



Australian Government
Bureau of Meteorology

Improving Water Information Programme Progress Report



ADVANCES IN WATER INFORMATION MADE
BY THE BUREAU OF METEOROLOGY IN 2014



Improving Water Information Programme Progress Report:
Advances in water information made by the Bureau of Meteorology in 2014

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GPO Box 1289
Melbourne, Vic 3001
Tel: 03 9669 4000
Fax: 03 9669 4699

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Australia's streamflows are among the most variable in the world, but a reliable flow of data and information will help us manage the challenges of variable water security into the future.



Through the Improving Water Information Programme, the Bureau of Meteorology has been building our capacity to integrate weather, climate and water information. Working closely with water managers around the country, we are monitoring, assessing and forecasting water availability, condition and use.

During the Millennium Drought, when the programme was born, concern about Australia's water security rose to the highest levels but access to crucial water information was limited.

In 2014, severe rainfall deficiencies again affected many parts of the country, but now we have a wealth of national water information at our fingertips. This will help decision-makers in many industries and sectors respond to challenges and plan for the future.

After years of hard work, we released two new ways to access nationally harmonised water information online in 2014: the Australian Groundwater Explorer for groundwater and Water Data Online for surface water.

We are also refining and expanding existing products in response to user feedback. For example, registered users can now access Seasonal Streamflow Forecasts for 99 locations, including every State and Territory; and the data warehousing component of our Australian Water Resources Information System is back on track after some initial difficulties.

We held targeted water information briefings in all capital cities in 2014—for water agencies, utilities and other key organisations. These really brought home to me the importance of collaboration between data providers, operators and users.

Short online videos also help us share water information more effectively, and have been very popular. Our first six monthly Climate and Water Outlook videos and two product videos had been watched more than 300 000 times by the end of 2014.

I've been impressed by the programme's momentum in 2014. Like other Bureau services, the value of this work is growing over time, as our products become more localised, current, accurate and insightful.

I'd like to thank the data providers, whom we continue to rely on, and the jurisdictional reference group—a valuable forum for consulting with lead water agencies.

It gives me great pleasure to report on the programme's activities and achievements for 2014, and to oversee the important remaining work.

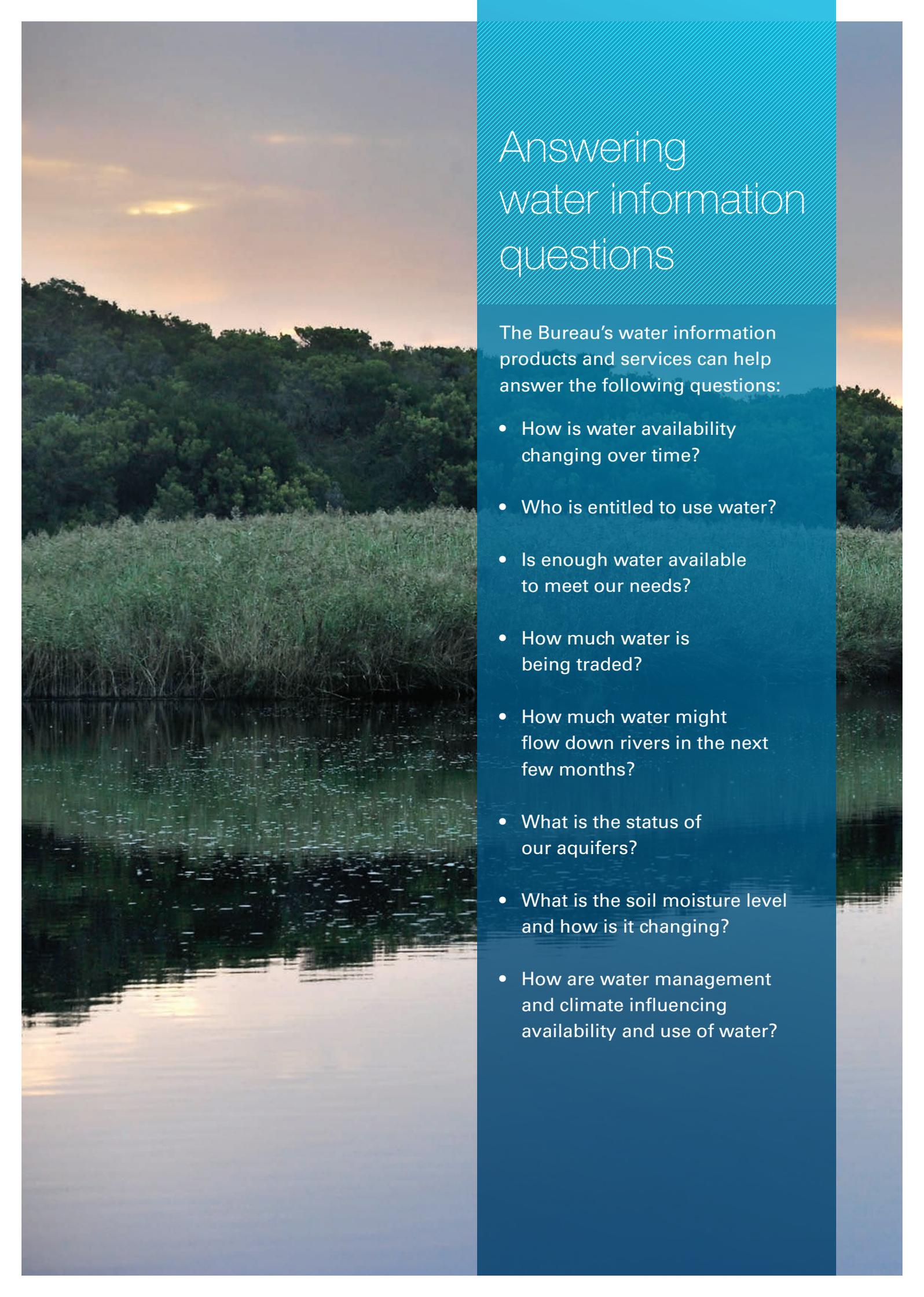
Graham Hawke
Deputy Director
Environment and Research

PROGRAMME OBJECTIVES

The Improving Water Information Programme is a key component of the nation's water reform agenda, led by the Bureau of Meteorology and supported by water agencies across Australia.

Under the *Water Act 2007*, the Bureau took on responsibility for compiling and disseminating comprehensive water information across Australia. In 2008, the Australian Government announced an investment programme to secure long-term water supply for all Australians. This included \$450 million over ten years for an Improving Water Information Programme, to be administered by the Bureau and backed by key stakeholders. The programme has ten objectives:

1. Establish enduring national water data sharing and licensing arrangements.
2. Develop and disseminate national water information standards.
3. Build and maintain the Australian Water Resources Information System to underpin all of the Bureau's water information products and services.
4. Collate, standardise and archive water data collected by more than 200 organisations named in the schedules to the *Water Regulations 2008*.
5. Support data providers to improve the coverage, currency and accuracy of water data collected around Australia and enable ready transmission of data to the Bureau.
6. Provide the Australian public with free, online access to reliable water information.
7. Analyse and report on trends in water availability and quality across the nation.
8. Publicly disclose water entitlements, allocations, trades and take for all major water supply systems in an annual National Water Account.
9. Provide effective and reliable streamflow forecasting services for high-priority water supply systems.
10. Enhance the science and technology base of the Bureau's water information products and services by supporting strategic research and development.



Answering water information questions

The Bureau's water information products and services can help answer the following questions:

- How is water availability changing over time?
- Who is entitled to use water?
- Is enough water available to meet our needs?
- How much water is being traded?
- How much water might flow down rivers in the next few months?
- What is the status of our aquifers?
- What is the soil moisture level and how is it changing?
- How are water management and climate influencing availability and use of water?

KEY ACHIEVEMENTS SO FAR

RECEIVED MORE THAN

1001101
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1001101

29 MILLION WATER DATA FILES

FROM MORE THAN

200 PROVIDERS 

CONTAINING MORE THAN **4 BILLION**

TIME-SERIES OBSERVATIONS 



NATIONALLY CONSISTENT
TRACKING AND REPORTING OF
WATER RESTRICTIONS
ACROSS MAJOR
**METROPOLITAN
AND REGIONAL
URBAN CENTRES**

NATIONWIDE,

463



TO UPGRADE
DATA PROVIDERS'
**HYDROLOGICAL
MONITORING SYSTEMS**

STANDARDS

- The world's first water accounting standards, based on the financial accounting model.
- National industry guidelines for hydrometric monitoring.
- An Australian Water Information Dictionary, defining more than 1400 terms.
- National and international standards for water data transfer, including time-series observations and information about streamflow ratings, gaugings and river cross-sections.
- A National Aquifer Framework for naming and grouping rocks and sediments with similar hydraulic characteristics.

