2 Murrumbidgee Regulated River Water Source (Reg river, GS)

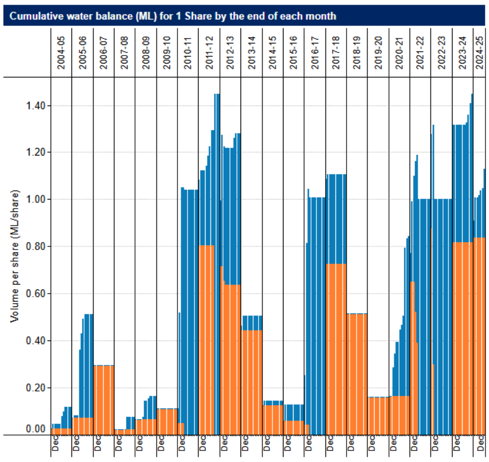


Figure 4 Macquarie Water Source (Reg river, GS)

[11] Note: This is intended to show variations within a water source over time, not to compare water sources, as each source has unique WSP rules, including carryover provisions, and accounting rules (i.e. cumulative accounting).

12 Note: this does not show usage, rather, the cumulative water that is 'brought to the table' by means of water allocations.

Key observations from these figures are:

(i) AWDs are significantly reduced, or zero, in dry years (see Millenium drought pre-2009, and the Tinderbox drought around 2019); and

(ii) AWDs increase in years of higher water availability (see 2011-12, and 2021-22).

This dynamic system can be considered self-adjusting or an automatic climate response mechanism. As the MDBA says, "*the allocations system is therefore naturally adaptive to climate variations, and adjusts year-to-year*"[13]. In the context of scarcity, this system favours those 'higher priority' users (towns and the environment, followed by a hierarchy of entitlement types), at the cost of 'lower priority' users (such as general-security entitlements). But alternatively, when there is sufficient water, this system means water can then be allocated for productive purposes.

Over the long-term, this inter-year variation in water allocations, shapes the overall reliability of a water entitlement. A proxy indicator of the reliability of water allocations, against a water access entitlement is the Long-Term Diversion Limit Equivalent Factor (LTDLE). LTDLE provides an indication of the long-term average water use associated with a class of water entitlement in a valley (shown as a number between 0 and 1, with 1 being greater). For example, an average entitlement of 100 unit shares with an LTDLE factor of 0.6 would be expected to use 60 megalitres of water per year in the long-term. Factors included in calculating the LTDLE include, the type of water entitlement, the entitlement volume, long-term average level of water allocation, long-term average usage of allocated water, and the priority of sharing available water among different entitlement types while limiting total use to the BDL.[14] The 2018 LTDLE factors for NSW are shown in Table 1[15] . As shown, the LTDLE Factors for general-security entitlements are relatively low, providing a general indication of the reliability of these entitlements over the long-term.

Table 1 LTDLE Factors for NSW Surface Water Sources, General-Security Entitlements (2018)[16]

Water Source (General-Security Entitlement)	LTDLE Factor
Border Rivers (B Class)	0.337

[13] Murray-Darling Basin Authority, 'Climate change and the Murray–Darling Basin Plan' *MDBA Discussion Paper* (2019) [16].

[14] Murray-Darling Basin Authority, 'Derivation of LTDLE factors in NSW' *Water Reform Technical Report* (May 2018).

[15] Ibid.

[16] Ibid.

Gwydir	0.380
Peel	0.209
Namoi	0.753
Macquarie–Castlereagh	0.516
Lachlan	0.396
Murrumbidgee	0.591
Murray	0.699
Lower-Darling	0.931

While AWDs are the primary climate response mechanism, they are not the only one - other interventions are available. The Basin Plan requires Water Resource Plans (WRPs) to describe how the water resources of the water resource plan area will be managed during extreme events (such as an extreme dry period). If the event "*would compromise a Basin State's ability to meet critical human water need*"[17], then the WRP "*must set out measures to meet critical human water needs during such an event*"[18]. In NSW, this occurs via the overarching NSW Extreme Events Policy[19], and via Incident Response Guides (IRGs) at a water source scale, which provide an expanding toolkit of measures for water managers to select from as an event becomes more severe. These toolkits of interventions, based on risk and severity, balances the need to be adaptive in response to changing circumstances, with the need for certainty, to improve longer term planning, predictability and stability in other periods.

Furthermore, as managing for climate change is inherently managing for a variety of uncertain scenarios, the ability to adapt over time, and respond when needed, is critical. This is why water policy frameworks have adaptive management functions built in, such as regular reviews, as well as the ability for emergency interventions if deemed necessary. For example, this includes (but is not limited to):

- Statutory 10-year review of the Basin Plan, including SDLs
- Statutory reviews of the Water Act 2007

[17] Basin Plan 2012 (Cth) Part 13, 10.51 (2).
[18] Ibid.
[19] NSW Government, 'Extreme Events Policy' (August 2023).

- Statutory reviews of WSPs and time limitations for WSPs to be renewed or replaced
- Ongoing Monitoring, Evaluation and Reporting (MER) and adjustments made as required
- Emergency interventions powers if required in the public interest (such as extreme water shortages), as later explained.

Due to this, water policy instruments are designed to manage water within the context of their lifespan (typically 10-years), not a long-term horizon beyond that. This is not to disregard the importance of long-term horizons, particularly for water planning and infrastructure development, which is absolutely critical to be informed by long-term climate forecasts. However, the role of a long-term climate forecast in a relatively shorter term WSP or Basin Plan or annual water allocations is limited in application. Making changes to instruments for uncertain scenarios risks, that may or may not eventuate many years into the future, risks costly and high-impact policy reactions pre-emptively. Rather, ongoing MER should occur to ensure instruments remain fit-for-purpose based on the climate information for the period of the lifespan of that instrument. This must occur alongside broader strategic planning, such as to ensure infrastructure needs will remain fit for purpose into the future, as well as planning for population growth and other developments.

The MDBA acknowledges this, saying:

> *"The Authority is not proposing changes to the SDLs to respond to a wide range of plausible 2050 climate futures through this review. This takes account of the broader context of a changing climate and acknowledges that the 10-year Basin Plan review cycle supports progressive review and adaptive management opportunities."*[20]

This approach based on adaptive management means not only does the water policy system respond automatically to variations in climate in real time, but the instruments themselves are the subject of regular reviews and renewals, enabling changes to be made if climate scenarios beyond the scope of what that instrument can manage for do eventuate or are expected to eventuate within the life of the renewed instrument.

[20] **2026 Murray–Darling Basin Plan Review Discussion Paper**

Variable extraction limits

The above sections have examined how water allocations respond to climate variability, and thus change, and the below section will now look at how extraction limit volumes themselves are also not fixed, but respond to climate.

Extraction limits are a formula, rather than a fixed number, for this very reason. The NSW Government says: "*Legal limits are described as definitions or formulae, rather than set volumes*."[21] They can sometimes be expressed as a number, which simply reflects the product of the formula for the inputs at that point in time.

There is a common misunderstanding that extraction limits do not factor in climate change. That is an oversimplification, and fails to recognise how extraction limits are operationalised in practice.

The Basin Plan Sustainable Diversion Limit (SDL) and State limits such as the NSW Long-Term Annual Average Extraction Limit (LTAAEL) operate as long-term average limits, both of which are implemented through mechanisms that respond to the water actually available each year.

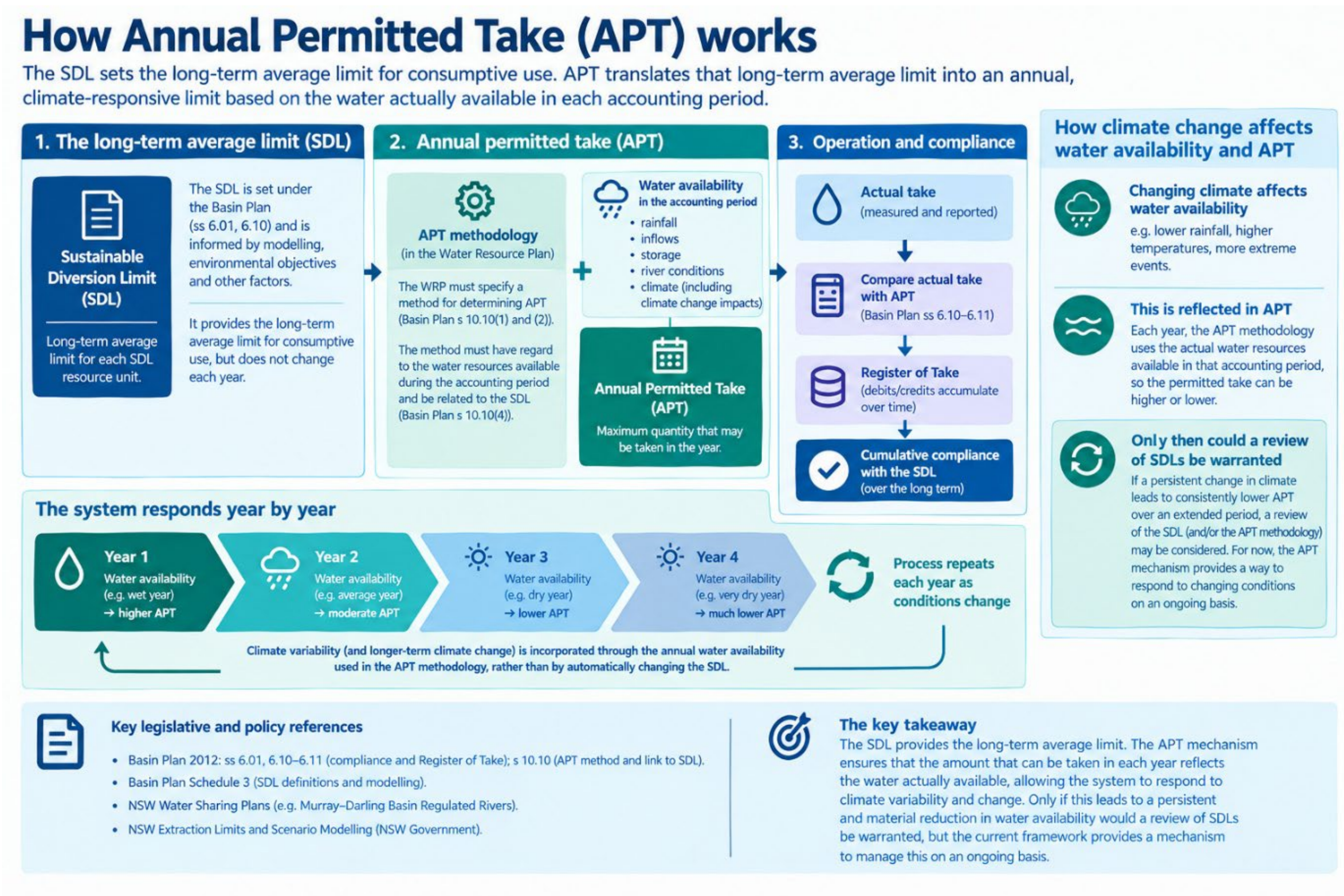
At the Basin level, the SDL is operationalised through Annual Permitted Take (APT). APT is the operational expression of the SDL. Water Resource Plans (WRP) must establish the APT method, having regard to the water resources available during the relevant accounting period. The method must also be related to the SDL so that, when applied over the historical climate sequence, it results in meeting the SDL.

This means that APT is the key year-to-year mechanism through which the SDL responds to changing water availability. In a dry year, lower water availability can result in a lower APT; in a wetter year, the permitted take can be higher. Actual take is then compared with APT through the Basin Plan's annual accounting and Register of Take arrangements.

The process is:
SDL → APT methodology → annual APT → actual take → assess compliance

[21] How surface water legal limits on water take are defined

If climate change progressively results in lower rainfall, inflows or other components of water availability, those effects can therefore progressively be reflected in lower APT. A sequence of increasingly dry years results in a declining APT trend. Meaning, the SDL does not need to be recalculated every year for the system to respond to changing conditions because the APT will.



At the State level, in NSW, a related process occurs via Water Sharing Plans (WSP) and Long-Term Average Annual Extraction Limits (LTAAELs). The LTAAEL is the long-term average limit for extraction, determined through hydrological modelling over the available climate record. Climate variability is therefore incorporated directly into the calculation of the long-term limit (LTAAEL), as well as into the annual operation of the WSP through allocation and water-sharing rules.

