Climate and Streamflow Data information sheet

Understanding and accessing climate data, streamflow data and climate projection data for town water security analysis

Introduction

To meet the strategic planning outcome *Understanding water security* under section 3 of the Regulatory and Assurance Framework (RAF), a local water utility needs to understand the long-term availability and reliability of access to water from relevant water sources and any risks to access now and into the future.

To analyse to a reasonable standard the availability and reliability of access to water from a water source, the local water utility should take a long-term outlook and consider impact of climate variability and change on access to water sources.

The Understanding Water Security guidance (the guidance) sets out expectations for achieving the water security outcome. This includes modelling climate variability through the use of instrumental and paleostochastic data sets and climate change through the use NARCliM climate projections. A key concept shaping the use of climate data is the distinction between climate variability and climate change, which is discussed in Appendix A.

Data for Water Security Analysis

To support town water security planning, two main types of datasets are available:

Historical and Baseline Data

These datasets provide a foundation for understanding past and natural climate variability:

- **Instrumental climate data** – Continuous historical records of rainfall, temperature, and evaporation from SILO.
- **Instrumental streamflow data** – Modelled daily streamflow derived from historical climate records.

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- **Paleo-stochastic climate data** – 10,000-year synthetic sequences that capture long-term natural variability.
- **Paleo-stochastic streamflow data** – Extended synthetic streamflow sequences based on paleo-stochastic climate data.

Future Climate Projections (NARCliM)

These datasets help assess potential future changes in climate:

- **NARCliM 2.0 projections** – NSW's official high-resolution climate projections (1951–2100).
- **NARCliM 1.0 projections** – Legacy projections used in earlier modelling.

The following sections describe each dataset in detail, including their characteristics, sources, and how to access them.

Historical and baseline data

Instrumental climate data

The Bureau of Meteorology has collected rainfall and temperature records at post offices, police stations, railway stations and private property since the 1890s throughout NSW and since 1970, evaporation records. Many of these climate stations have gaps in the records or the stations have been decommissioned or relocated.

SILO is a Queensland Government subsidiary that constructs datasets using observed historical data collected by the Bureau of Meteorology. SILO 'patches' the missing data in the climate station records to provide a continuous 1889 to current (135+ years) record of rainfall, temperature, and evaporation at climate stations (or 'patch points'). The instrumental climate datasets are these continuous historical climate records.

SILO also uses interpolation techniques to construct a 5 km grid of climate data points (patch points). SILO owns and updates the resulting instrumental climate datasets and licenses users to access the data.

SILO instrumental patch point data and grid data are available on the SILO website. Additional useful information about SILO data and how to access the data is available as frequently asked questions.

Instrumental streamflow data

The Department converted the SILO instrumental climate datasets to 130+ years of daily instrumental streamflow at specific WaterNSW stream gauges using calibrated river system models. The instrumental streamflow data is the modelled net streamflow after taking into consideration flow routing from stream and tributaries, water takes by users and conveyancing losses upstream to the gauging stations.

These instrumental streamflow datasets produced as part of the modelling for the regional water strategies are being released progressively on the Open Data SEED Portal. Within SEED, click **Related Datasets** and follow the hierarchical structure to the appropriate catchment. Once you're at the catchment level (e.g. *Lachlan*), click **Dataset Packages** to download the ZIP file containing the data.

Paleostochastic climate data

Instrumental climate records span just over a century, offering valuable insights but representing a relatively short timeframe in the context of Earth's climate history. To better understand the full range of inflow variability, it can be useful to consider data sources that extend beyond the modern instrumental record.

To extend our records, scientists have developed a "paleostochastic" dataset that represents a long-term baseline of natural climate variability. This dataset represents 10,000 years of daily rainfall and evapotranspiration for NSW river valleys drawing on three key sources:

- observations from climate gauges across NSW,
- information from natural archives like tree rings, ice cores, and other records that record centuries of wet and dry cycles before measurements began,
- advanced statistical modelling to recreate realistic daily and seasonal patterns and long-term climate variability, including the influence of large-scale cycles like the IPO.