MONITORING

- Nationwide, 463 projects delivered to upgrade data providers' hydrological monitoring systems and improve data quality and delivery—funded by a \$78 million Australian Government grants programme, administered by the Bureau.

DATA SYSTEMS

- An Australian Water Resources Information System that collates most of the nation's water information on an ongoing basis.
- Since 1 July 2008 we have received more than 29 million water data files from more than 200 providers, containing more than 4 billion time-series observations.
- These observations relate to 95 information subcategories, across ten categories.

REPORTS

- A comprehensive Australian Water Resources Assessment—published every two years so far; changing to annual 'Water in Australia' reports from 2015.
- An annual National Water Account.
- A national landscape water balance model that underpins our reports.
- Assessments of streamflow trends at 221 Hydrologic Reference Stations, updated every two years.

STREAMFLOW TRENDS AT



221

**HYDROLOGICAL
REFERENCE STATIONS**

UPDATED EVERY 2 YEARS

A SPATIAL DATABASE OF

GROUNDWATER INFORMATION

CONTAINING MORE THAN

800 000

**GROUNDWATER BORES
ACROSS AUSTRALIA**



DAILY REPORTING OF

**SURFACE
WATER
STORAGE
VOLUMES IN**

310 

**PUBLICLY OWNED LAKES, RESERVOIRS
AND WEIRS ACROSS AUSTRALIA**



MONTHLY FORECASTS

**OF STREAMFLOW
CONDITIONS FOR**

74 

SITES

NATIONAL

**INDUSTRY
GUIDELINES**

**FOR HYDROMETRIC
MONITORING**



FORECASTS

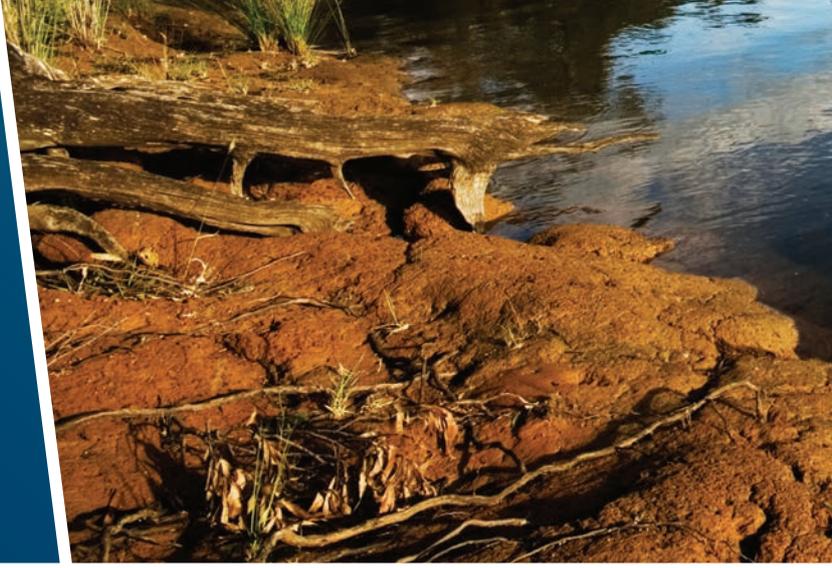
- Monthly forecasts of streamflow conditions for the forthcoming three months for 74 sites in eastern Australia (plus sites in other States, currently only for registered users).
- Trials of Short-term Streamflow Forecasts for 39 catchments across all hydro-climate regions in Australia (for registered users).

WEB-BASED DATA SERVICES

- A geographic information system for discovering, querying, reporting and modelling water information.
- Online access to standardised watercourse level and discharge time-series data from more than 3200 water monitoring stations across Australia.
- A time-series database of water level, volume, discharge and water quality data for more than 14 000 watercourse, water storage and groundwater sites.
- Updated Intensity–Frequency–Duration Design Rainfalls for use in designing gutters, culverts, bridges and drains.

- A spatial database of groundwater information, containing more than 800 000 groundwater bores across Australia.
- A new mapping portal for visualising, analysing and downloading groundwater information without specialised software.
- Daily reporting of surface water storage volumes in 310 publicly owned lakes, reservoirs and weirs across Australia.
- Contribution to the Australian Government’s National Water Market website, which provides information on water trades and allocation.
- Nationally consistent tracking and reporting of water restrictions across major metropolitan and regional urban centres.

1 SHARING DATA



Objective: Establish enduring national water data sharing and licensing arrangements.

Our national water information service is built on a reliable flow of data. The Bureau routinely receives water data from 178 organisations, across 95 information subcategories. Coordination and cooperation between the Bureau and these data providers are critical.

PROGRESS SUMMARY

Over 80 per cent of data are now supplied in the standard Water Data Transfer Format. This makes it easy to process and share data with users through our online products in a nationally consistent and timely way. The data are also used in higher-level reporting and forecasting products.

2014 ACHIEVEMENTS

- The Independent Review of the *Water Act 2007* acknowledged that ‘the Bureau has made much progress in improving Australia’s water information systems in the last seven years, as evidenced by the large volumes and scale of datasets and the high quality of water information now available.’ It also recommended that the reporting burden on the water industry be further reduced.
- Transparency around the metadata that should be associated with water data helps all organisations use the data. New requirements for surface water and groundwater metadata took effect in 2014. Requirements for water storage and water rights, allocations and trades metadata were shared for external review in 2014 and will be published in 2015.

- Eighty-nine per cent of organisations providing ongoing data to the Bureau now do so under a Creative Commons licence. This has simplified licensing arrangements, reduced restrictions, and significantly enhanced the data’s usefulness—the data can be used for any purpose so long as the supplying organisation is acknowledged.
- We established a data-sharing agreement with the Murray–Darling Basin Authority, covering provision of Water Regulations data and access to non-standardised data. This means such data only need to be collected once, but can be put to multiple uses. Reducing duplicate reporting makes it easier for the authority and jurisdictions to monitor and report progress towards the Murray–Darling Basin Plan.

NEXT STEPS

- We are leading a Commonwealth inter-agency working group to investigate and report on the Water Act review’s recommendation to further reduce reporting burdens on data providers.
- We will also ensure that our supply of water data is better aligned with its use, by continuing to work with users and stakeholders to adapt and refine our data products in 2015 and beyond.

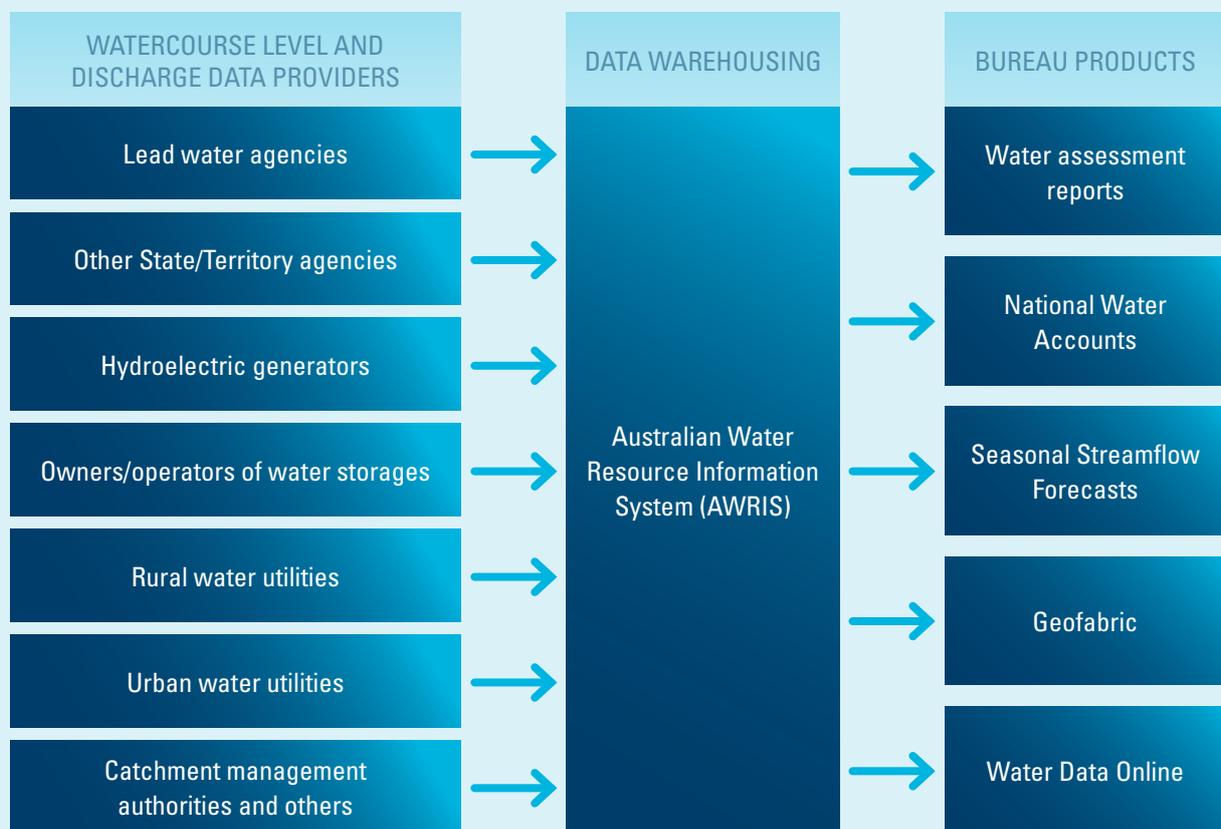
'This is a good standard for metadata, which will cover the range of data collected. This will provide users with a higher degree of confidence in the data.'