The two levels therefore work together. This means the extraction limit regime has an ongoing adaptive mechanism for responding to the real-time actual hydrological consequences of a changing climate, rather than requiring ex ante predictions made today of water availability decades into the future. To the extent that climate change manifests through changes in rainfall, inflows, storage or other factors affecting water availability, those changes are reflected in the annual operation of the APT method and WSP/LTAAEL over time.

So, put simply, if climate change results in progressively lower water availability:

- the first-order response within the existing framework is reflected at the Basin-scale in the APT mechanism, and for valley-scale, the WSP rules and operations including the LTAAEL and AWDs (water allocations).
- if that response results in a sustained and material divergence between the existing SDL/ APT relationship and the emerging climate and hydrology, only then could there be a basis for reviewing the reasons for the divergence At this point in time, given SDLs only came into effect in 2019, there is not yet the basis to review this long-term relationship. However, statutory review periods built into both the Basin Plan and WSPs provide regular medium-term opportunity to do this, as well as amendments which can occur from time to time if required.

Therefore, over time, a persistent change in climate could nevertheless raise a separate question about whether the underlying long-term limits or the methods and assumptions used to calculate them remain appropriate. However, the important distinction is that annual adaptation through APT and State water-sharing rules provides the immediate operational response, while review of the underlying long-term limits provides the mechanism for addressing longer-term structural changes in the climate once those patterns have been observed.

For the purposes of todays context, and the upcoming Basin Plan Review, it is important to consider this distinction. Many public submission provided to the Review have incorrectly suggested climate change is not considered – this is incorrect. As outlined above, climate variability and thus change are directly factored into how diversion limits, and water sharing plans, are operationalised.

<u>Case study: NSW Water Sharing Plans - Border Rivers WSP</u>

As above, the climatic record used as input for WSPs is based on the full available climate record. This includes in determining the LTAAEL and the priorities according to which allocations must be adjusted if extraction limits are exceeded.

Since WSPS are based on a water source scale, a case-study is used – NSW Border Rivers. This case study was selected as it has been a WSP subject to significant discussion (and legal challenge) on whether/how climate change is factored in.

Note: judicial review was brought forward by the NSW Nature Conservation Council (NCC) but was later discontinued.

Clause 27 of the WSP for the NSW Border Rivers Regulated River Water Source 2021 requires the LTAAEL to be calculated as the lesser of two modelled long-term average extraction outcomes: one based on the WSP conditions applying at the relevant baseline date, and one based on the Cap baseline conditions. Critically, clause 27(3) requires both calculations to be undertaken over the duration of the available climate record, using the hydrological model approved by the Minister. The NSW Department's 2023–24 Border Rivers LTAAEL assessment used a refreshed climate record from 1895 to 2024.

Extracts from that WSP are shown below.

Section 13 shows how climate variability is recognized in the WSP:

13 Climatic variability

This Plan recognises the effects of climatic variability on river flow in the water source through provisions contained in Part 6 that:

(a) manage the sharing of water within the limits of water availability on a long-term basis, and

(b) establish priorities according to which water allocations are to be adjusted as a consequence of any reduction in the availability of water due to an increase in extraction against the long-term average annual extraction limit or the long-term sustainable diversion limit, and

(c) manage the sharing of water between categories of access licences on an annual basis through available water determinations.

Note. Other statutory tools are available to manage climatic variability within a water source, for example, temporary water restrictions under section 324 of the Act.

This reflects the mechanisms discussed above.

Further, the WSP species that the calculation of the LTAAEL is based on the full climatic record available.

Division 2 Long-term average annual extraction limit

27 Calculation of the long-term average annual extraction limit

(1) Following the end of each water year, the Minister must calculate the long-term average annual extraction limit for the water source in accordance with this clause and clause 26.

(2) The long-term average annual extraction limit is the lesser of the following:

(a) long-term average annual extraction calculated based on the following:

(i) the water storages and water use development that existed in the 2001/2002 water year, excluding that which is the subject of subclause (v),

(ii) the basic landholder rights and access licence share components that existed on 1 July 2009,

(iii) the rules set out in the *Water Sharing Plan for the NSW Border Rivers Regulated River Water Source 2009* as at 1 July 2009,

(iv) the level of development for plantation forestry that existed on 1 July 2009,

(v) the level of development for floodplain harvesting that existed in the 2001/2002 water year in connection with extractions from a regulated river in the water source, as assessed by the Minister,

(b) long-term average annual extraction calculated under Cap baseline conditions as agreed under the Murray-Darling Basin Agreement that was in place at the commencement of the *Water Sharing Plan for the NSW Border Rivers Regulated River Water Source 2009.*

Note. ***Murray-Darling Basin Agreement*** is defined in the Dictionary.

(3) For the purposes of subclause (2), the long-term average annual extraction limit is to be calculated over the duration of available climate records using the plan limit hydrological computer model approved by the Minister.

Notes.

1 Under section 8F of the Act the long-term average annual extraction limit is to be varied by any change to licensed environmental water, excluding water committed under section 8C of the Act.

2 The long-term average annual extraction limit recognises the effect of climatic variability on the availability of water in accordance with section 20 (2) (c) of the Act, as historic climate and river flow information is used in its determination.

It is a common misconception that climate change is not factored in setting extraction limits. Whilst WSP may not explicitly say "this is how we consider climate change", it is incorrect to say they do not factor it in in their effect or operation in practice.

This Border Rivers case study demonstrates two different ways in which climate variability and change is considered in the state-level diversion limit framework:

1. First, climate variability is embedded in the calculation of the long-term limit: the LTAAEL is derived from a hydrological simulation over the historical climate record.
2. Second, climate variability affects the operation of the WSP rules from year to year: available water determinations, allocation outcomes, supplementary access and other extraction rules respond to the water available in the system.

The case study also demonstrates that, where an LTAAEL or SDL compliance assessment identifies non-compliance (i.e. actual water take is above limits), the WSP provides for management action, including reductions in Available Water Determinations.

Minimum inflows in the setting of reserves

Where that misconception typically comes from is a policy decision in 2014 - *Water Management Amendment Act 2014 (cl 28 [1] of Schedule 2)* which amended all NSW Basin WSPs in force in 2014 to maintain reserves based on the "*worst period of low inflows into this water source (based on historical flow information held by the Department when this Plan commenced)*". The reason for this decision was primarily to lock-in the existing bulk sharing arrangements between high-security and general-security entitlement holders (i.e. to avoid transferring between the two types of security, particularly during a drought).

The effect of this is that 'reserves' (the water set aside for critical needs before allocating water to lower priority users) is set based on 'assumed inflows' of the lowest inflow sequence when the WSP commenced. Given all these water sources experienced very severe droughts prior to WSP commencement, these assumed inflows are very low – i.e. it takes a very conservative approach by assuming an exceptionally dry year, every year, when setting reserves, to ensure sufficient water is made available.

This practice of planning ahead (based on a highly conservative assumption of a very dry period) means that allocations for general security entitlements may be able to be made earlier in the water year (without waiting for inflows to arrive). Put simply, it is saying at the start of a water year, rather than waiting for flows to actually arrive later in the year, accepting some risk, that at least a very dry year will occur. This is critical for prior planning for all water users, environment and irrigators alike.

For farmers, early (in the water year) water allocations are critical to make decisions around summer crops. Similarly for environmental water holders, such methods provide greater indication of possible availability of spring water actions, and inform planning efforts early.

The concerns with this practice relate to a rare (but plausible) scenario in which the actual inflows are lower than the worst period of low inflows prior to the WSP commencing, and the question of whether the reserves set aside will be sufficient. It is entirely plausible for this to happen (and has occurred in the Macquarie Valley, as later outlined), but importantly, there are a number of interventions in place if inflows are not tracking above this scenario during the water year, as well as other levers available to act if needed. These include: allocations made throughout the year can be made more conservatively (AWDs are made at the start of the water year but are adjusted periodically throughout the year as more information comes to hand about water availability that year), the Minister can make a temporary water restriction, or other interventions. For example, in 2019 inflows into Burrendong Dam were less than forecast and an emergency measure successfully suspended and moved 100% of all general security carryover and allocations into a temporary drought reserve account. The embargo remained actively in place until heavy inflows in early 2020 began replenishing the dam, allowing the restricted water to be progressively returned to users.

Alternatively, changing the inflow assumptions would involve substantial impacts to all users, including the environment, centered around later water allocation announcements, and reliability impacts. While the full extent of the impact would require modelling for each entitlement-type, in each water source, discussions with the NSW Department as part of the 2022 *Parliamentary Inquiry into Water Right Transparency and Water Allocation Drought Information* suggested this impact would average a 13% reliability reduction, but could be as much as 25% in any given year, regardless of the climatic conditions[22].

This essentially therefore comes down to the question of risk management. Taking a more conservative approach to climate forecasting in modelling setting aside reserves would lead to significant impacts to all users, every year. The alternative current approach, remains a highly conservative assumption of very low drought inflows, with a range of tools available if actual conditions are worse than forecast.

Importantly though, the setting of the LTAAEL is a largely separate process to this, and is based on the full available climatic record.

Available interventions if required for extreme events

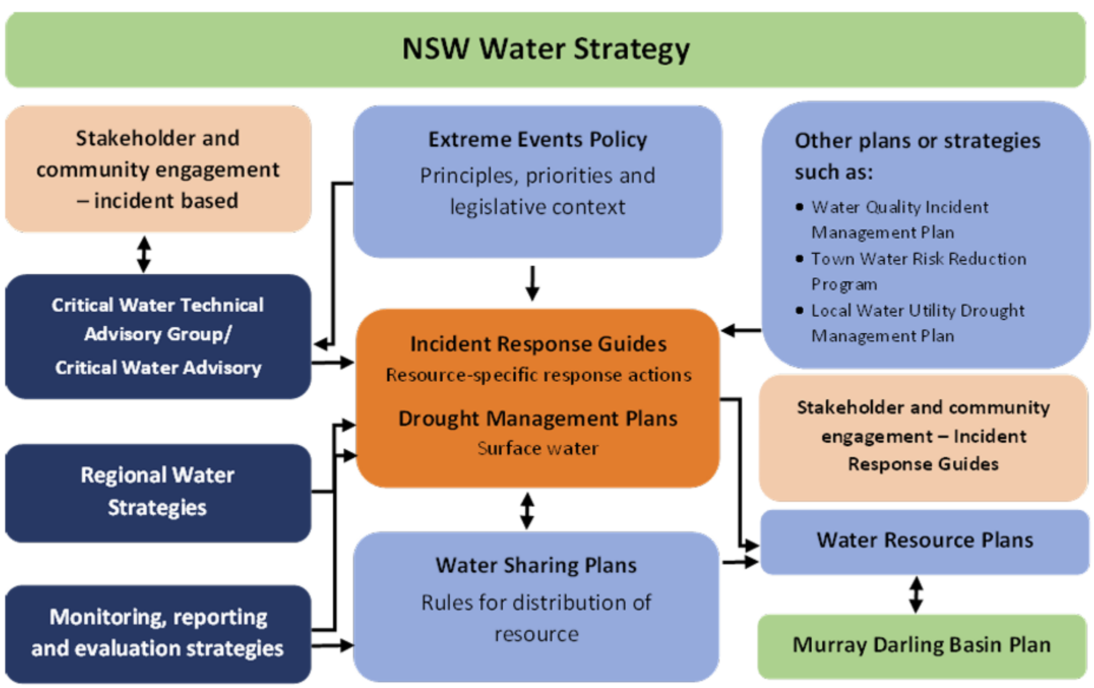
A common concern raised in discussions of the ability for water policy to respond to climate change, is situations where climate scenarios exceed the climate scenarios contemplated in policy settings. For example, where climate is worse than the worst

[22] **2020-07-10-NSWIC-Submissions-Water-Transparency-DoR-Inquiry.pdf**

on record scenario. This has led to some stakeholders arguing for the need for more risk-averse approaches to water policy settings, to cater for situations that are more extreme. Such an argument would essentially involve a more conservative approach every single year, irrespective of actual water availability, in case of an extreme event.

However, the problem with that approach is that this involves substantial trade-offs every single year, with a high opportunity cost of leaving water reserved in storage unused, which is felt by all users (agricultural, environmental, and all). Rather, the system as it currently is, is designed to still cater for very, very extreme conditions – with management interventions outlined for if worse circumstance develops. This seeks to strike a balance between managing uncertainty, risk appetite, and still the ability to manage for extreme events if they do occur.

The below diagram shows Extreme Event management in NSW.



The Basin Plan requires an Incident Response Guide (IRG) to be developed as part of the Water Resource Plan (WRP).