The paleostochastic dataset has undergone rigorous scientific review to ensure its accuracy and usefulness. The NSW Office of the Chief Scientist and Engineer has assessed the methods, data sources, and modelling approaches used to create it, and has formally endorsed[1] it as consistent with best-practice approaches to climate risk management.

Why it matters

Paleostochastic data suggests that NSW has experienced droughts and wet periods more extreme than those captured in the instrumental record. While this dataset enhances our understanding of past climate variability and extremes, it does not incorporate the influence of climate change. To explore future risks, it is most informative when used in conjunction with climate projections.

Availability and updates

The paleostochastic datasets covering 10,000 years of daily rainfall and evapotranspiration are available at climate stations selected for Regional Water Strategies (see Appendix B) and can be accessed via the Open Data SEED Portal.

The datasets were developed over a five-year period (2018–2022) using the SILO instrumental climate data available at the time. Depending on the need for future modelling, there is flexibility to regenerate the datasets to improve representation of recent extremes and ensure they remain fit for purpose.

Paleo-stochastic Streamflow data

The Department converted the 10,000-years of stochastic climate data to 10,000-years of daily stochastic streamflow at specific WaterNSW stream gauges using calibrated river system models. The paleo-stochastic streamflow datasets are the net streamflow after taking into consideration flow routing from stream and tributaries, water take by users and conveyancing losses upstream to the gauging stations.

These stochastic streamflow datasets produced as part of the modelling for the regional water strategies are being released progressively on the Open Data SEED Portal from the above link. The stochastic streamflow incorporates characteristics of longer-term climate variability.

[1] https://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0018/1593/Independent-Review-Climate-Risk-Methods-For-RWS_Main-Report.pdf

Future climate projections

High quality climate projection data is available through the NSW and Australian Regional Climate Modelling (NARCliM) project.

NARCliM 2.0 projections

NARCliM 2.0 is NSW's official climate projection dataset endorsed as a Common Planning Assumption[2]. It is based on the latest generation of global climate models (CMIP6) and refined to a high resolution of 4 km, allowing for better representation of topography, coastlines, and local weather patterns reducing errors in rainfall and temperature estimates.

The dataset provides continuous climate simulations from 1951 to 2100 under three different global greenhouse gas scenarios:

- SSP1-2.6 – a low-emissions pathway
- SSP2-4.5 – a medium-emissions pathway
- SSP3-7.0 – a high-emissions pathway.

These climate projections can be used to scale baseline climate datasets using established methods such as monthly change factor scaling or quantile–quantile (QQ) scaling. These techniques apply projected changes in rainfall, temperature, and evaporation to historical or stochastic baseline climate sequences, making them suitable for hydrological modelling. For practical guidance on applying these methods, users can refer to the Climate Change in Australia scaling methods page. The Department may also make selected scaling factors and/or scaled datasets available in the future to support consistent application across NSW.

Information on NARCliM 2.0 climate projections are available from the Open Data SEED Portal and/or the AdaptNSW website.

NARCliM 1.0 projections (legacy)

NARCliM 1.0 climate projections, published in 2014, provide regional climate modelling outputs for New South Wales under the SRES A2 emissions scenario. These projections cover three 20-year periods: 1990–2009, 2020–2039, and 2060–2079. The SRES A2

[2] https://www.nsw.gov.au/nsw-government/public-sector/financial-information-for-public-entities/common-planning-assumptions

scenario, developed by the Intergovernmental Panel on Climate Change (IPCC) in 2000, represents a future with limited global action on emissions and generally drier conditions.

As part of earlier modelling work for the Regional Water Strategies, the Department used NARCliM 1.0 projections to stress-test water systems under low rainfall conditions. To do this, the CSIRO Mk3.0 Global Climate Model (GCM), which simulates large-scale climate processes across the globe, was selected because it produced the lowest projected rainfall. This GCM was downscaled using three Regional Climate Models (RCMs) to better capture local features such as topography, coastlines, and weather patterns.