TONY BERNARDI, NSW Department of Primary Industries
on the metadata and contextual information requirements for surface water resource information

Sharable surface water data

Lead water agencies and 160 other organisations around the nation collect watercourse level and discharge data for many different business needs. They also provide these data to the Bureau for use in the Australian Water Resources Assessment, the National Water Account, streamflow forecasts, Water Data Online, the Geofabric and Hydrologic Reference Stations.

To increase the uniformity and interpretability of watercourse level and discharge data, the Bureau has published National Industry Guidelines for hydrometric monitoring, plus detailed metadata and contextual element lists, and explanatory notes for data providers. Creative Commons licence agreements with the providers authorise further use of shared information, improving its utility to the users of the products.



2 SETTING STANDARDS



Objective: Develop and disseminate national water information standards.

To harmonise water data collection, analysis and reporting across the nation, we are working closely with water agencies, researchers and experts to develop a range of national water information standards.

PROGRESS SUMMARY

WaterML2 is an international open standard for water observations and measurements, developed by an international collaboration led by the Bureau and CSIRO. This standard guides the development of the Water Data Transfer Format (WDTF), which helps Australian water agencies share data with the Bureau.

Part 1 of the standard (a time-series encoding standard) was adopted by the Open Geospatial Consortium in August 2012. The Bureau and CSIRO are now leading the development of Part 2, which will cover streamflow ratings, gaugings and river cross-sections.

Sharing data online

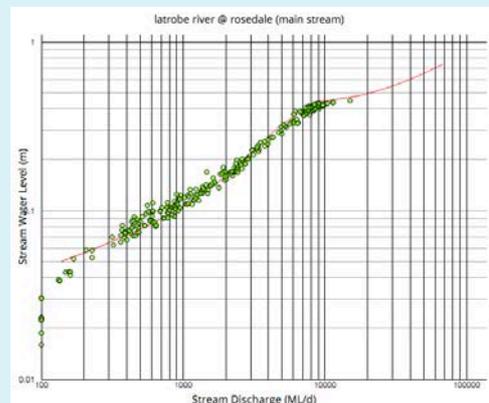
The Bureau receives hydrological data from water agencies across Australia and shares this through many web-based services, however we are yet to develop a service for ad hoc or dynamic data requests. To show how such a service might work, the WaterML2 Part 2 interoperability experiment tested a scenario in which a number of Australian organisations shared data on ratings and gaugings:

DATA SUPPLIERS

- Department of Primary Industries, Parks, Water and Environment, Tasmania;
- New South Wales Office of Water; and
- Department of Environment and Primary Industries (now the Department of Environment, Land, Water and Planning), Victoria.

DATA CONSUMERS

- Bureau of Meteorology;
- Murray–Darling Basin Authority;
- CSIRO;
- State Water, New South Wales; and
- New South Wales hydroelectricity operators.



Interoperability experiment: CSIRO web client inspecting Victorian ratings and gaugings.



2014 ACHIEVEMENTS

- The WaterML2 Part 2 information model was tested in an interoperability experiment, conducted by Bureau and CSIRO staff through our Water Information Research and Development Alliance. Web services were used to share data from three Australian State water agencies between Australian, UK and US agencies. The team used experimental software from international vendors and water data agencies, and implemented several scenarios to support the Bureau and the Murray–Darling Basin Authority.
- Our Water Information Standards Business Forum developed, and released for comment, a draft water quality metadata guideline, in collaboration with the Australian Water Association and the Australian Hydrographers Association.
- We expanded the Australian Water Information Dictionary, adding a new glossary relating to the National Water Account. The dictionary now contains 19 glossaries and defines more than 1400 terms.
- We released the Australian Water Accounting Standard 2 (Assurance Engagements on General Purpose Water Accounting Reports) in conjunction with the Auditing and Assurance Standards Board. This standard gives greater confidence to users of general-purpose water accounting reports, by setting out assurance requirements for such reports.
- Having established common terminology and concepts for water accounting, we updated the Water Accounting Conceptual Framework that underpins the Australian Water Accounting Standards.
- We have been working to improve our ability to ingest and validate data in WTDF—including development of support for WDTF 1.2, which was released in late 2013

‘Development of the WaterML2 Part 2 standard will help improve interoperability between systems and support greater water data sharing in Australia and internationally.’

MARTIN READ,
Manager of Water Assessment Branch,
Department of Primary Industries, Parks,
Water and Environment, Tasmania

NEXT STEPS

- In 2015, the Bureau and CSIRO will submit a specification for WaterML2 Part 2 (Ratings, Gaugings and Sections) to the Open Geospatial Consortium for approval as an information exchange standard.
- We discontinued our Water Information Standards Business Forum in October 2014. Future development of water information standards will be led by a new industry collaboration, the Water Monitoring Standardisation Technical Committee, which first met in November 2014. The Bureau maintains a strong interest in standardising water monitoring, and will contribute as a member of the new committee, along with 25 other organisations.

3 BUILDING SYSTEMS



Objective: Build and maintain the Australian Water Resources Information System (AWRIS) to underpin all of the Bureau's water information products and services.

The Bureau is sent more than 10 000 water data files per day by providers around the country. AWRIS receives, ingests and standardises these data in order to deliver a range of water information products and services.

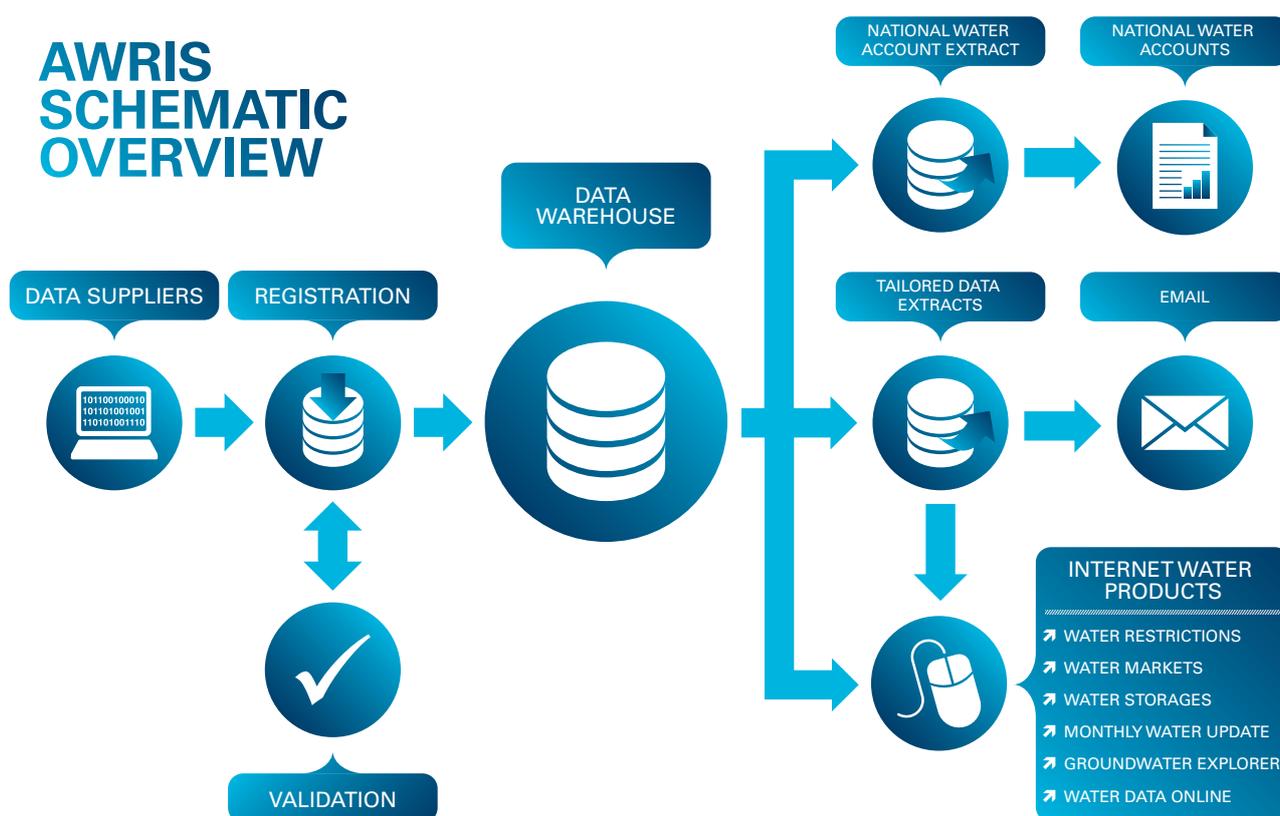
PROGRESS SUMMARY

We are redeveloping and improving AWRIS, based on lessons learnt implementing the original system. For example, while most water data are provided to the Bureau in the standard Water Data Transfer Format (WDTF), data supplied in other formats require continuous effort to verify and incorporate into the system. The improved system will address several of these complexities, and will feature increased functionality and sustainability.