NSW IRGs specify:

"Incident Response Guides (IRGs) outline the framework for managing extreme events for each major water source in the NSW Murray–Darling Basin based on the principles outlined in the NSW Extreme Events Policy. They provide a progressively

expanding toolkit of approaches for water managers to select from as an event becomes more severe. This balances the need to be adaptive in response to changing circumstances, with the need for certainty, to improve longer term planning."

These cover various stages of criticality, ranging from Stage 1 where all water can be delivered on demand or under normal management operations, to Stage 4 where a critical water shortage means normal operations are untenable and emergency management is activated.

A key principle of the NSW Extreme Events Policy is: "Operation of the statutory water sharing plans should be maintained for as long as possible". The policy says: *"Water sharing plans have been developed to operate in a range of climate circumstances, and water availability decisions consider historical droughts and associated periods of very low inflows. Only in extreme circumstances would suspension of their provisions be required to meet critical water needs. For example, when the drought of record minimum inflows do not eventuate over successive years."*[23]

In summary, while policy settings that consider the broadest range of feasible climate scenarios benefits all users in providing certainty – there are a number of interventions available to deal with scenarios that are beyond the scope of what policy has been designed for. This means that pre-emptively changing policy settings caries a large opportunity cost every water year, which may not be required given the interventions available for if climate is tracking beyond the capacity of policy settings to respond.

Looking at other jurisdictions

It is important to note that while this Report focuses on NSW as the primary case study, all Basin states have similar arrangements in place, albeit with different terminology, and slightly difference processes. It is beyond the scope of this Report to compile the exact detailed arrangements for every jurisdiction. However, it is strongly recommended that the MDBA compiles such a piece of work to document a comprehensive picture across Basin States.

[23] **Extreme Events Policy**

However, to briefly identify that these variable arrangements extend beyond just NSW, the operation of variable water allocations based on water availability in South Australia can be seen below, across three scenarios. This is based on the volume of water available to South Australia, with the allocations for irrigation being High-Security entitlements.

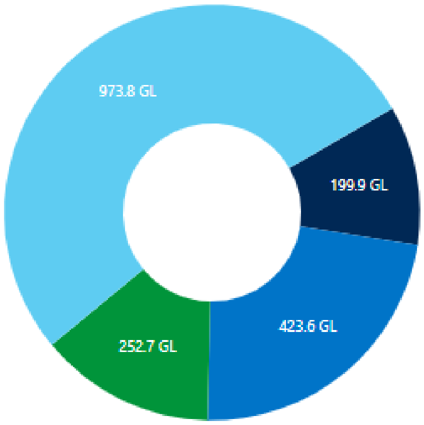
As background, the Murray-Darling Basin Agreement defines the rules for how water in the River Murray is shared between NSW, Victoria and South Australia. South Australia receives a maximum entitlement of 1850 GL under the Agreement. This is reduced when conditions are dry and water availability is limited. SA's River Murray Entitlement is shared in accordance with the requirements of the Water Allocation Plan for the River Murray Prescribed Watercourse.[24]

Key	Description (as per website)
Water to 'run the river' (light blue)	*This includes water set aside to meet the conveyance requirements to "run the river", as well as water that "remains in the river" to contribute to environmental outcomes. Conveyance water is required to deliver Critical Human Water Needs and water for all River Murray water users.*
Environment (green)	*This water is held by the Commonwealth Environmental Water Holder and the South Australian Government for environmental purposes. Water for the environment benefits wetlands and floodplains along the length of the River Murray and supports the health of the Lower Lakes and Coorong.*
Critical human water needs and town water supply (navy blue)	*This water is used to support critical human water needs in both urban and rural areas across South Australia. This water underpins the water security of the majority of South Australians, including those in metropolitan Adelaide.*
Irrigation (mid blue)	*This water is used to support productive irrigation businesses and communities in South Australia.*

Scenarios of water available for irrigation in SA, based on water availability

1850 GL: Allocations for irrigation 100%

[24] Home - River Murray Water Allocation Calculator



Volume available 1850 GL

Irrigation

This water is used to support productive irrigation businesses and communities in South Australia.

All Purpose – Class 3
High Security 100%
All Purpose – Class 8
Environmental Land Management 100%

Critical human water needs and town water supply

This water is used to support critical human water needs in both urban and rural areas across South Australia. This water underpins the water security of the majority of South Australians, including those in metropolitan Adelaide.

All Purpose – Class 1 & 5
Stock, Domestic, Industrial 100%
Metropolitan Adelaide – Class 6
Urban Water Supply 100%
All Purpose – Class 2
Country Towns 100%

Environment

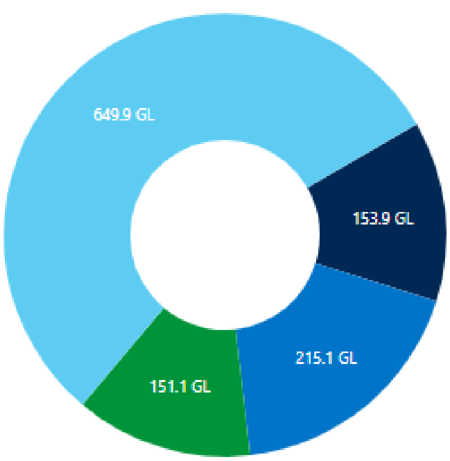
This water is held by the Commonwealth Environmental Water Holder and the South Australian Government for environmental purposes. Water for the environment benefits wetlands and floodplains along the length of the River Murray and supports the health of the Lower Lakes and Coorong.

All Purpose – Class 1
Stock, Domestic, Industrial 100%
All Purpose – Class 3
High Security 100%
Class 9
Wetland / Environment 100%

Running the river

This includes water set aside to meet the conveyance requirements to "run the river", as well as water that "remains in the river" to contribute to environmental outcomes. Conveyance water is required to deliver Critical Human Water Needs and water for all River Murray water users.

1170 GL: Allocations for irrigation 50%



Volume available 1170 GL

Irrigation

This water is used to support productive irrigation businesses and communities in South Australia.

All Purpose – Class 3
High Security 50%
All Purpose – Class 8
Environmental Land Management 50%

Critical human water needs and town water supply

This water is used to support critical human water needs in both urban and rural areas across South Australia. This water underpins the water security of the majority of South Australians, including those in metropolitan Adelaide.

All Purpose – Class 1 & 5
Stock, Domestic, Industrial 100%
Metropolitan Adelaide – Class 6
Urban Water Supply 77%
All Purpose – Class 2
Country Towns 68%

Environment

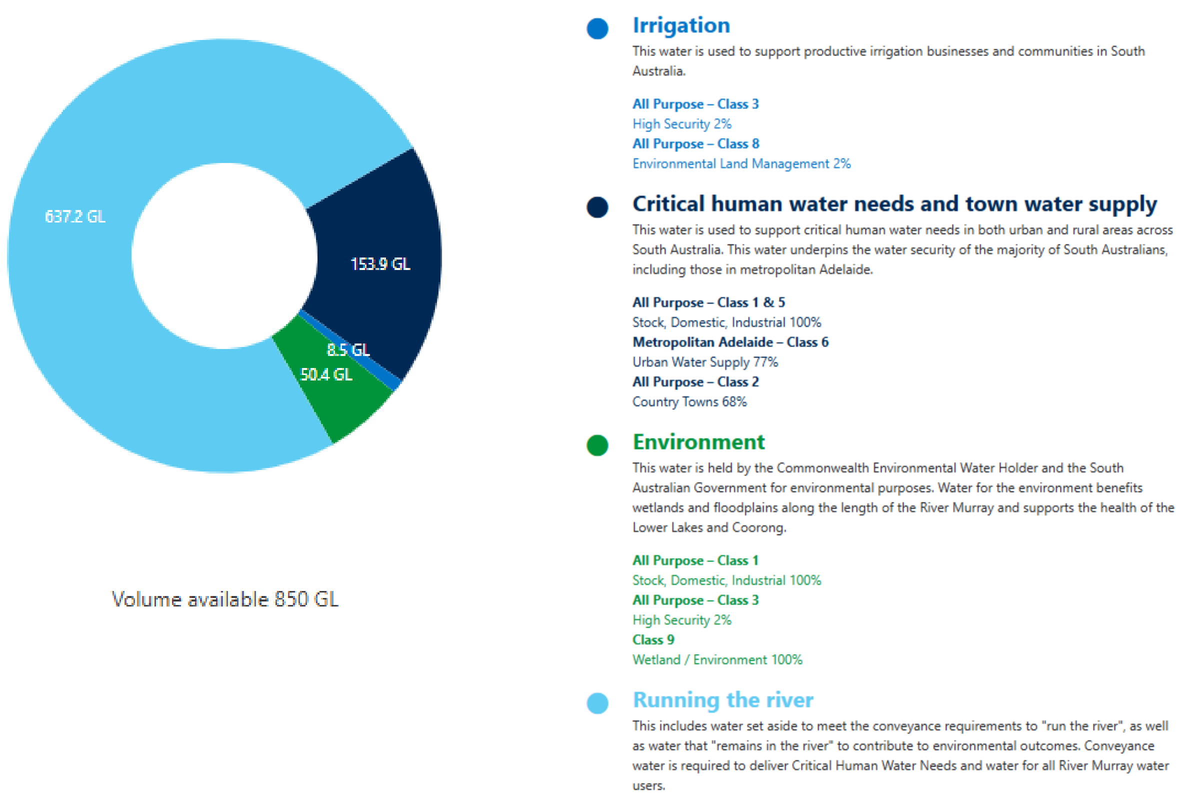
This water is held by the Commonwealth Environmental Water Holder and the South Australian Government for environmental purposes. Water for the environment benefits wetlands and floodplains along the length of the River Murray and supports the health of the Lower Lakes and Coorong.

All Purpose – Class 1
Stock, Domestic, Industrial 100%
All Purpose – Class 3
High Security 50%
Class 9
Wetland / Environment 100%

Running the river

This includes water set aside to meet the conveyance requirements to "run the river", as well as water that "remains in the river" to contribute to environmental outcomes. Conveyance water is required to deliver Critical Human Water Needs and water for all River Murray water users.

850 GL: Allocations for irrigation 2%



Further detailed compilation of the exact arrangements in each Basin jurisdiction would be a valuable piece of work for the MDBA.

The science-policy landscape

Bringing together the science landscape, with the policy landscape, is critical to understanding actual outcomes. Climate science provides very important information to inform policy discussions, but, this must be considered within the context of policy mechanisms which translate those forecasts into on-ground outcomes. This applies to both the contemplation of future policy settings, as well as understanding the status quo or baseline, to which any future policy proposals must be built on.

This section takes the climate forecasts identified from the science landscape section, and applies them to the policy landscape, to identify the expected results of current policy settings under climate change. The purpose here is to identify the status quo of how water-sharing would play out under current settings. As above, there are considerable data gaps for this science-policy nexus, so this Report will compile those currently available, and suggest where further research is required to address other gaps.

Applying climate change scenarios to policy settings for water entitlements

Given the existing arrangements for factoring in climate variability via AWDs, there is considerable concern, particularly amongst holders of general-security water access entitlements, regarding the reliability of water allocations into the future. The NSW Government has done some initial work[25] on calculating the extent of these impacts, as part of the development of Regional Water Strategies. This analysis looks at AWDs at the start and end of the water year (not including carryover) under three scenarios:

- Historical climate – based on 130+ years of recorded daily rainfall, temperature and evaporation data for 1889-2020 (used to show a repeat of the historical conditions);
- Long-term historical climate – derived stochastically from historical daily climate data and paleo climatic information (used to show a repeat of the extremes that are possible in the historical record)
- Dry future climate – adjusting the long-term historical climate scenario rainfall, temperature and evapotranspiration data according to regionally downscaled

[25] NSW Government, 'Baseline climate and hydrological assessment for the NSW Murray and Murrumbidgee regions' *Regional Water Strategies Program* (May 2024).

factors generated from the NSW and Australian Regional Climate Modelling (NARCLiM) 1.0 project.[26]

Findings are shown in Table 2 for general-security water access entitlements in Southern NSW.

Table 2 shows that under a dry climate future scenario, with current policy settings, the reliability of water allocations to entitlements will significantly decline. The percentage of the time AWDs reach 100% is expected to drop, from 40% of the time to 6% in the Murrumbidgee, and from 60% of the time to 20% in the NSW Murray. This presents a significant change, under current policy arrangements.