Using these models, monthly scaling factors were calculated at each climate station to represent the percentage change in rainfall, temperature, and evaporation for 2060–2079 compared to 1990–2009. These scaling factors were then applied to 10,000 years of daily stochastic climate data to produce perturbed sequences for climate risk modelling.

NARCliM 1.0 monthly scaling factors and supporting documentation, including the fact sheet Average Monthly Scaling Factors from NARCliM 1.0 used in RWS Climate Risk Modelling, are available via the SEED portal.

Assistance for accessing the data

Further assistance on data and models for town water security analysis is available from the Water Data Products team of the DCCEEW Water Group by emailing to: water.dataproducts@dpie.nsw.gov.au

Note of caution

Uncertainty is an inherent feature of climate modelling because projections depend on future greenhouse gas emissions, differences between climate models, and natural climate variability. These factors mean that results should be interpreted as ranges of plausible futures rather than precise predictions. While advances in science and modelling continue to reduce some uncertainties, they cannot be eliminated entirely. Users should ensure that the data and methods are appropriate for their intended purpose, document key assumptions, and plan for periodic review as new information becomes available.

Appendix A: Understanding climate variability and climate change

Climate variability describes the natural fluctuations in climate conditions over time, from year-to-year and decade-to-decade, driven by phenomena[3] such as the El Niño–Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO). These processes produce alternating periods of wet and dry conditions without demonstrating any long-term directional trend.

Climate change refers to persistent, long-term shifts in average climate conditions resulting from human induced changes in the global climate system, as a result of increased greenhouse gas concentrations. These shifts alter baseline patterns of temperature, rainfall, and drought risk over decades and centuries.

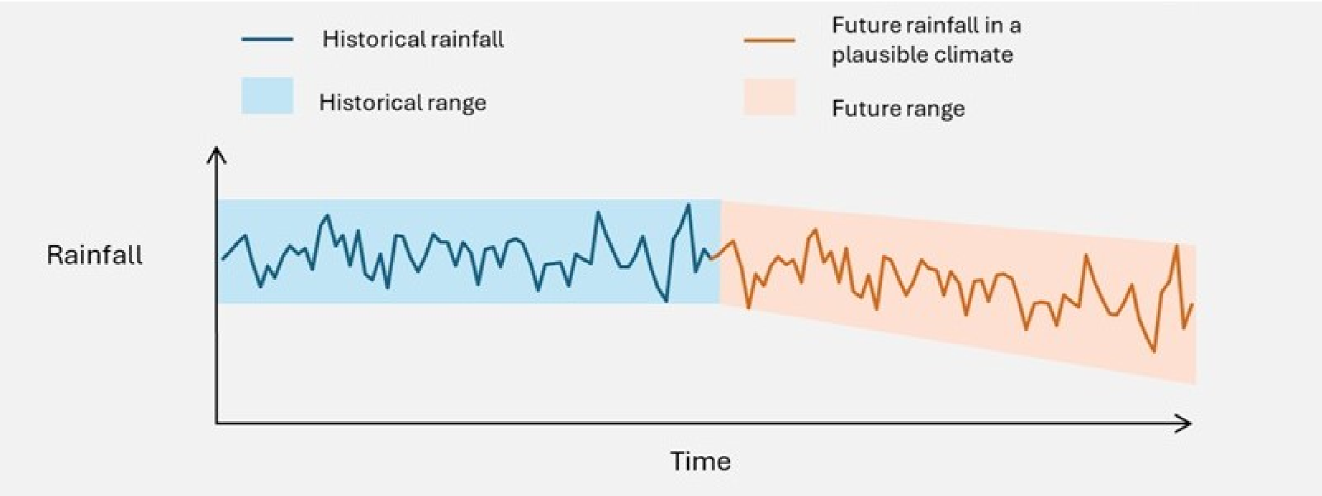

Figure 1: Rainfall patterns - illustrating climate variability vs climate change. Climate variability refers to natural ups and downs in rainfall from year to year. Climate change is the long-term trend that shifts the overall pattern.