We are also working with water data providers to increase the consistency of data by using national water information standards—see Objectives 1 and 2.

2014 ACHIEVEMENTS

- Completed new data warehouse design based on WDTF to enhance the speed of data ingestion, reduce system storage requirements and provide standard methods for selected data extraction.
- Trialled data ingestion routines for multiple file types, including several versions of WDTF and CSV.
- AWRIS data systems are now continuously ingesting data from providers, standardising the data through the time-series data management system, and publishing daily updates to our new web-based product Water Data Online.
- Web services have been implemented to supply river observation data to Seasonal Streamflow Forecasts. The time-series data management system web services enable efficient sharing of data for many purposes and products.
- Integration of data from diverse suppliers for another new product—the Australian Groundwater Explorer—presented a particular challenge. Each jurisdiction collects data in different formats, using different technology. Access to the data will be more standardised after the AWRIS re-development.



The new AWRIS incorporates 'datamarts' to facilitate performance in data distribution and report processing.

NEXT STEPS

- The Bureau is coordinating a programme of upgrades by data providers to improve the data supply process. An increasing number of data providers are moving to the latest WDTF standard. As a result, data processing and handling will improve, and errors and reprocessing will be reduced.
- We will replace our existing file storage technology with a dedicated water data file registry, offering significantly improved search and file tracking functions. This will improve access for water data users.

4 DATA WAREHOUSING



Objective: Collate, standardise and archive water data collected by more than 200 organisations named in the schedules to the Water Regulations 2008.

Since the regulations came into effect we have received more than 29 million water data files, containing more than 4 billion time-series observations. To ensure a free flow of these data to the public, we must negotiate and monitor data supply agreements, develop data management procedures and assemble teams to curate the information.

PROGRESS SUMMARY

For the first time, users can access Australian water data from a standardised and integrated national data warehouse. This is a comprehensive archive of water information from organisations across Australia—from historical, quality-controlled data to recent, provisional data.

In 2014 we made significant progress with data ingestion and automated processes for assembling time-series data for water monitoring stations across Australia.

Our existing Australian Water Resources Information System (AWRIS) data warehouse will be replaced in 2015 by a significantly faster and less resource-intensive platform. This will better support existing Bureau products, many of which require daily data updates, and more rapid development of new products and services over the next three years. For example, we are procuring a business intelligence tool that will support more efficient data analysis and faster development of web ‘dashboards’ and mobile applications.

2014 ACHIEVEMENTS

- We have built a new data warehouse for AWRIS, which is being readied for data loading. Improvements are also being made to the data ingest system, and how the warehouse is integrated with data products.
- A new time-series database named WISKI gave Bureau staff access to water level, volume, discharge and water quality data for more than 14 000 watercourse, water storage and groundwater sites. Surface water data from this database are now published through Water Data Online (see Objective 6).
- The coverage of our Water Storage website rose this year to 310 storages across the country. We have undertaken significant work to migrate water storage data to the new WISKI time-series database, which will enable enhancements to the Water Storage website in 2015–16.
- We now receive data from 96 agencies with at least one category encoded in the Water Data Transfer Format (WDTF), amounting to more than 80 per cent of the water data provided to the Bureau. Data received from lead water agencies in WDTF are routinely ingested automatically into AWRIS.



- Our Urban System Analysis Tool has improved collection and analysis of urban water data, significantly increasing the efficiency with which analyses can be carried out for the National Water Account (see Objective 8).
- We completed eight 'health check reports' on providers' supply of water data and compliance with requirements. We then worked with providers to fill gaps in this supply, increasing the range and volume of data provided to the Bureau, and in turn, made available through our products and services.

NEXT STEPS

- A new business intelligence tool that queries product-specific AWRIS 'datamarts' will improve the productivity and efficiency of our analyses for water information reports and forecasts, and will support more rapid development of web dashboards and mobile apps.
- We also plan to use data-warehousing technology to integrate our water, climate and environmental information in the coming years.

Sharing data with the Murray–Darling Basin Authority

The Bureau has data service level agreements with key stakeholders such as the Murray–Darling Basin Authority (MDBA) for sharing data from AWRIS. In 2013–14, MDBA staff examined sample extracts of data from six of the ten Water Regulations categories. The MDBA is developing a product specification that outlines the specific AWRIS data and analyses required for Basin Plan reporting.

The Bureau is setting up automated systems to allow stakeholders to access the data via web services. For example, the MDBA can access Category 1 (streamflow and water level) data through the Sensor Observation Service. Other categories of data will be made available via similar methods in 2015.

'We recognise that good things take time, but our access to Murray–Darling Basin State surface water datasets is already informing our work. We look forward to other water regulations data becoming accessible in the near future.'

LEX COGLE,
Director, Information and Data,
Murray–Darling Basin Authority

5 IMPROVING OBSERVATIONS



Objective: Support water data collecting organisations to improve the coverage, currency and accuracy of water data collected around Australia and enable their ready transmission to the Bureau.

The Modernisation and Extension of Hydrologic Monitoring Systems Programme is now complete. Funding from the Australian Government, administered by the Bureau, has enabled data providers to update monitoring systems and improve data quality and delivery to the Bureau.

PROGRESS SUMMARY

Just over \$78 million was provided for 463 projects, over five rounds of the Modernisation and Extension Programme from 2007–08 to 2011–12.

The benefits of these investments continue to be seen years after the money was spent. Delivery of data in the Water Data Transfer Format (WDTF), for example, has been a key factor in our ability to ingest and interpret information efficiently from a multitude of sources. More than half the organisations providing data to the Bureau are now using WDTF, and all the data available through our new Water Data Online product were provided in WDTF.

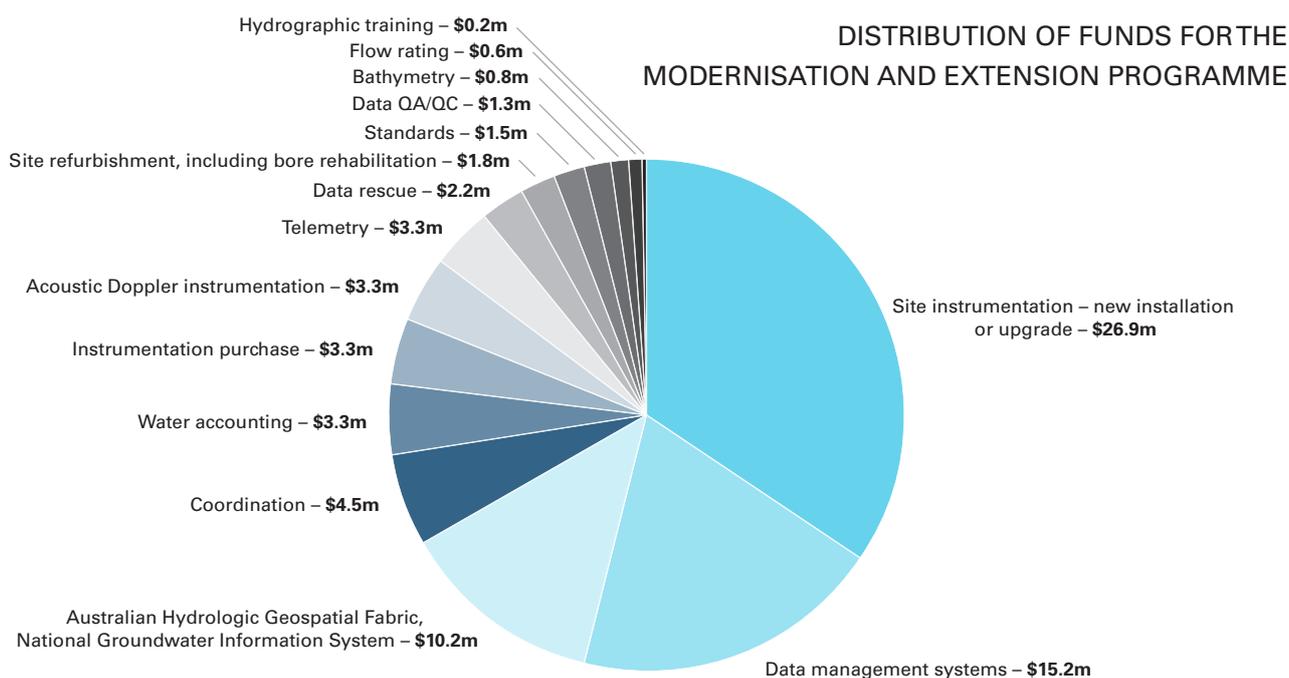
As well as funding significant improvements to the country's water monitoring networks, the Modernisation and Extension Programme has helped to build a culture of cooperation between monitoring organisations and the Bureau.