Table 2 Impact of climate scenarios on Available Water Determinations (AWDs) for general-security WALs in southern NSW – showing the percentage of the time AWDs reach certain points based on various climate scenarios (sourced from NSW Government data)[27]

Water Source	Scenario	Start of water year allocations 0%	Start of water year allocations >50%	End of water year allocations reach 100%
Murrumbidgee Regulated Water Source	Long-term historical and historical scenarios	5% & 10%	15-16%	40%
	Dry climate future scenario	20%	3%	6%
Murray Regulated Water Source	Long-term historical and historical scenarios	30%	20% & 10%	60%
	Dry climate future scenario	80%	5%	20%

[26] Note: the data source clarifies this is not a forecast of how climate change is expected to eventuate, but a possible future outcome.
[27] NSW Government, 'Baseline climate and hydrological assessment for the NSW Murray and Murrumbidgee regions' *Regional Water Strategies Program* (May 2024) [55&26].

For the Murrumbidgee, this is further detailed in the below figures from the Regional Water Strategy.

Figure: Impact of dry future climate scenario on Murrumbidgee region's general security available water determinations for 1 July (top) and 30 June (bottom), (Source NSW Government)[28]

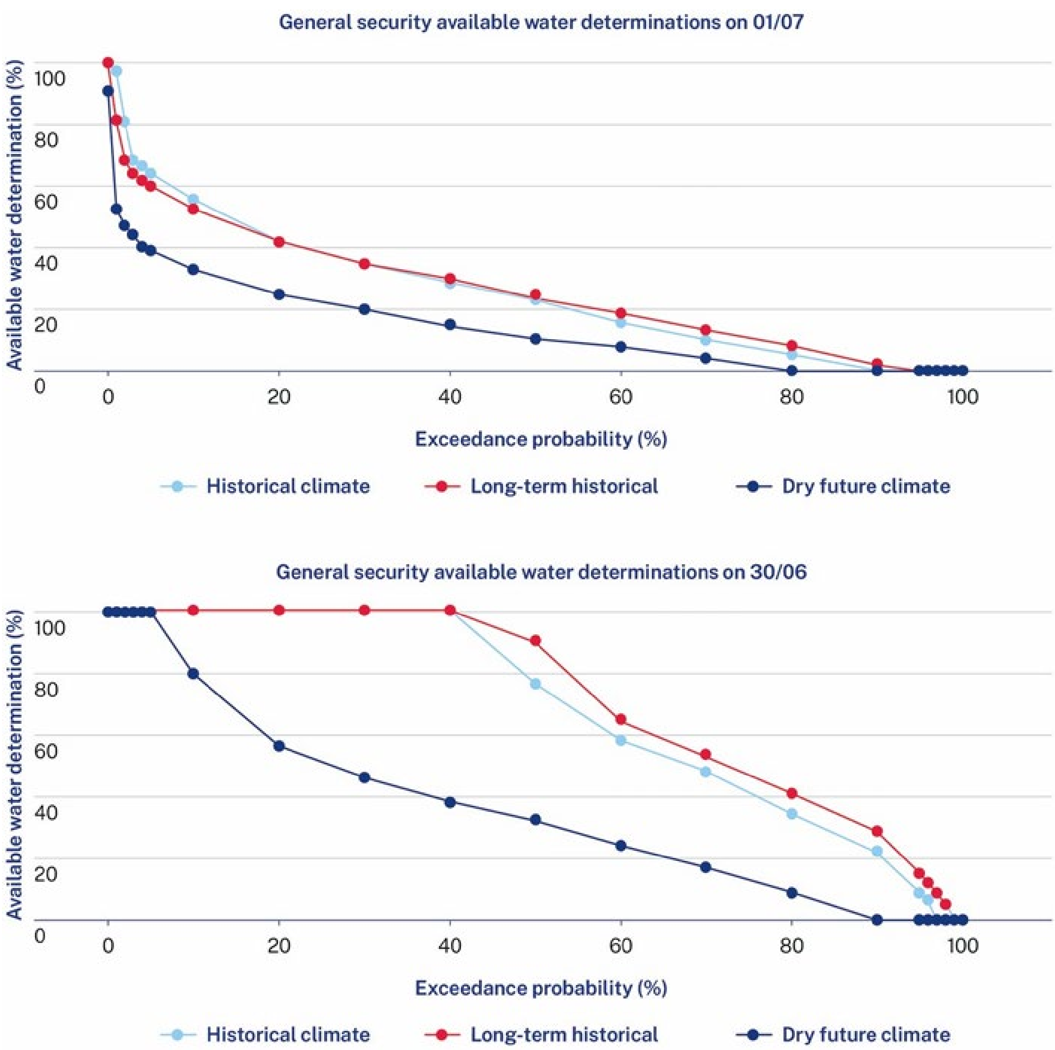
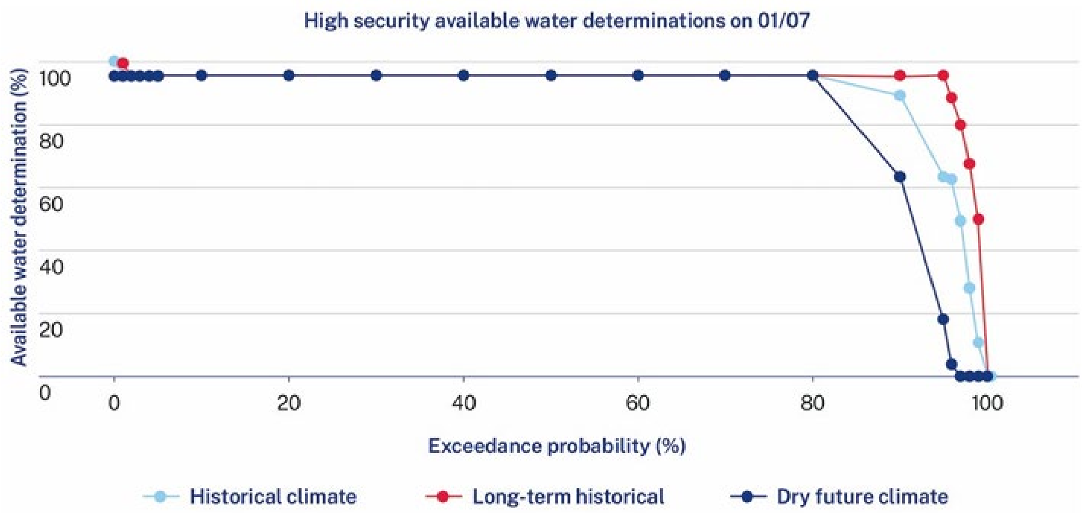
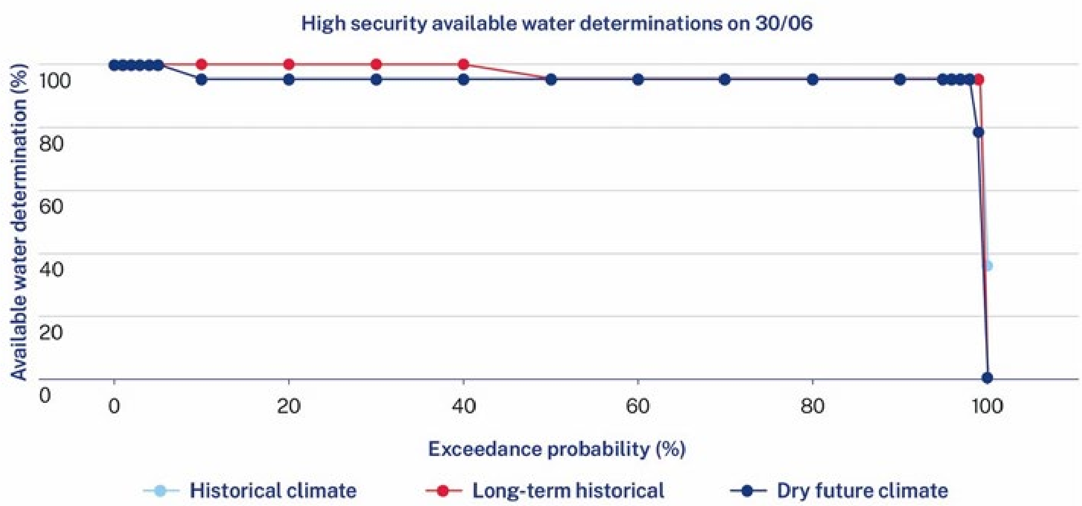


Figure: Impact of climate scenario on the Murrumbidgee region's high security available water determinations for 1 July (top) and 30 June (bottom), (Source NSW Government)[29]

[28] NSW Government, 'Regional Water Strategy Murrumbidgee' (2025) [72].
[29] NSW Government, 'Regional Water Strategy Murrumbidgee' (2025) [72].





Similar work for the NSW Murray is shown in the below figures.

Figure: Impact of dry future climate scenario on the NSW Murray region's general security available water determinations for 1 July (top) and 30 June (bottom), (source NSW Government)[30]

[30] NSW Government, 'Regional Water Strategy NSW Murray' (2025) [68].

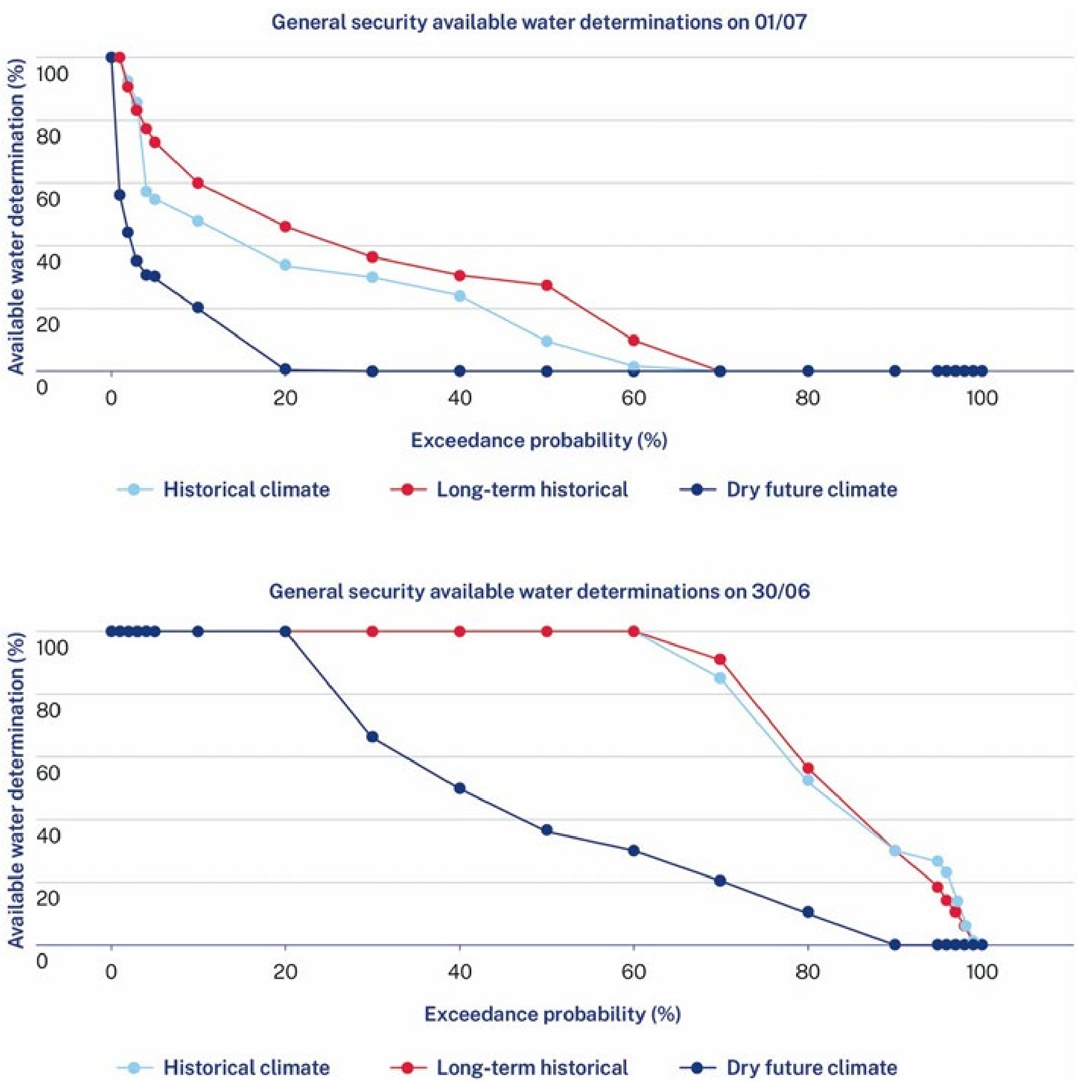
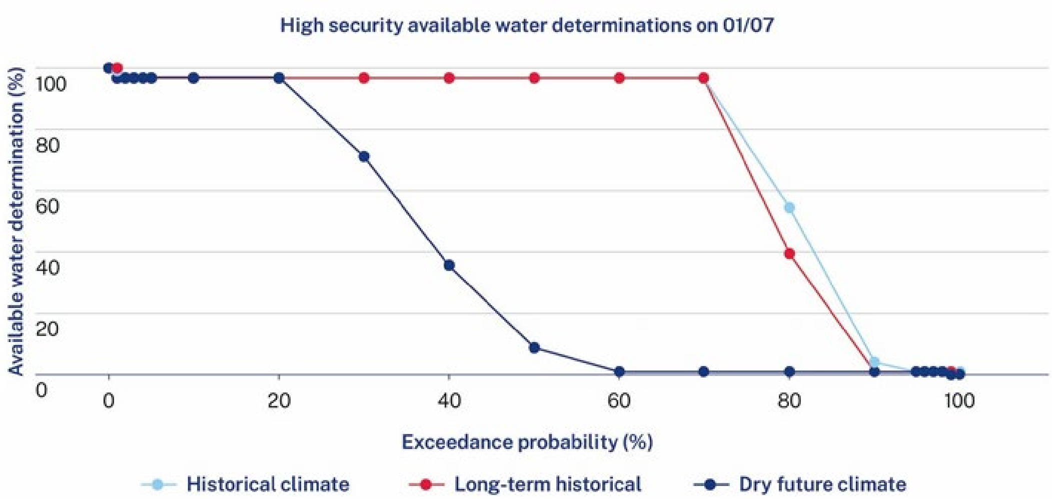
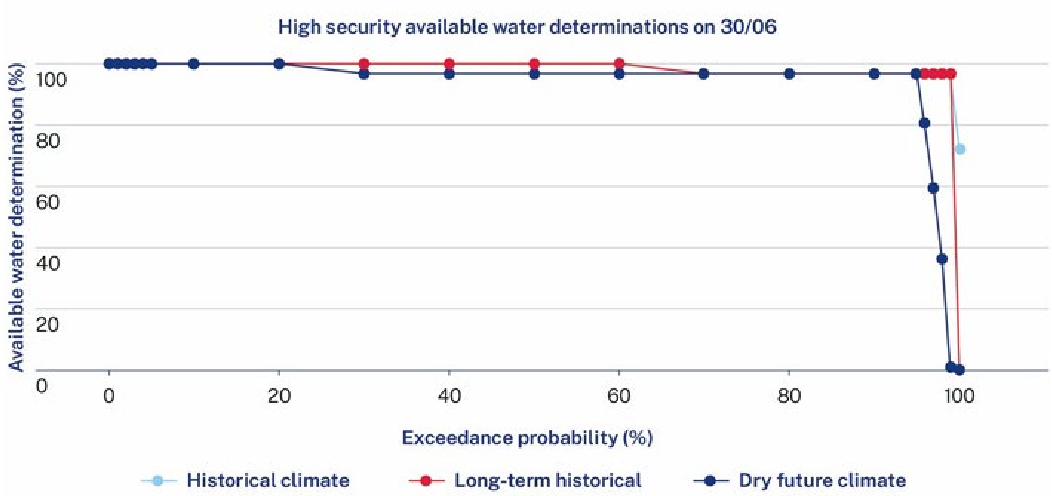


