Modernisation and Extension of Hydrologic Monitoring Systems Program

Australian Government
Bureau of Meteorology

Water Information
DATA › INFORMATION › INSIGHT

Front Cover: Pictures by Lynton Crabb.

Back Cover: Pictures by Lynton Crabb and Hydro Tasmania

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Introduction

When the Australian Government gave the Bureau of Meteorology (the Bureau) responsibility for reporting on Australia's water resources in 2007, it quickly became evident through discussions with water agencies across the country that major improvements in data availability, quality and coverage were needed. In order for the Bureau to undertake its new national water information role, it was clear that new technologies were needed to monitor, communicate, process and store water data.

The Government's $80 million Modernisation and Extension of Hydrologic Monitoring Systems Program (M&E Program), administered by the Bureau, is doing more than helping to address these issues. The fund is also enhancing collaboration and cooperation between the Bureau and the lead water agencies and water managers essential to the success of the Bureau's Improving Water Information Program.

Since it began in 2007, the M&E Program has funded 397 projects over four rounds—one round per year—with a total investment of just over $67 million. These projects are undertaken by organisations ranging from natural resource management bodies to large state and territory corporations.

Googong Reservoir, ACT.

The Bureau of Meteorology is assisting water data collecting agencies to modernise and extend their streamflow, groundwater monitoring and water storage measurement networks, enhancing their accuracy and permitting real-time data transfer to the internet.

Funded projects include:

- rollout of improved measurement technology such as Acoustic Doppler Current Profiler (ADCP) Technology
- installation of telemetry for major storage inflow and discharge at critical stream gauging sites and on groundwater monitoring bores in heavily utilised aquifers
- refurbishment of high priority monitoring stations
- installation of processes for transferring data in Water Data Transfer Format (WDTF)
- enhancement of data management systems
- improving surface water and groundwater spatial data sets
- engagement of Strategic Water Information Coordinators
- promoting the public accessibility of water information through new licensing arrangements.

The M&E Program is now helping the Bureau to receive and process a range of data necessary to giving Australians their first truly national picture of how much water is available for all uses. The following case studies present a small sample of the breadth of this highly successful program and show how simple ideas and modern technology can improve vital water information for all users.

Craigbourne Dam, Tasmania.

Case Study 1:
Improving groundwater monitoring in the Northern Territory

Many communities in Australia's dry centre and northern dry tropics rely on groundwater aquifers or natural underground water storages. In remote areas, the logistical challenges and cost of maintaining adequate groundwater monitoring can be significant.

Over the last decade, monitoring of remote groundwater supplies has been patchy. Without sufficient information to manage groundwater resources, aquifers are at risk of over-extraction and declining water quality, threatening the ecosystems and livelihood of the communities that depend on them.

Above: Bureau of Meteorology Regional Hydrology Manager, Nigel Mules at Yuelamu, Northern Territory.
Centre: Nerida Beard, Community Water Planning Project Manager for Power Water, checks a production bore for the town of Yuelamu, NT.

"This additional funding from the Bureau has helped us bring forward our automation plans for groundwater monitoring by at least five years. It will help us better understand and manage our groundwater resources in a changing climate."

NERIDA BEARD, MANAGER OF REMOTE COMMUNITY WATER PLANNING FROM REMOTE OPERATIONS, POWER AND WATER CORPORATION, NT.

Vital groundwater monitoring equipment has now been upgraded at 34 remote Indigenous communities across the Northern Territory, with populations between 170 and 2500 people.

Data collected from these monitoring facilities will enable more informed decisions to be made about the sustainable management of the resource and opportunities for wider use for the benefit of the community.

Better monitoring will also enhance Power and Water Corporation's ability to study groundwater characteristics in aquifers and to gain a better understanding of the way aquifers respond to climate variations.

The work has been undertaken over two years by the Remote Operations Division of the Power and Water Corporation using $648,000 of funding from the Bureau's M&E Program to supplement their own available funding.