2014 ACHIEVEMENTS

- We prepared a finalisation report for the Modernisation and Extension Programme, confirming financial acquittal for each project funded and completion of all reporting and administrative requirements.
- An audit of the Improving Water Information Programme published by the Australian National Audit Office in February 2014 confirmed the success of the Modernisation and Extension Programme. It found that the investments have enhanced the value of hydrologic data to water managers and the general public, lowered the cost of data acquisition and reduced the duration of monitoring system outages.

'The Modernisation and Extension Programme has assisted grant recipients to modernise and extend their water monitoring systems. This has addressed the objectives of the programme and improved the accuracy, quality and frequency of the data available to the Bureau.'

AUSTRALIAN NATIONAL AUDIT OFFICE,
2013–14 Audit Report No.18: Administration
of the Improving Water Information Program



Measuring river flows

Acoustic Doppler current profiler (ADCP) technology is the most accurate, safe and cost-effective way to measure river and streamflow. The Modernisation and Extension Programme provided \$3.9 million to fund purchase and installation of 145 ADCP units across 25 projects around Australia.

In Tasmania, for example, this assisted the Department of Primary Industries, Parks, Water and Environment to purchase ADCP equipment to improve stream gauging data, and logging and telemetry equipment that will improve the functionality and reliability of data being recorded.

More accurate riverbed and water velocity profiles help to better predict floods.

A Sontech M9 acoustic Doppler current profiler attached to a Hornet cableway.



6 PUBLISHING INFORMATION



Objective: Provide the Australian public with free online access to reliable water information.

Readily available water information not only assists water managers and policy makers to do their jobs more effectively, but also helps satisfy the needs of water-dependent businesses, farmers, industry, educators and the general community.

PROGRESS SUMMARY

Every year, we extend our water information services far beyond flood forecasting (the only Bureau water information service available before 2007). We now provide up-to-date reporting of water storage levels and water market activity; the state of water restrictions in cities; the intensity, frequency and duration of rainfall events for use in engineering design; and a geospatial database of hydrological features.

2014 ACHIEVEMENTS

- In October 2014, then Parliamentary Secretary Simon Birmingham launched the Australian Groundwater Explorer—a web-based mapping portal providing access to groundwater information from more than 800 000 bores across Australia. The portal is underpinned by the National Groundwater Information System—a spatial database for geographic information system specialists.
- In preparation for adding new data types to the Australian Groundwater Explorer we integrated groundwater level, salinity and entitlements data into a standardised national database.
- Also in October we released Water Data Online, a product containing watercourse level and discharge time-series data from more than 3200 sites across Australia. It is updated daily and contains current and historical data, analysis and reports.
- The next online product to be released to the public will be Climate Resilient Water Sources, containing data on desalination and water recycling from more than 100 locations. The product is now available to registered industry users, and will be publicly released in 2015. It was commissioned by the Desalination and Water Recycling Centres of Excellence.
- Our work on Phase 2 of the Intensity–Frequency–Duration (IFD) Revision Project has moved on to providing design rainfalls more frequent than one year and less frequent than 100 years. These inform the design of gutters, culverts, bridges and stormwater drains. We are also contributing to research into the impacts of climate change on the new IFDs. Our IFD webpages attracted nearly 180 000 unique page views in 2014.
- We released version 2.1.1 of the Australian Hydrological Geospatial Fabric (Geofabric), which includes 3310 streamflow monitoring points and has links to Water Data Online time-series data. It includes a simplified node-link network for the Murray–Darling Basin, and revised hydrology reporting regions in response to stakeholder feedback.

'The Australian Groundwater Explorer is a significant achievement for groundwater users and managers. For the first time users can access standardised groundwater data for the entire country.'

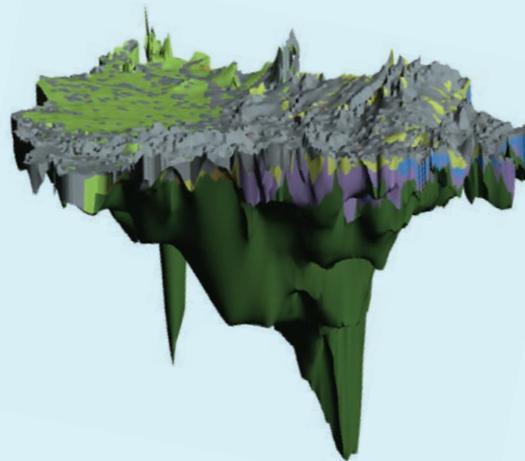
PETER HYDE, Director, Groundwater Planning, Murray–Darling Basin Authority

Modelling without boundaries

Groundwater data are traditionally collected and managed on a State basis, so local groundwater managers have previously only had access to groundwater data for their jurisdiction. However, some important groundwater basins such as the Murray Basin and Great Artesian Basin cover several jurisdictions.

Steve Barnett, Principal Hydrogeologist at the South Australian Department of Environment, Water and Natural Resources, recently developed a 3D hydrogeological model for the South Australian region of the Murray Basin—an important source of groundwater in southeastern Australia.

Using the Australian Groundwater Explorer, Steve was able to include groundwater data from New South Wales and Victoria as context to create a more comprehensive and robust model for the South Australian section.



He also collaborated with the Bureau to integrate this into a whole-of-basin model, now available through the Explorer.

3D hydrogeological models are a key input to numerical models used to predict the impact of management changes on groundwater resources. They are also a powerful communication tool when discussing groundwater and management concepts with groundwater users.

NEXT STEPS

- The Australian Groundwater Explorer will publish additional types of groundwater data—such as salinity, licensing and use—in 2015.
- We will also expand Water Data Online to include more organisations, water information categories and monitoring stations.
- The final phase of the IFD project will be released by December 2015, in conjunction with a revised edition of Engineers Australia's *Australian Rainfall & Runoff*.
- Phase 3 of the Geofabric project, in collaboration with Geoscience Australia, the Fenner School at ANU and CSIRO, will progressively update regions to the 1 second digital elevation model across Australia by 2017.
- The Bureau has agreed to sponsor—and provide substantial input into development of specifications for—the water theme of the ANZLIC Foundation Spatial Data Framework. This aims to make standardised, quality-controlled, national-scale foundation spatial data for Australia freely available.

7 ASSESSING WATER RESOURCES



Objective: Analyse and report on trends in water availability and quality across the nation.

We periodically report on changes in the availability, condition and use of Australia’s water resources. The assessments require detailed climatologic and hydrologic analyses of 13 hydrologic regions, spanning the whole continent.

PROGRESS SUMMARY

We have published two Australian Water Resources Assessments, each with a national overview and regional assessments for 13 drainage divisions across the continent. Key stakeholders found the information useful and, in response to their feedback, we are now working on ways to provide more frequent information and in-depth interpretations.