Figure: Impact of dry future climate scenario on the NSW Murray region's high security available water determinations for 1 July (top) and 30 June (bottom), (source NSW Government)[31]

[31] NSW Government, 'Regional Water Strategy NSW Murray' (2025) [69].





Similar work has been undertaken for the Northern Basin, noting some climate modelling indicates future climates may be *wetter* overall in this region.[32]

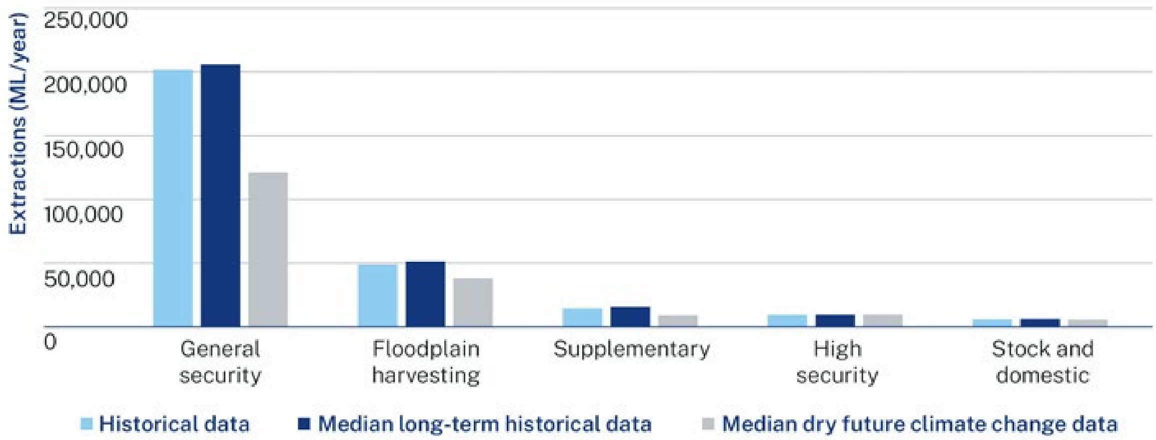
However, for a modelled dry scenario, the NSW Government has indicated, for the Macquarie:

> *"The potential impacts of decreased inflows on water licences in the regulated Wambuul / Macquarie River show that there could be a 40% reduction in water availability for general security licences and supplementary licences over the coming 40 years. For the irrigated agriculture industry, this would represent a 45% reduction in*

[32] Murray-Darling Basin Authority, 'Climate change and the Murray–Darling Basin Plan' *MDBA Discussion Paper* (2019) [10].

profit. It would also impact the ability of water managers to provide water for the environment."[33]

Figure: Possible impacts on average annual diversions for Macquarie–Castlereagh regulated rivers water access licences and floodplain harvesting (source NSW Government)[34]



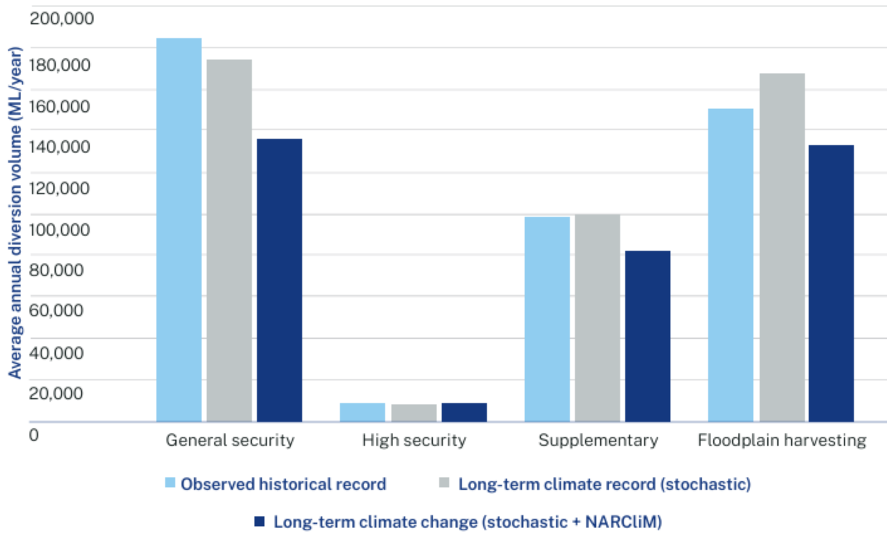
Source: Department of Planning, Industry and Environment–Water 2020, hydrological modelling

For the Gwydir,

"…under a long-term worst case dry climate change scenario, average annual extraction by general security water access licence holders, which support environmental and industry needs could decrease significantly."[35]

Figure: Possible impacts on average annual diversions by Gwydir regulated river water access licences and floodplain harvesting under the 'average' 130-year period of the future climate change projection period compared with the observed record (source NSW Government)[36]

[33] NSW Government, 'Regional Water Strategy Macquarie-Castlereagh' (October 2023) [33].
[34] **Ibid.**
[35] NSW Government, 'Regional Water Strategy Gwydir' (November 2022) [27].
[36] **Ibid.**

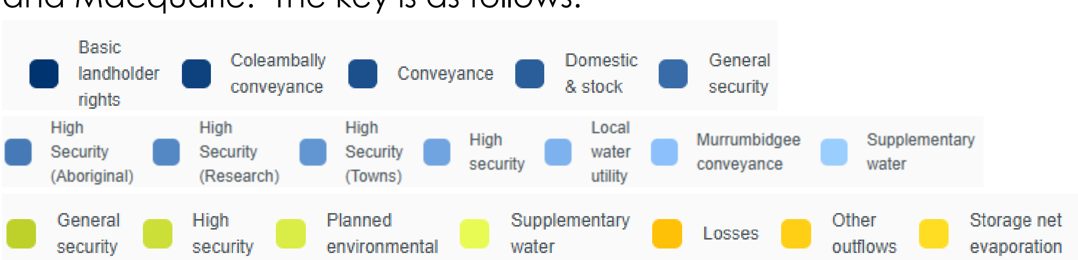


Water policy settings responding to climate across the full water balance

While the above looks at AWDs, we also need to look at the full water balance, to view water usage of all other components (such as planned environmental water, or operational water) during wet and dry years. There is no future looking work looking at this. However, by observing past trends of fluctuations in water shares across the full water balance, we can see the operationalisation of current policy settings.

The below graphs are taken from WaterNSW Water Insights. This data covers the period 2010-11 to 2023-24. Note: in this instance, water 'usage' is used broadly, and also includes water used by the environment (such as PEW), losses, other outflows and evaporation.

The same 4 case study water sources are shown: NSW Murray, Murrumbidgee, Gwydir and Macquarie. The key is as follows:



Key observations from the graphs below are:

- During dry years:
    - water usage by all users decreased as total water availability decreased;
    - water usage by consumptive users significantly decreased;
    - there was some Planned Environmental Water maintained (i.e. water for the environment that is not on a license), but not as much as during a wet year;
    - water usage by the environment from licenses (i.e. Held Environmental Water) also decreased similar to consumptive users (as these licenses are subject to the same conditions and characteristics as licenses sued for consumption).
- During wet years:
    - water usage by all users increased, as total water availability increased;
    - the largest booms in wet years are from the environment (PEW) and operational water (losses, other outflows and evaporation shown in orange).
- During all years:
    - Consumptive use is a small proportion of the total water usage.