The project uses the latest data collection technology, including electronic depth sensors, data loggers and local area Supervisory Control and Data Acquisition (SCADA) systems, to measure groundwater levels and enhance data collection capability.

Anthony Juttner, Essential Services Officer for Yuendumu, NT, explains the operation of SCADA telemetry equipment installed in the Eclipse borefield to Nerida Beard and Nigel Mules.

Case Study 2:
How much water is in our dams?

Building an accurate picture of our available water supply is critical to effectively managing this precious resource. In the past, the water storage capacity of major dams and weirs has been based on limited surveys of cross-sections along their length. New Airborne Laser Scanning and other technologies are allowing water managers to more accurately calculate the storage capacity of weirs and dams.

Accurate storage capacity tables, which show the volume of water stored in a dam at different water levels, are essential for determining how much water is available. However as tables are based on the shape of the storage, they can change over time due to erosion and build up of sediment on the storage floor. Sediment reduces the volume of water stored in the dam and when storage levels are low, water resources managers do not have certainty about exactly how much water is available.

Knowing the volume of water in a storage allows managers to more precisely allocate available water, particularly during droughts when water becomes scarce. Accurate information on water availability is also important to the Bureau as it undertakes water balance modelling in the preparation of the National Water Account and Australian Water Resources Assessments.

Above: Survey Assistants Vaughan Wady and Simon Dunn taking water depth measurement using depth sounder at Lock 15 weir on Murray River. Centre: GPS data recorder for recording depth and position.

"The bathymetric surveys of State Water's Storages, which enabled the creation of new capacity tables, was of great benefit to State Water's operations by enabling the volumes of water available to water users to be more accurately determined."

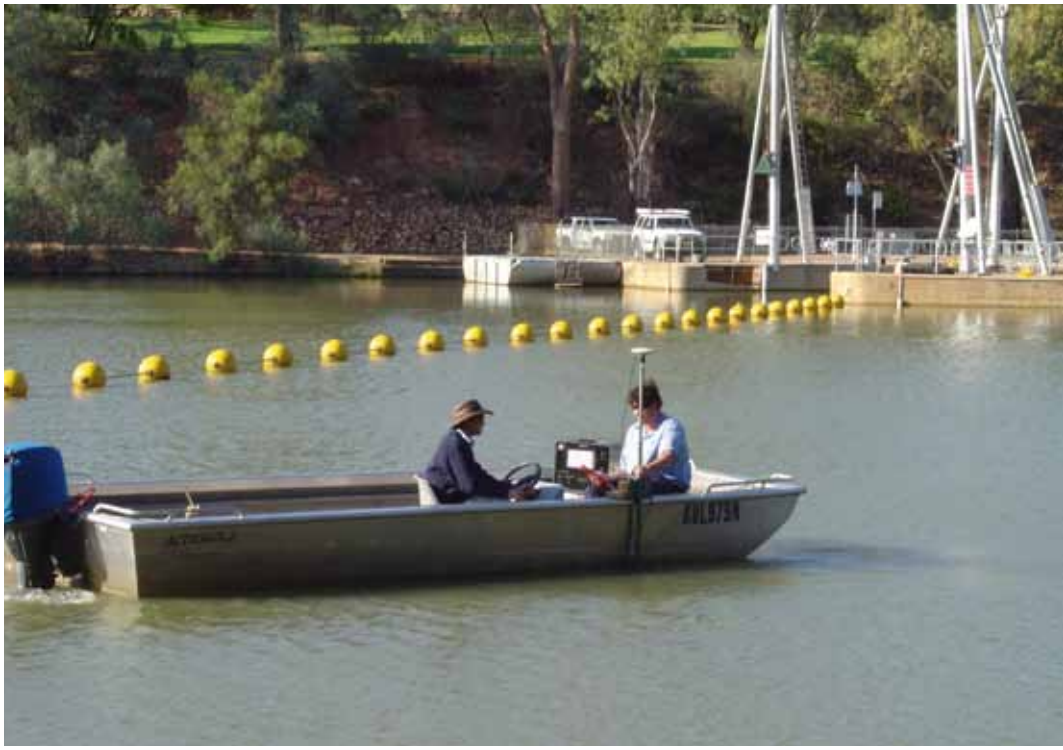
SAM SAMARAWICKRAMA, STATE WATER CORPORATION, NSW.