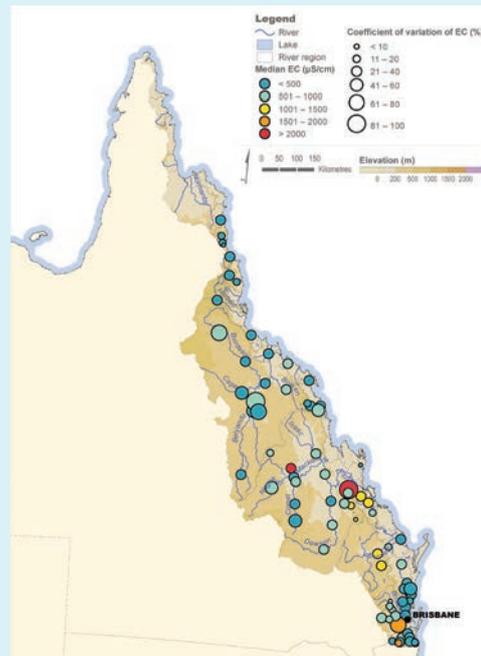
Our landscape water balance model—developed through a research alliance with CSIRO (see Objective 10)—is now being transferred into an operational model in the Bureau. We also have a river reach model, which calculates river water balance terms such as discharge to floodplains, seepage to groundwater and irrigation use.

Assessing risk of invasive fish

A risk-assessment project at James Cook University (Queensland) used groundwater and streamflow salinity data from our Australian Water Resources Assessments to determine the potential habitat of an invasive species of freshwater fish.

Invasive freshwater fish have very narrow salinity and conductivity tolerances, which limit their potential range in Australia. Surface water conductivity of less than 500 $\mu\text{S}/\text{cm}$ and groundwater salinity of less than 1000 mg/l were used to determine where there is a risk of invasive fish species.

The Australian Water Resources Assessments analysis and report provided this information at catchment level, supporting the development of a salinity tolerance map for invasive freshwater fish species.



Salinity as electrical conductivity and its associated coefficient of variation for 2011–12 in the North East Coast region

‘We will continue to use evaporative loss estimates provided by the Australian Water Resources Assessments in future hydrodynamic and water quality modelling projects.’

CHRIS O’NEILL, Operations Manager and Water Resources Engineer, HydroNumerics

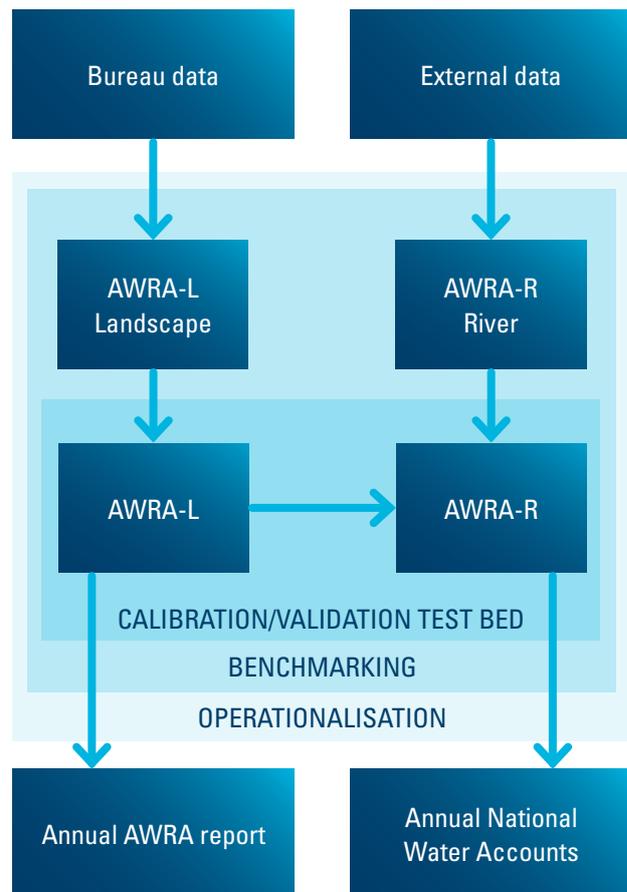
The models are also being used for a range of purposes beyond the Improving Water Information Programme—including bioregional assessments of coal and coal seam gas regions, and a floodplain harvest volume study for the Murray–Darling Basin Authority.

2014 ACHIEVEMENTS

- We have designed a new Monthly Water Updates web page to report recent streamflow and rainfall conditions by drainage division, for launch in 2015.
- Our landscape water balance model is now running daily within the Bureau. It provides soil moisture, evapotranspiration and gridded runoff data by 9 am every morning, and a historical record that covers Australia for the past century (available to registered users).
- Transferring our landscape water balance model to an operational model has led to significant improvements in speed. It can now produce 100 years of daily results in less than 24 hours.

NEXT STEPS

- For 2014 and beyond, we will combine the Australian Water Resources Assessment report with the National Water Account summary (see Objective 8) to form a high-level annual report on Australia’s water situation, to be called Water in Australia. We will publish the first of these new reports in 2015.
- To complement each year’s Water in Australia report, we will publish a set of regional statistics on water availability and water use on our website.



AWRA modelling system deployment architectures for interactive, production and web publication uses

- To enhance the assessments we plan to publish weekly national grids of estimated streamflow, evapotranspiration, recharge and soil moisture using our landscape water balance model.
- We will also use our river reach model to support the National Water Account and assessments work.
- We plan to launch our new Monthly Water Update web page in 2015.

8 ACCOUNTING FOR WATER



Objective: Publicly disclose water entitlements, allocations, trades and take for all major water supply systems in an annual National Water Account.

The National Water Account presents information on water stores and flows, water rights and trading, and water use—forming an important resource for policy, educational and research purposes. It currently covers nine nationally significant water use regions, which are collectively home to more than 70 per cent of Australia’s population and account for 70–80 per cent of the country’s annual water use.

PROGRESS SUMMARY

The value of the National Water Account is increasing over time, as consecutive reports build a comprehensive record of the nation’s water resources. The 2013 National Water Account, published in 2014, was the fourth in this annual series.

Uptake of the accounts online continues to grow: www.bom.gov.au/water/nwa saw more than 37 000 unique page views in 2014, compared to just under 30 000 in 2013.

2014 ACHIEVEMENTS

- We published the 2013 National Water Account significantly earlier in the year than previous reports, due to improved internal processes and highly productive relationships with reporting partners. Reports for the Canberra, Daly, Perth and Ord regions were released in February (more than four months earlier than previous years) and all nine region reports were released within 12 months of the reporting period.
- An expanded national summary was also released in June, building on the success of this new initiative in the previous year and refined following user feedback.

- We successfully trialled a streamlined format for the region reports, and will use it again in the 2014 National Water Account.
- The consistency and quality of region accounts have also been improved, with maps and icons redesigned to be clearer and easier to understand.

NEXT STEPS

- We have begun work to expand geographical coverage of the National Water Account to include a tenth region: Burdekin in northeast Queensland. We aim to release a pilot Burdekin region report in late 2015.
- We will continue to improve timeliness and usability, and seek opportunities to streamline data collection and address key information gaps.
- The National Water Account summary report for 2014 and beyond will be combined with the Australian Water Resources Assessment (see Objective 7) to form a high-level annual report on Australia’s water situation, called Water in Australia. We will publish the first of these new reports in 2015.



'The National Water Account is world-leading in attempting to account for all water in Australia. We use it as an example of forward thinking in water management.'

R. WILLEM VERVOORT,
Associate Professor in Hydrology and Catchment Management, Department of Environmental Sciences, Sydney University

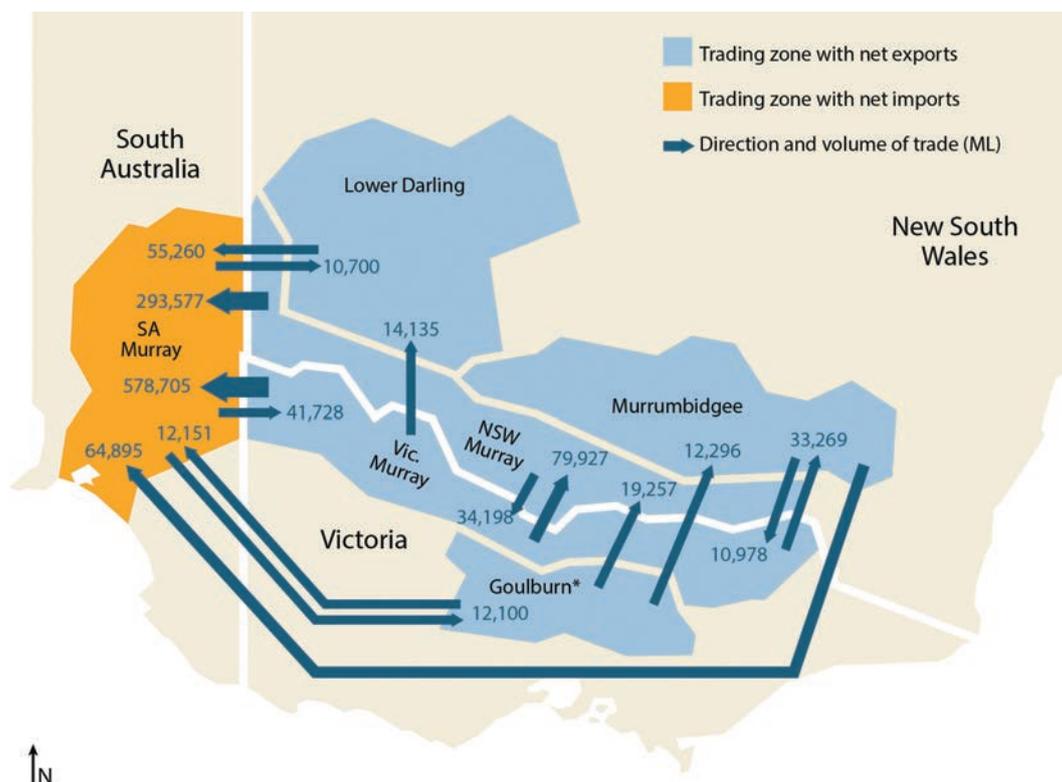
Accounting for the water needs of future generations

The National Sustainability Council's *Sustainable Australia Report 2013* highlights trends in Australia and the world that are set to have a significant impact on the next generation of Australians.