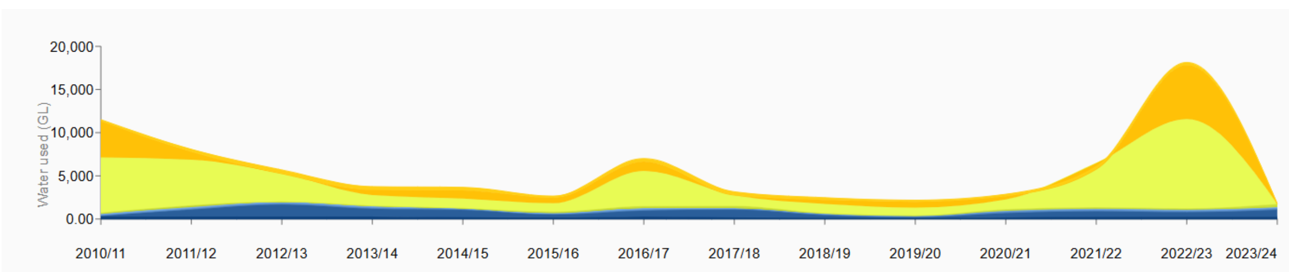


Figure 5 NSW Murray Reg Water Usage

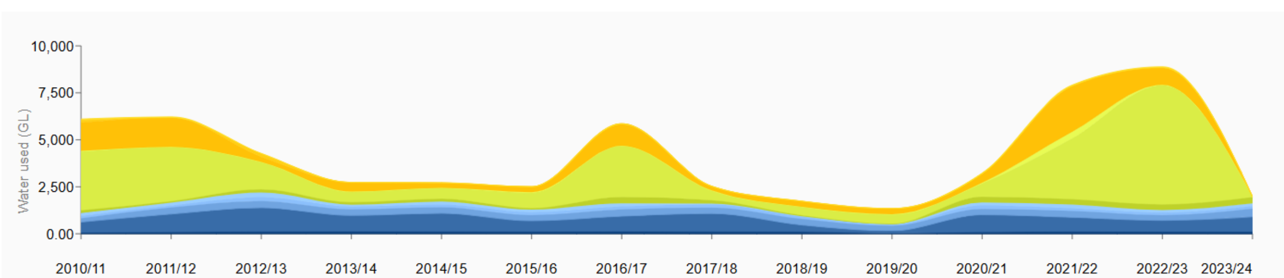


Figure 6 Murrumbidgee Reg Water Usage

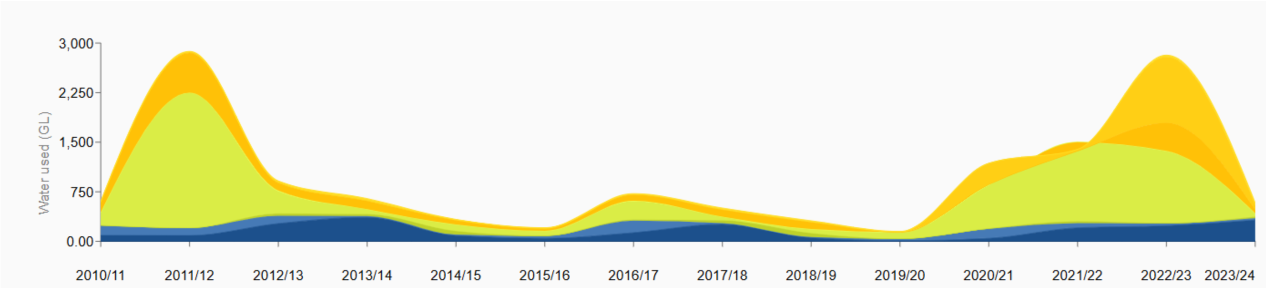


Figure 7 Gwydir Reg Water Usage

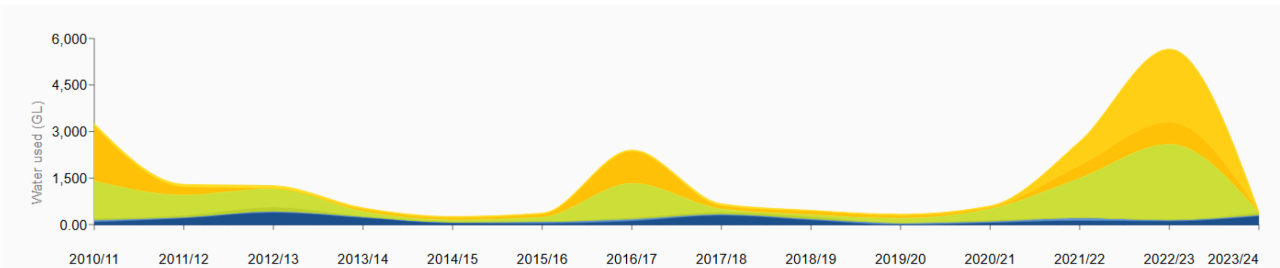


Figure 8 Macquarie and Cudgegong Reg Water Usage

The purpose of presenting this data is to demonstrate how climate change impacts on water availability are expected to translate to impact water access entitlements, under *current* policy settings. Understanding how various climate scenarios will manifest under current policy settings is an integral part of the conversation on future management arrangements.

Discussion

Climate change presents a shared challenge and risk for water resource management in Australia, affecting all stakeholders who depend on water and requiring a collective response. Nothing in this report is to suggest it is not a problem, nor that nothing needs to change in response. Rather, this report seeks to ensure that the right solutions are in place for these challenges, with an evidence-based approach, and one that understands the current framework and plausible risk.

a) Why understanding the science-policy nexus of climate and water policy is important?

A failure to properly understand the current framework, and how it is operationalised, poses major risks, particularly during periods of major review and reform, such as:

- Poorly designed policy solutions that are not effective against the intended purpose;
- Pre-emptive, or unnecessary, policy reactions with the subsequent costs, trade-offs and impacts;
- Unnecessary tensions, undermined social cohesion, or poor confidence in public water management, through poor water literacy;
- Failure to invest in the types of interventions or mechanisms which are required (such as infrastructure) if there is a view that policy has the capacity to achieve the outcomes.

More generally, understanding the current framework, particularly the future forecast reliability of water entitlements is critical for:

- The Federal Government to understand the security of a multi-billion dollar public asset.
- The Federal Government to inform any future water purchasing decisions, as decisions to purchase water from irrigators for climate purposes will likely not be effective, as that entitlement is unlikely to generate the desired water allocation at the point in time it is intended to serve (i.e. a dry period). Put simply, it would be purchasing an empty asset. If the objective is to enhance drought resilience, new innovative and targeted tools and infrastructure investments will be required to build resilience and improve reliability of water security. This is beyond what simple water recovery can achieve.
- Water users – both agricultural, environmental and other – to understand potential risks, and to inform future planning and decision-making;

Water-dependant stakeholders - there are important conversations that need to occur amongst all stakeholders about objectives, and coming together to form shared visions for what is possible under certain climate change scenarios. As the MDBA acknowledges, *"Under a range of future climate scenarios, it will not be possible to manage or protect all assets in ways that achieve current Basin Plan outcomes. This makes prioritisation and targeted actions essential."*[37]

[37] **2026 Murray–Darling Basin Plan Review Discussion Paper [34].**

b) What does this mean for the 2026 Basin Plan Review and policy decisions

The Water Act 2007 (Cth) specifically requires the regular 10 yearly reviews of the Basin Plan to consider certain matters, including "the management of climate change risks".

There is evidently a large water literacy gap for stakeholders understanding how risks of climate variability and change is managed through the water management framework, across both the Basin Plan and state instruments. A valuable contribution of the Basin Plan Review should be clearly articulating the current settings of how risks are managed, to ensure evidenced-based dialogue of all decisions and policy dialogue.

The MDBA has said:
"The Authority has considered climate change. Given the wide range of plausible climate futures, the Authority is not proposing changes to the SDLs in response to climate change in 2050 through this review. Our approach is to assess and guide the management of Basin climate risks and enable climate change adaptation over the long term. The Water Act 2007 (Cth) requires 10-yearly reviews of the Basin Plan. During these reviews, the Authority will assess whether the SDLs continue to support the Basin Plan's environmental outcomes through to the next Basin Plan Review and towards the planning horizon of 2050. These reviews will consider plausible climate change scenarios. Through this process, the Authority may recommend changes to the Basin Plan outcomes and identify priorities for science, knowledge and monitoring, to ensure the Basin Plan continues to be fit for purpose under climate change."[38]

Based on the above explanations, this is an appropriate and proper process. The water management framework, including actual annual permitted levels of take, will continue to vary year to year based on actual hydrological conditions, and will change over time with the climate. If, over the long term, data on APT compared with SDL suggests a trend of divergence, then the methods and assumptions for SDL and APT may require consideration. This can occur as part of future reviews when longer data sets can be established. At this point in time, with SDLs only having taken effect in 2019, there is no case for changes now to long term annual average limits,

[38] 2026 Murray–Darling Basin Plan Review Discussion Paper

particularly given the ongoing variations to actual levels of take which occur in response to climate.

This does not mean we "do nothing". Some valuable ways forward are contemplated in the Basin Plan Review Discussion Paper, including:

- **Consideration of realistic and feasible outcomes under climate change** – "*Climate adaptation will involve difficult decisions about priorities and trade-offs. There will be circumstances where we will not be able to support the Basin Plan's environmental outcomes and protect environmental assets*."[39] Further: "*Under a range of future climate scenarios, it will not be possible to manage or protect all assets in ways that achieve current Basin Plan outcomes. This makes prioritisation and targeted actions essential.*"[40]
- **Opportunities to optimise management of water for the environment to get better outcomes more efficiently** – "*Continuing to improve how water for the environment is managed is crucial to delivering outcomes under climate change*"[41]
- **Utilising integrated catchment management or complementary measures to optimise outcomes** – *"Embedding integrated catchment management at the heart of future Basin planning is critical as we face increased pressure on our resources under climate change. It means making best use of limited resources, including environmental water, through coordinated planning and investment in interrelated actions that recognise the system works, not in isolation."*[42]
- **Addressing infrastructure risks** – "*While critical to address, most of the Basin's infrastructure and water security challenges cannot be solved through the Basin Plan*"[43]. Further: "*Having fit-for-purpose assets in operable condition is essential to support effective Basin water management under an increasing variable climate.*" Furthermore: *"Improving water security for northern Basin communities will require diversification of alternative water supplies. Safe and secure water for small and remote communities depends on strategic water planning, sustainable funding and workforce arrangements, plus upfront and ongoing infrastructure investment and maintenance."*[44]
- **Ongoing science and knowledge generation –** *"Climate change creates major challenges for Basin water management. To respond well, we need sustained*

[39] **2026 Murray–Darling Basin Plan Review Discussion Paper [7].**
[40] **Ibid [34].**
[41] **2026 Murray–Darling Basin Plan Review Discussion Paper [17].**
[42] **Ibid [45].**
[43] **2026 Murray–Darling Basin Plan Review Discussion Paper [18].**
[44] **Ibid [72].**

> *funding, better data, improved science and the ability to predict change to inform adaptive decision-making."*[45]

However, other components require better recognising the current frameworks in place, including the water management powers and responsibilities vested in States. For example, part of the Discussion Paper also contemplates to "*introduce minimum requirements to plan for critical human water needs during periods of low water availability and hydrological drought*". As outlined above, the Basin Plan already requires States to have IRGs as part of the WRP to deal with situations of extreme water shortages.

The above list of dot points provides a series of meaningful opportunities for the water management framework, and necessary co-investments, can support climate resilience. Notably, changing diversion limits is not the only mechanism, nor can it feasibly serve to achieve many of the outcomes listed above.

c) How do we conceptualise water security in an Australian context with a variable and changing climate?

Water security is at the heart of Australia's water management, and specified as an Object across legislative instruments such as the Water Act 2007 (Cth). However, water security is a complex concept, and has unique contextual considerations, particularly in Australia with an inherently insecure (or variable) supply of water.

UN-Water defines water security as:
"*The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.*"

On a simplistic level, water security could be understood as all users having sufficient water. However, in a pragmatic sense, in a world of finite and variable supply, and potentially infinite demand, such a definition becomes of little practical value to

[45] **Ibid [81].**

policy. The concept, therefore, attempts to move beyond just the physical availability of water, but the broader capacity of a population to manage for it, within hydrological and other realities. Water security is not just an abundance of water, but concerns whether water systems can provide acceptable levels of service and outcomes in the face of variability, shocks and longer-term change. Put simply – confidence in how water systems can manage risk and uncertainty.

This becomes even more significant in an Australian context for two key differences. Firstly, where water availability itself is intrinsically variable, with boom-and-bust periods of rainfall, and therefore streamflow, soil-moisture and water in storages. This typical variability is strongly shaped by large-scale climate drivers (including El Niño–Southern Oscillation, the Indian Ocean Dipole, Southern Annular Mode and the Hadley Cell and the Sub-tropical Ridge) while also experiencing longer-term climatic changes bringing additional risks of extreme conditions (both droughts and floods). The variability is the certainty.

Secondly, our Australian water management foundation by design, provides for a risk-based system adjusting to our variable climate, through a clear system rules, entitlements, allocation processes and risk-assignment settings for water separate from land. Our contemporary water management system is largely unique in this way.

Water security – as a policy objective - in this context is therefore more complex than current global definitions and concepts present.

Water security in Australia, cannot realistically mean guaranteeing a fixed volume of water, at all times, despite the desirability**.** Such a conception would ultimately fail because the physical resource itself is variable. However, this does not mean water security is not possible, nor that it is not a worthy ambition and policy objective. But it does require refining our understanding of what water security looks like in the Australian context, which in turn, influences what the role of water policy (or other levers) can play in managing for water security. Water policy settings can only manage the water that is available.

This provides an important conceptual foundation for an Australian definition of water security: security is not the absence of variability; it is confidence that variability will be managed within a durable, robust, transparent and accepted institutional and policy framework. Put simply, certain water policy, to manage for uncertain water availability.

It is the rules, entitlements, allocation processes and risk-assignment settings that are stable and predictably applied as conditions change – not the volume of water available in any given year, which will continue to vary with climate and seasonal conditions. Conflating the two, risks reading water security as a promise of fixed allocations, which the system neither delivers nor is designed to deliver (or could deliver). Similarly, it risks unrealistic or unattainable expectations on policy, and perceived policy failures, where water quantities are undesirable.