Source: Adapted from MDBA Sustainable Yields 2025 Summary Report (Draft, In preparation)

Historical climate records capture natural variability but not the long-term, human-driven changes that are altering temperature, rainfall, and drought risk. These shifts mean that past conditions are no longer a reliable baseline for planning. Effective planning requires combining historical variability with forward-looking climate projections to ensure decisions are based on the conditions we are likely to experience in the decades ahead.

[3] https://www.dpi.nsw.gov.au/dpi/climate/seasonal-conditions-and-drought/climate-and-weather/climate-influences-on-australian-weather

Appendix B: Regions for which paleo-stochastic climate data and NARCliM 1.0 scaling factors are available[4,5]

Regional Water Strategy	Description of the region	Includes towns of the region	Year of Paleo-stochastic data generation
Border Rivers	Northern most part of NSW, stretching along Queensland border covering the catchments of the Barwon, & Macintyre Rivers	Inverell, Glenn Innes, Tenterfield, Boggabri, Goondiwindi & Mungindi	2019
Namoi	Northern NSW stretching from the Great Dividing Range in the east to semi-arid plains in the west covering the catchments of the Peel, Manilla, & Namoi Rivers	Nundle, Tamworth, Manilla, Werris Creek, Gunnedah, Boggabri, Narrabri, Wee Waa, Pillage, & Walgett	2019
Gwydir	Northern inland NSW covering the catchment of the Gwydir River	Uralla, Bundarra, Bingara, Warialda, Pallamallawa, & Moree	2019
Macquarie-Castlereagh	Central NSW covering the catchments of the Macquarie, & Castlereagh Rivers	Mudgee, Wellington, Dubbo, Narromine, & Warren	2019
Lachlan	Central NSW west of the Great Dividing Range covering the catchment of the Lachlan River	Crookwell, Gunning, Boorowa, Cowra, Forbes, Parkes, Young, Condobolin, Lake Cargelligo, Euabalong, Hillstone, Oxley, & Ivanhoe	2021
Western (down to Wilcannia)	The western region to the west of the Barwon & Darling Rivers	Louth, Walgett, Collarenebri, Bourke, Tilpa, Wilcannia, & Pooncarie	2020

[4] Data available only for the climate stations used for the regional water strategies

[5] Instrumental streamflow and paleo-stochastic streamflow data sets are being progressively made available.

Southern system – Murray and Murrumbidgee	Southern NSW above the border of Victoria running from the Great Dividing Range to the far south-west covering the catchments of Snowy, Murrumbidgee, Murray & Lower Darling Rivers	Murrumbidgee: ACT, Queanbeyan, Tumut, Yass, Gundagai, Cootamundra, Harden, Junee, Wagga Wagga, Narrandera, Leeton, Griffith, Hay & Balranald Murray: Jindabyne, Bombala, Albury, Corowa, Deniliquin, Moama, Euston & Wentworth	2021
Far North Coast	North-eastern NSW covering the catchments of the Tweed, Brunswick, & Richmond Rivers	Tweed, Murwillumbah, Mullumbimby, Byron Bay, Ballina, Evans Head, Kyogle, Casino & Woodburm	2019
North Coast	East of the Great Dividing Range covering the catchments of Nambucca, Clarence, Bellingen, Hastings & Macleay Rivers	Yamba, Maclean, Grafton, Woolgoolga, Coffs Harbour, Dorrigo, Bellingen, Nambucca Heads, Macksville, Armidale, Walcha, Kempsey, Port Macquarie, Wauchope & Laurieton	2019
Greater Hunter	East of the Great Dividing Range from the Manning River in the north to the Wyong River in the south	Wingham, Taree, Gloucester, Stroud, Forster, Tuncurry, Bulahdelah, Great Newcastle area, Maitland, Cessnock & Muswellbrook	2022
South Coast	East of the Great Dividing Range and south of the Greater Sydney area covering the catchments of the Clyde, Deua, Tuross & Bega Rivers	Batemans Bay, Moruya, Tuross Heads, Narooma, Bermagui, Bega, Tathra, Merimbula, Pambula & Eden	2020