One question addressed in the report was the whether there is enough water available in regions of Australia to meet demand. The council argued that water storage levels are only part of the picture—a more complete story is found by tracking water allocation and use within a region.

The report used the closing net water asset and water use information from the National Water Account as an indicator of sustainability.

The National Water Account's standardised approach to reporting across regions meant this information could be used to draw comparisons of the adequacy of water availability to meet demand across the country.



Direction and volume (ML) of interstate trades in the southern Murray–Darling Basin in 2012–13

9 FORECASTING FLOWS



Objective: Provide effective and reliable streamflow forecasting services for high-priority water supply systems.

Greater demand for timely and accurate water availability forecasts has prompted the Bureau to expand our services. Our continuous Short-term Streamflow Forecasts (up to seven days ahead) and Seasonal Streamflow Forecasts (up to three months ahead) represent valuable tools for managing water allocations, meeting water demand, providing environmental water, and managing scarce water resources during droughts.

PROGRESS SUMMARY

Our streamflow forecasts inform a range of decisions related to river and reservoir management and operations, irrigation supply, water supply and environmental flows.

We currently provide probabilistic forecasts of total streamflow volumes over the next three months, freely available to the public, for 74 locations in eastern Australia. Stakeholders around the country are helping us test these 'seasonal' forecasts at other sites, as well as an experimental deterministic short-term streamflow forecast service.

To complement these forecasts, we are using a dynamic modelling approach to generate experimental monthly and three-monthly streamflow forecasts at 38 locations around Australia.

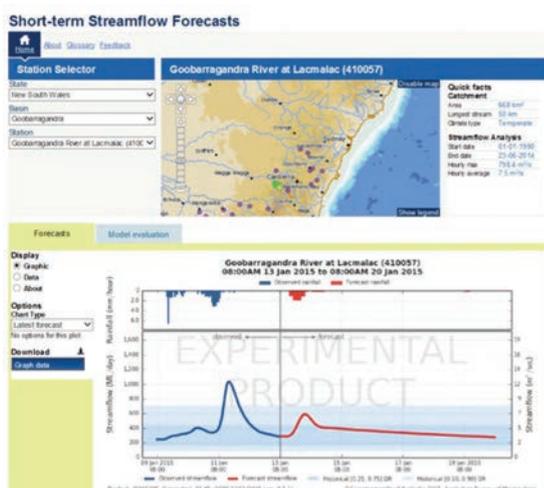
We also track climate-driven long-term streamflow change at 221 Hydrologic Reference Stations—well-maintained river gauges across the country with long, high-quality streamflow records.

2014 ACHIEVEMENTS

- In 2014 we added 28 catchments to our experimental Short-term Streamflow Forecast service—bringing the total coverage to 39 catchments across all hydro-climate regions in the country. Modelling was completed for another 23 catchments, in preparation for release in early 2015. The experimental service began in November 2013 and is undergoing evaluation by more than 100 registered users.
- We also added 34 experimental locations to our Seasonal Streamflow Forecast service. Registered users can now view forecasts for 112 sites, covering every State and Territory.
- We began using a dynamic modelling approach to produce additional experimental forecasts, for both monthly and three-monthly streamflows, at 38 locations. This approach uses rainfall forecasts from our Predictive Ocean and Atmosphere Model for Australia and runs catchment hydrological models with soil moisture accounting.

NEXT STEPS

- In 2015 we plan to release to the public short-term deterministic streamflow forecasts for up to 61 catchments.
- We will expand the coverage of Seasonal Streamflow Forecasts available to the public to 250 locations, covering every State and Territory, based on statistical analysis of climate and catchment conditions.
- Registered users will also be able to access Seasonal Streamflow Forecasts for an additional 150 sites by the end of 2015, based on a combination of statistical analysis and dynamic modelling.
- Finally in 2015, we plan to update our Hydrologic Reference Stations product with more recent streamflow data and trends.
- In the longer term, we aim to develop seamless streamflow forecasts ranging from a couple of days ahead to several months ahead, using a unified modelling methodology and an integrated modelling system.



The Short-term Streamflow Forecasts website (currently available to registered users)

Informing water planning in the Murrumbidgee catchment

The Bureau is working with the New South Wales Office of Water and the State Water Corporation (New South Wales' rural bulk water delivery business) to examine how streamflow forecasts in the Murrumbidgee catchment can improve their water planning and decision-making. The water in this catchment accounts for a significant proportion of the water available in the Murray–Darling Basin. Irrigation is important in the Murrumbidgee catchment, and it also contains many sites of environmental importance.

We have developed experimental three-month streamflow forecasts for unregulated inflows to the Burrinjuck and Blowering reservoirs in the Murrumbidgee catchment. The State Water Corporation is evaluating these forecasts and investigating how they can be used to inform water management decisions.

‘Seasonal streamflow forecast information gives us confidence that we are making the best decisions possible to efficiently manage our water.’

KATHERINE LARKINGS,
Water Strategic Planning Engineer,
Icon Water (trading as ACTEW Water)

10 RESEARCH AND DEVELOPMENT



Objective: Enhance the science and technology base of the Bureau's water information products and services by supporting strategic research and development.

The Bureau invests in research and development to ensure our water information role is supported by the best available science and technology. We do this primarily through a partnership with CSIRO—the Water Information Research and Development Alliance (WIRADA). We also maintain important research and development collaborations with the Centre for Australian Weather and Climate Research and universities.

PROGRESS SUMMARY

Improving water information outcomes continues to require substantial innovation. This largely occurs through WIRADA, which brings together CSIRO's expertise in water and information sciences and the Bureau's operational role in hydrological analysis and prediction to deliver value-added water information products and tools.

Ongoing investment in WIRADA is allowing earlier research to be refined, built upon and delivered to operation. Current research themes focus on water information systems, water accounting and assessment, and water forecasting and prediction.

'I congratulate the WIRADA team on their achievements of the past year and very much look forward to the delivery of further positive impacts from the continuation of this important alliance.'

DR CAROL COUCH, Former Director,
CSIRO Water for a Healthy Country Flagship

2014 ACHIEVEMENTS

- In 2014, our research resulted in an improved structure for the national water balance model, along with extra capabilities to handle local water management information such as irrigation and water extraction.
- We extended accuracy and refined methods for producing short-term (next seven days) streamflow forecasts.
- We also improved methods for forecasting flows out to three months, bringing together methods based on global atmospheric physics and hydrological processes with those based on statistical analysis of climate and catchment conditions. With these achievements, we are improving the performance of our Seasonal Streamflow Forecast service and the number and geographical spread of locations covered.
- WIRADA completed the development and delivery of Australian Hydrological Geospatial Fabric (Geofabric) science—adding the capability to manage information on man-made features such as pipes and canals, and expanding the data services to make the Geofabric accessible to more user systems.



- As part of an international working group developing a standard for exchanging groundwater data, WIRADA is publishing data from the National Groundwater Information System in Ground Water Markup Language (GWML) format.
- Bureau staff are collaborating with University of Melbourne researchers to develop advanced statistical tools that can derive greater insights from the nation's groundwater records. To date, the team has published tools for quantifying the impacts of various temporal drivers, and prepared 25 years of water table data from across Victoria for use in developing probabilistic water table mapping tools.

NEXT STEPS

In the final year and a half of the WIRADA partnership, we will focus on three key areas:

- transitioning recent WIRADA research into operations;
- drawing a line under recent successful WIRADA research areas and preparing these for future development under Bureau leadership; and
- making eight years of WIRADA science available in the form of a publicly accessible archive.