However, it is important to recognise that even with the most robust and climate-responsive policy settings, there will come times of severe water shortages where critical needs (such as town water supplies, critical environmental needs, or critical needs for agriculture) will be compromised. The question is – is that something water policy (in terms of rules of access and distribution) can prevent, or does it require non-regulatory tools such as supply-side measures (infrastructure and secondary or alternative water sources); interventions outside the water portfolio (such as urban planning); as well as adaptations by all users to new climate realities.

If the conversation on water security in Australia gets stuck on guaranteeing volumes of water to all users at all times – it will not only fall short of expectations – but we will likely not be having the types of nuanced conversations possible on what legitimate and meaningful interventions may be required. Understanding the role, capacity and limitations of water policy is crucial.

Water security for agriculture is a critical consideration in any climate. Reliable access to water under stable and predictable rules underpins agricultural production, regional economies and Australia's domestic and international food security. In a variable and changing climate, this does not mean guaranteeing fixed volumes of water; rather, it means maintaining a durable entitlement and allocation framework that allows water users to understand, plan for and manage variability and risk.

This Report therefore looks at the current design of the water policy framework to respond to both climate variability and change.

d) The role of infrastructure

A further dimension of water security is whether the physical infrastructure and supply sources that Basin communities, irrigated agriculture and modern environmental management currently rely on remain fit-for-purpose under future conditions.

As highlighted above, the Basin Plan Review Discussion Paper rightly points out: "*While critical to address, most of the Basin's infrastructure and water security challenges cannot be solved through the Basin Plan*"[46].

Policy responses can only go so far, to manage the water available across various demands, but conversations on the supply-side of the equation are equally important.

NIC is concerned by evidence of ageing water infrastructure risk, as identified in the 2026 Basin Plan Review Discussion Paper: "*Much of this river infrastructure, including for town water treatment and supply, is near or passed its engineered life span and increasingly vulnerable to failure... Current capital expenditure is one-third to half the necessary level to sustain this important asset base over the long term.*"

Adequate, safe and well-maintained water infrastructure is the essential foundation of the entire water management system as we know it today. Traditional water supplies and storages that Basin communities and irrigated agriculture have relied on may not, on their own, provide the same reliability into the future. Building genuine water security will require governments to actively invest in:

- maintaining current infrastructure to be operational and fit-for-purpose into the future; and
- investing in a broader range of supply solutions that may include new infrastructure to more efficiently store and deliver water such as dams, weirs, pipelines, on-farm storage, alternative sources, water recycling, desalination and better preparedness for emergency supply interventions such as water-carting for high-priority town and community needs. These will need to be within current limits but must be explored working with local councils, who are primarily responsible for town water supply.

NIC is pleased to see that "*the review will highlight the urgent need for a significant uplift in investment to reduce the risk of asset failure and safety risks*".[47]

As part of this, NIC recommend an infrastructure audit is undertaken to examine the infrastructure requirements to manage for critical human water needs in the Basin, and determine if they are fit-for-purpose for climate change. This is separate to reviewing

[46] **2026 Murray–Darling Basin Plan Review Discussion Paper [18].**
[47] **2026 Murray–Darling Basin Plan Review Discussion Paper [69].**

the policy settings, rather, looks at the infrastructure requirements (and current availability) to meet needs.

Conclusion

Climate change is a critically important part of the conversation for Australia's water management. Developing the right responses will necessarily involve not only understanding climate science (both the opportunities, limitations and uncertainties), but also how those scenarios play out given current policy settings for the use, management and sharing of water resources. Failure to consider the science-policy nexus will risk both solutions that are not effective against intended objectives, as well as the risk of pre-emptive reform with large costs and impacts.

This Report is not saying everything is perfect and no change is needed - rather – it urges an evidence-based approach, which recognises the current systems in place, the uncertainties in climate science and forecasting, and the need for a proper conversation to get the right solutions to an inherently wicked problem.

The scope of this report is the MDB – while similar systems and process exist in other jurisdictions outside the MDB – for jurisdictions which have made less progress towards NWI commitments (such as variable water entitlements unbundled from land), there remains opportunity to further their climate-responsiveness of policy settings by further implementation of those NWI commitments. However, as evidenced by this report, for MDB jurisdictions – which are the focus of current reviews - climate-responsiveness of policy settings is well-established.

Key recommendations, moving forwards, will be for:

- The MDBA maintain their draft position that "*Given the wide range of plausible climate futures, the Authority is not proposing changes to the SDLs in response to climate change in 2050 through this review.*"
- The MDBA to collate existing policy mechanisms at both a state and federal level to communicate how water allocations and permitted take vary in response to climate in each jurisdiction, to ensure appropriate levels of understanding of the status quo to inform decision-making and stakeholder understanding;
- The MDBA, as part of the Basin Plan Review, coordinate work with each jurisdiction to forecast likely reliability impacts to water allocations across entitlement types, in each water source, for various climate scenarios – to understand how climate scenarios will play out based on the status quo of policy settings;

- The CEWH similarly undertake a program of work to examine reliability trends of water entitlements in their portfolio under various climate change scenarios;
- The MDBA, as part of the Basin Plan Review, include explanation of how actual and permitted levels of take vary based on climate, to improve confidence in the ability of the current system to respond to climate variability and change on an ongoing adaptive basis;
- The Federal Government undertake an audit of Australia's water infrastructure, focusing on town water supplies, to assess against climate-readiness and invest funding to future-proof critical human water needs in at-risk communities;
- Expand the capabilities of My Climate View and other climate tools to include forecast trends in the reliability of water allocations to water entitlements, to be of increased value for irrigated agriculture and other water entitlement holders.

Ultimately, Australia's unique climate and highly variable water availability requires a uniquely Australian approach to water security that cannot be solved by water policy alone. Policy cannot remove variability; it provides stable, robust and transparent rules to give confidence in how variable water availability and risk will be managed. As evidenced through this report, such policy settings are well-established in the MDB.

However, even with climate-responsive policy, there are limits to what policy itself can realistically deliver towards water security in a variable climate, particularly in extreme dry times when the water simply isn't available.

There are a range of non-policy levers that must be considered. Modern, fit for purpose water infrastructure is essential to capture, store, and use water efficiently and is will be a critical climate adaption and mitigation tool needed to maintain water security for all. Dams and water storages are part of that conversation, but infrastructure also extends beyond that.

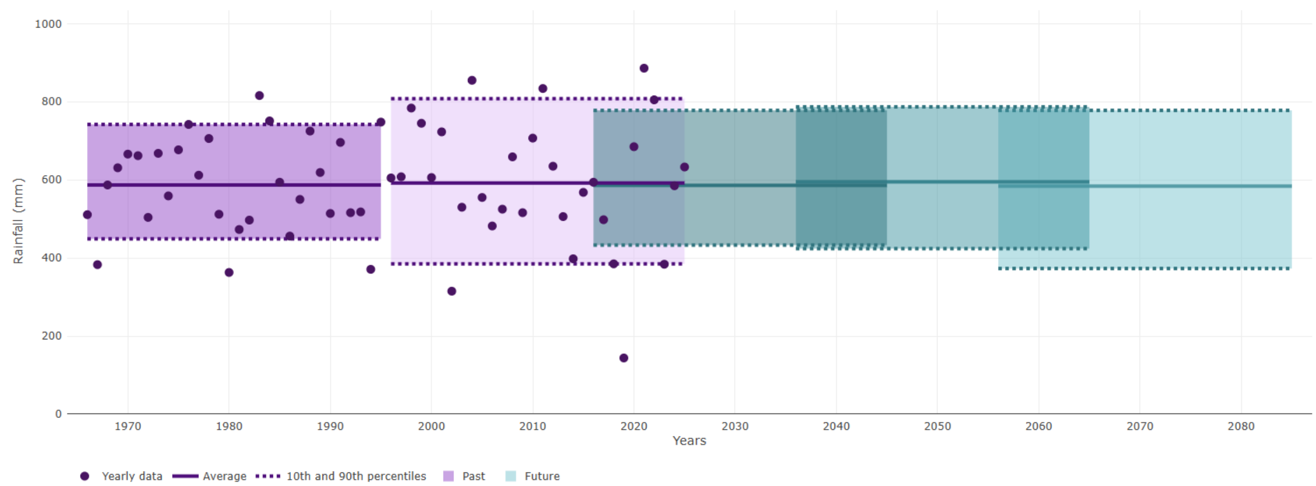
For agriculture, farmers already lead in adaption to climate to remain sustainable and globally competitive, but adaption will have limits. Future resilience depends on optimising all tools, continued investment in water use efficiency, research and development, and climate smart, as well as fit for purpose infrastructure (on farm and shared infrastructure).

Climate uncertainty is a collective challenge requiring Governments, communities, industry, irrigators, and the environment to share the risk, and cooperatively better plan and prepare for everyone to achieve more from less.

Appendix 1) Case studies of town climate futures

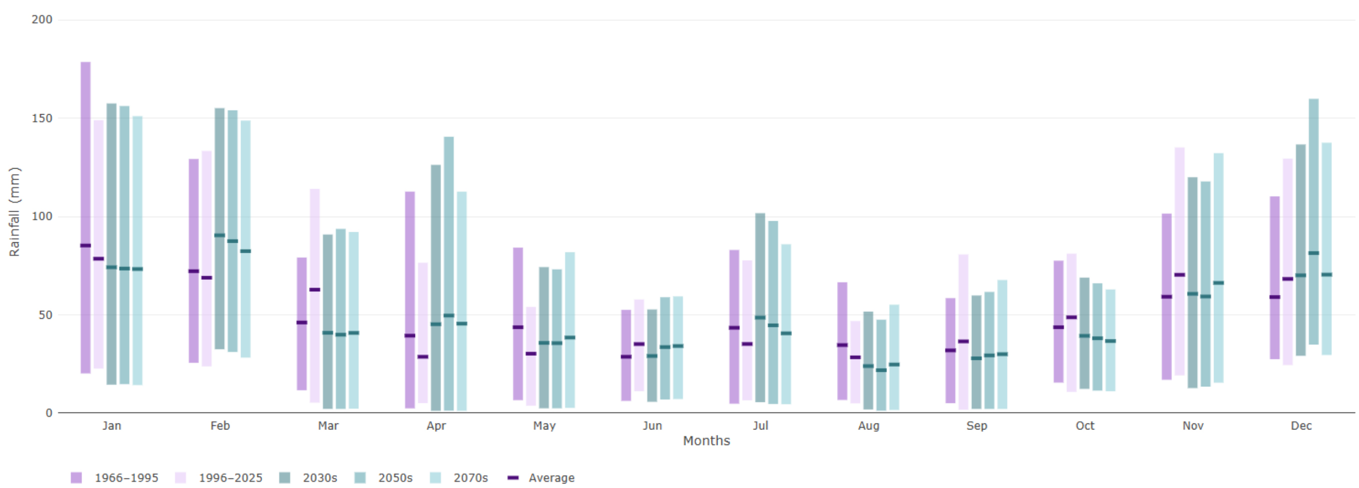
Moree

Figure: Past and projected future total rainfall



1966–1995 average	1996–2025 average	2030s average	2050s average	2070s average
587 mm	592 mm	586 mm	595 mm	584 mm

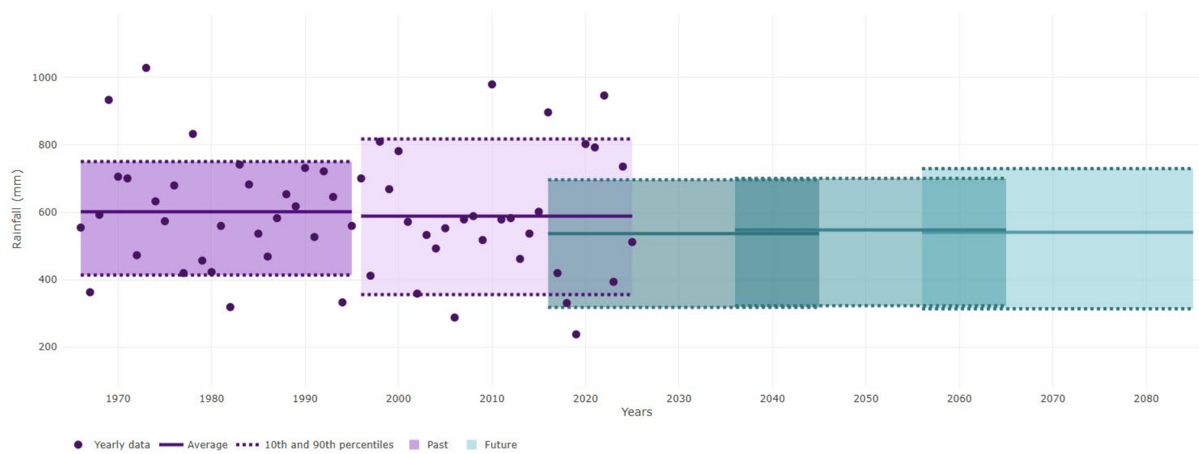
Figure: Past and projected future monthly rainfall