Better streamflow forecasts through improved estimates of catchment rainfall

WIRADA research has developed improved methods to estimate sub-catchment rainfall that address issues of missing and poor-quality data. Good-quality time-series data of historical rainfall are essential to calibrate and apply hydrological models in real time—data that are inconsistent between calibration and operation of models can compromise the performance of forecasts.

Our new methods remove spurious observations through enhanced quality control procedures applied to archived rainfall data. We then run sophisticated models to infer the space-time structures of rain gauge observations. Fitted models are used to replace missing observations, estimate rainfall at ungauged locations and produce sub-catchment rainfall for historical periods and in real time. These models also estimate the uncertainty of sub-catchment rainfall.

We have demonstrated that the new methods estimate rainfall at ungauged locations better than the methods currently used. Hydrological models that use the improved sub-catchment rainfall estimates are more consistent between calibration and validation periods, contributing to improved streamflow forecasts.

JURISDICTIONAL REFERENCE GROUP ON WATER INFORMATION

The Jurisdictional Reference Group on Water Information is the primary vehicle for coordinating the Bureau's water information activities with those of the States and Territories. It comprises representatives of the lead water agencies in each jurisdiction and delegates from some major water utilities. It provides a forum for members to articulate water information priorities in their jurisdictions and give feedback on the Bureau's water information products and services.

2014 meetings:

- 19–20 June
- 20–21 November

NATIONAL WATER ACCOUNT COMMITTEE

The National Water Account Committee provides strategic advice on all aspects of the National Water Account, guides the collaborative development of the account, and provides advice on alignment to user needs.

2014 meetings:

- 26 February
- 11 June
- 12 November

STANDARDS BUSINESS FORUM

The Water Information Standards Business Forum brought water industry representatives together with the Bureau to inform the development of water information standards. The Bureau discontinued this forum in October 2014. Future development of water information standards will be led by an industry collaboration called the Water Monitoring Standardisation Technical Committee, which first met in November 2014. The Bureau will contribute as a member of the new committee along with 25 other organisations.

2014 meetings:

- 22 May
- 8 October

FLOOD WARNING CONSULTATIVE COMMITTEES

In each State, flood warning consultative committees meet regularly on a three- to six-month time frame.

These committees comprise representatives such as emergency managers, water authorities, local government and catchment management authorities. Meetings cover items ranging from network issues to service needs. In the Northern Territory, a similar group is called the Flood Warning Working Group.

2014 meetings:

- New South Wales: 19 February
- Northern Territory (Flood Warning Working Group): 20 May and 4 November
- Queensland: 12 June and 28 November
- South Australia: 23 July
- Tasmania: 30 January and 10 December
- Victoria: 27 February and 7 August
- Western Australia: 25 August

NATIONAL FLOOD RISK ADVISORY GROUP

The National Flood Risk Advisory Group works to strengthen the community's resilience to floods by providing leadership and advice on best practice for flood risk management. It brings together representatives from each jurisdiction actively involved in flood risk management with other key stakeholders.

In 2010, the group became a reference group of the National Emergency Management Committee. The Secretariat is provided by the Australian Government, through Geoscience Australia and the Bureau of Meteorology.

2014 meetings:

- 14 March
- 28 July

NATIONAL GROUNDWATER INFORMATION SYSTEM STEERING COMMITTEE

The National Groundwater Information System (NGIS) Steering Committee provided advice on developing and implementing the national groundwater information initiative. The committee was supported by a Technical Reference Group. As the NGIS project finished at the end of 2013–14, both groups met for the last time in 2014. The Bureau has since formed a new groundwater reference group with a broader mandate.

2014 meetings:

- 23 May
- 5 August

THE WATER ACCOUNTING STANDARDS BOARD

The Water Accounting Standards Board was an independent advisory board, to oversee and coordinate development of water accounting standards. The board ceased operation on 1 July 2014, following the release of Australian Water Accounting Standard 2 and the revision of the Water Accounting Conceptual Framework in 2014 (see Objective 2).

2014 meetings:

- 3 March
- 2 May
- 6 June

GEOFABRIC STEERING COMMITTEE

The Geofabric Steering Committee provides strategic guidance on technical direction, adoption and government policy—with the aim of making the Geofabric the authoritative source of information about Australia's surface and sub-surface water features.

2014 meetings:

- 21 March
- 26 May
- 31 July (Future Directions workshop)

CONFERENCES

Hydrology and Water Resources Symposium, Perth, 24–27 February

The Bureau's Assistant Director, Water Forecasting, Dr Dasarath Jayasuriya, gave a keynote address on responding to floods and droughts. Bureau representatives also presented on flood warnings, Intensity–Frequency–Duration Design Rainfalls, frequency analysis, estimating probable maximum precipitation, the relationship between climate drivers and rainfall extremes, simulation of rainfall patterns, and Hydrologic Reference Stations.

9th Annual Water Symposium, Sydney, 27 February

The Bureau's Deputy Director, Environment and Research, Graham Hawke, delivered a presentation on 'Integrating value from climate and water information', highlighting the Bureau's unique position to integrate these intrinsically linked aspects of environmental information.

OzWater'14 conference, Brisbane, 29 April–1 May

Graham Hawke provided a presentation on 'Water management in the Murray–Darling Basin', to showcase the products and services available from the programme.

International Riversymposium, Canberra, 15–18 September

ACTEW Water (now Icon Water) presented a poster in collaboration with the Bureau, describing how our Seasonal Streamflow Forecasts add confidence to their water-management decisions.

Australian Hydrographers Association conference, Sydney, 28–31 October

Bureau involvement included an exhibition stand, Dr Dasarath Jayasuriya as the keynote speaker ('Drawing insights from water data—challenges and opportunities') and Linton Johnston speaking on 'National industry guidelines for hydrometric monitoring—adoption and implementation at a national level'.

PRODUCT LAUNCHES AND INFORMATION SESSIONS

- On 21 October 2014 the Hon. Senator Simon Birmingham, then Parliamentary Secretary to the Minister for the Environment, launched the Australian Groundwater Explorer at Australian Parliament House. The event was attended by more than 30 key stakeholders.
- From August to November, water information briefings were held in capital cities. We invited key stakeholders and more than 300 people attended, representing 126 organisations. State and Territory departments and water utilities co-hosted the events, strengthening alliances. We showed the latest Climate and Water Outlook video at each event, inviting attendees to distribute these monthly videos among their networks.



Senator the Hon. Simon Birmingham at the launch of the Australian Groundwater Explorer

E-NEWSLETTERS

- We continued to distribute regular water information updates as e-newsletters in 2014—publishing four issues of enGauge, two editions of our new Groundwater News email and a special email update for National Water Week.
- Subscriptions to our monthly Seasonal Streamflow Forecast service grew to approximately 2200, up 43 per cent from the previous year.
- Our new Groundwater News service attracted more than 520 subscribers interested in the Bureau's suite of groundwater products.
- In addition to regular communications, we sent emails to water information subscribers and stakeholders updating them on the National Water Account, Geofabric developments and registered user access to Climate Resilient Water Sources.
- Overall, nearly 5200 people received specific product updates and special announcements from us in 2014, and e-newsletter subscription increased by around 30 per cent from 2013.

WEBSITE

Throughout 2014 we maintained an active water information website at www.bom.gov.au/water, which attracted nearly 800 000 unique page views. The groundwater information pages (now including the Australian Groundwater Explorer) and water restrictions pages both attracted more than twice as many views as in 2013.

VIDEOS

- Our monthly Climate and Water Outlook videos, launched in July 2014, each feature seasonal streamflow observations and forecasts for the coming three months. This information contributes to the decision-making of governments, industries and communities. By the end of 2014, the first six videos had been watched more than 270 000 times between them on YouTube, Facebook and our own website.
- During World Water Week (in September), we released a short video explaining our Seasonal Streamflow Forecasts service, which was watched more than 10 000 times in its first five months online.
- In October we released a second product explainer video—on the Australian Hydrological Geospatial Fabric (Geofabric). This was watched more than 25 000 times by 31 December.

NATIONAL CLIMATE AND WATER BRIEFINGS

Our monthly National Climate and Water Briefings continued to attract strong interest this year, with around 50 people attending each event. These briefings have grown steadily since their inception in August 2011, with attendees now representing more than 40 government departments and agencies and key organisations.

Each briefing presents a summary of recent climate and water conditions and then explores the outlook for coming months.

A range of special topics were presented this year, including:

- seasonal pre- and post-severe weather briefings;
- a review of the year globally and for Australia; and
- developments in streamflow forecasting, National Water Account and water markets information.

Feedback from attendees indicates that the briefings are meeting their objectives: They directly or indirectly inform decision-making (e.g. helping to brief senior colleagues or provide background for other work), and attendees would recommend them to their colleagues.

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