	1996–2025 average	2050s average	Approx. change by 2050s
Total rainall Total rainfall is defined as the total rainfall between 1 January and 31 December.	**592 mm**	**595 mm**	Inconclusive*
Autumn rainfall Autumn is defined as between 1 March and 31 May.	**122 mm**	**125 mm**	Inconclusive*
Winter rainfall Winter is defined as between 1 June and 31 August.	**99 mm**	**100 mm**	Inconclusive*
Spring rainfall Spring is defined as between 1 September and 30 November.	**156 mm**	**127 mm**	↓ 29 mm less
Summer rainfall Summer is defined as between 1 December and 28 February.	**212 mm**	**244 mm**	↑ 32 mm more

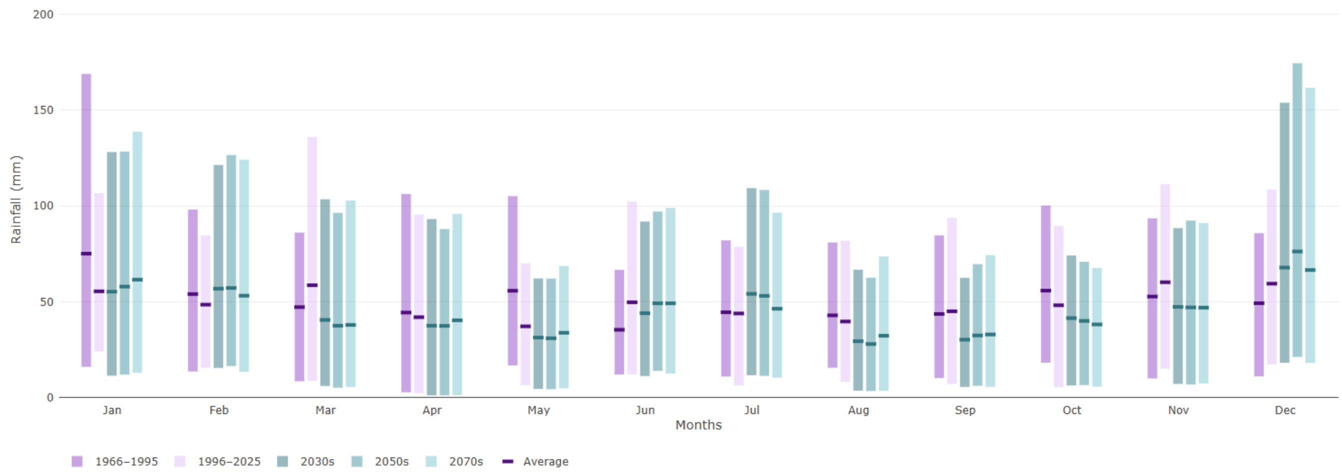
Dubbo

Figure: Past and projected future total rainfall



1966–1995 average	1996–2025 average	2030s average	2050s average	2070s average
602 mm	589 mm	537 mm	548 mm	541 mm

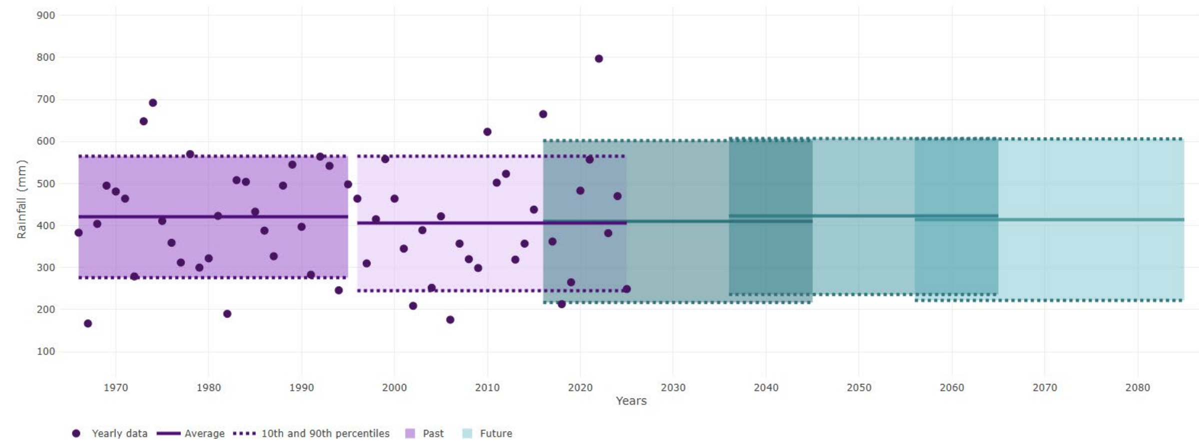
Figure: Past and projected future monthly rainfall



	1996–2025 average	2050s average	Approx. change by 2050s
Total rainfall Total rainfall is defined as the total rainfall between 1 January and 31 December.	**589 mm**	**548 mm**	Inconclusive*
Autumn rainfall Autumn is defined as between 1 March and 31 May.	**138 mm**	**106 mm**	↓ 32 mm less
Winter rainfall Winter is defined as between 1 June and 31 August.	**134 mm**	**131 mm**	Inconclusive*
Spring rainfall Spring is defined as between 1 September and 30 November.	**154 mm**	**120 mm**	↓ 34 mm less
Summer rainfall Summer is defined as between 1 December and 28 February.	**162 mm**	**188 mm**	↑ 26 mm more

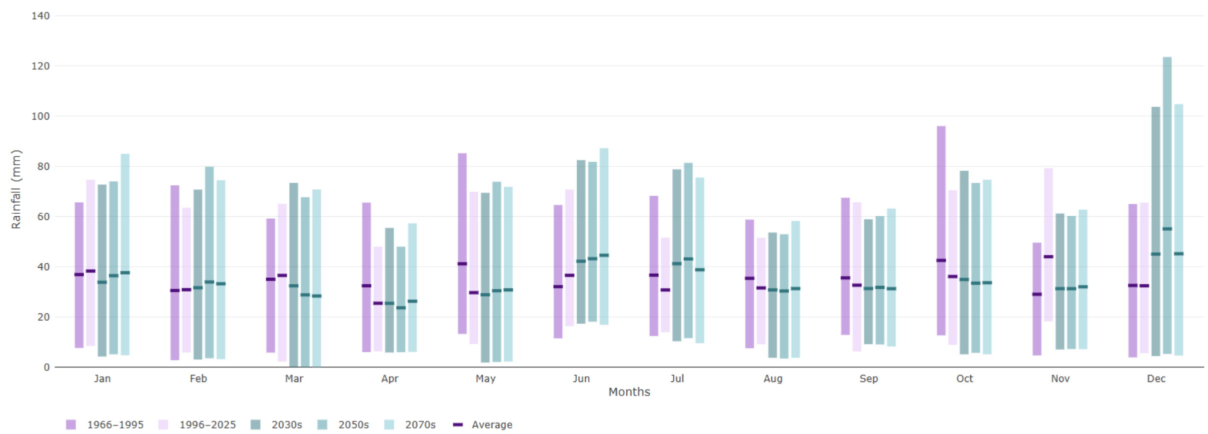
Griffith

Figure: Past and projected future total rainfall



1966–1995 average	1996–2025 average	2030s average	2050s average	2070s average
421 mm	406 mm	410 mm	423 mm	414 mm

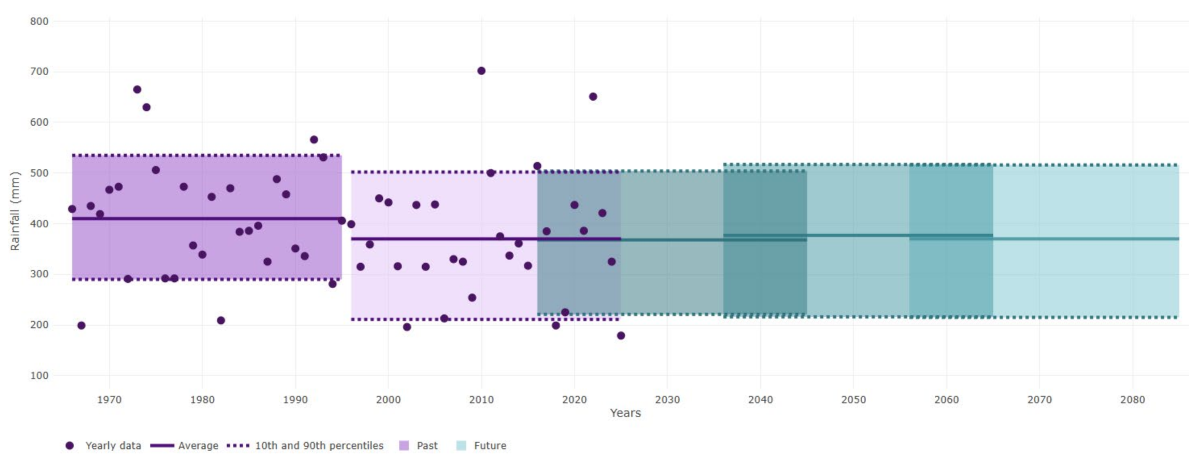
Figure: Past and projected future monthly rainfall



	1996–2025 average	2050s average	Approx. change by 2050s
Total rainfall Total rainfall is defined as the total rainfall between 1 January and 31 December.	**406 mm**	**423 mm**	Inconclusive*
Autumn rainfall Autumn is defined as between 1 March and 31 May.	**92 mm**	**83 mm**	Inconclusive*
Winter rainfall Winter is defined as between 1 June and 31 August.	**99 mm**	**117 mm**	↑ 18 mm more
Spring rainfall Spring is defined as between 1 September and 30 November.	**113 mm**	**97 mm**	↓ 16 mm less
Summer rainfall Summer is defined as between 1 December and 28 February.	**98 mm**	**124 mm**	↑ 26 mm more

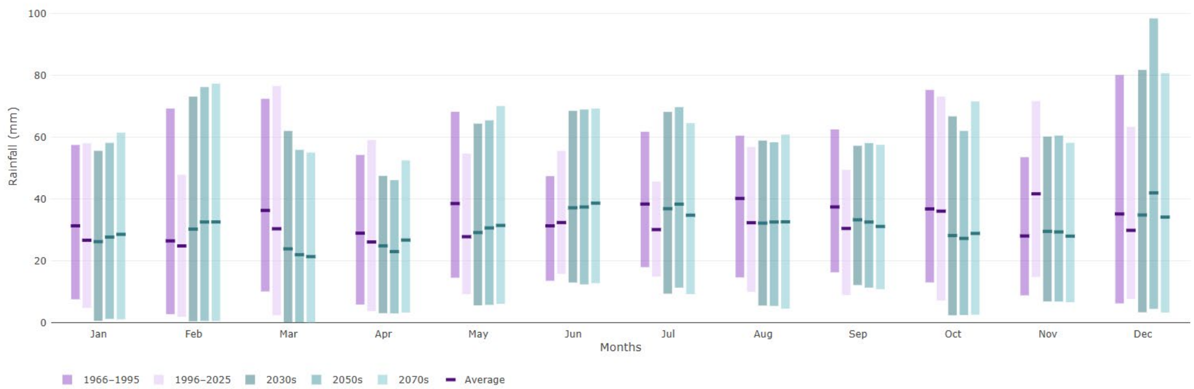
Deniliquin

Figure: Past and projected future total rainfall



Past		Future		
1966–1995 average	1996–2025 average	2030s average	2050s average	2070s average
410 mm	370 mm	368 mm	377 mm	370 mm

Figure: Past and projected future monthly rainfall



	1996–2025 average	2050s average	Approx. change by 2050s
Total rainfall Total rainfall is defined as the total rainfall between 1 January and 31 December.	**370 mm**	**377 mm**	Inconclusive*
Autumn rainfall Autumn is defined as between 1 March and 31 May.	**85 mm**	**76 mm**	↓ 9 mm less
Winter rainfall Winter is defined as between 1 June and 31 August.	**95 mm**	**109 mm**	↑ 14 mm more
Spring rainfall Spring is defined as between 1 September and 30 November.	**109 mm**	**89 mm**	↓ 20 mm less
Summer rainfall Summer is defined as between 1 December and 28 February.	**80 mm**	**100 mm**	↑ 20 mm more