In 2008/09, the Bureau granted NSW State Water Corporation $180,000 to conduct bathymetric (water depth measurement) surveys of five key storages well overdue for storage capacity updates: Jemalong Weir pool, Hay Weir pool, Gogelderie Weir pool, Bundidgerry Weir pool and Tombullen storage.

Jemalong Weir pool extends for 30 kilometres. Its capacity table was last estimated in the 1940s based on three cross sections, 10 kilometres apart. The Hay Weir capacity table, developed in 1979, was based on the survey of 21 cross-sections of the Murrumbidgee River extending 50 kilometres upstream of the weir structure. The other storages had similar capacity table histories.

The limited number of cross-sections used in the original storage capacity tables and changes in the storages over time due to erosion and sediment meant that the existing capacity tables no longer represented current water storage capacity of the weir pools. Each storage pool was surveyed in cross-sections at 500 metre intervals, and a longitudinal section of the centreline of the river was also surveyed. The surveys showed that in some storages the total capacity of the weir may not have changed greatly from the original surveys but the storage volumes at low levels had changed with some having less water than originally thought due to sedimentation.

Other storages showed that they had more water than originally thought. After the survey, State Water Corporation found that the Jemalong Weir pool volume was 27% more at the full supply level than the original surveys had shown.



CEEDUCER Pro complete hydrographic survey system setup for shallow water survey in NSW. Picture supplied by Bruttour International.

Case Study 3:
Enhancing reporting of water information

The Bureau works closely with more than 200 water management organisations across the country that gather information on water availability, water storage, river flows, groundwater, water quality and water allocations and trading. Much of this information is provided to the Bureau in different ways, but Toowoomba Regional Council is now using a new on-line reporting system to transfer water storage information on Cressbrook Dam, Perseverance Dam and Cooby Dam in the Bureau's preferred Water Data Transfer Format (WDTF).

Toowoomba Council is one of 63 Queensland water service providers using the Statewide Water Information Management (SWIM) system to manage and deliver their water data to a number of state and federal government agencies—16 of them report to the Bureau under the Water Regulations 2008.

SWIM has been developed by the Queensland Water Directorate (qldwater) to simplify the reporting process for water service providers across Queensland. The Bureau provided over $320,000 to the SWIM project during the first and second M&E Program funding rounds.

Above: Perserverance Dam. Picture by Laurie Ash.
Centre: Zarna Everett and John Betts, Toowoomba Regional Council, using SWIM system.

"SWIM has considerable value for both the State and the Bureau and has potential to be adopted by other organisations."

DONNA BEATTIE. STRATEGIC WATER INFORMATION COORDINATOR, QUEENSLAND.

Qldwater's work with SWIM has significantly improved the currency and accuracy of the data being reported to the Bureau. SWIM also improves efficiency because without this facility the 16 Queensland organisations using SWIM would be submitting urban water data to the Bureau in an assortment of less useable and consistent formats.

In the past, some data providers submitted water information that may have been missing critical explanatory notes including its relationship to a particular Regulations category, such as water discharge from a dam. Staff turnover in the water management agency might have resulted in spreadsheets being completed in different ways or incorrectly filled out. When water data arrived at the Bureau, it was often difficult to interpret.

The use of WDTF reduces the Bureau's computing complexities and staff workload to receive, decode and manage the data. Through a process of updating, validating and aligning indicators requested of water service providers, qldwater has reduced the number of indicators reported from 900 to around 250, significantly reducing the reporting workload of their members. This data is submitted to SWIM, where it is reformatted and distributed as required to various government agencies.

The SWIM system also allows any queries about data, such as not receiving scheduled data transfers, to be directed to a single source for attention.

Cressbrook Dam. Picture by Laurie Ash.

Case Study 4: Investing in better flood monitoring

Measuring flow in rivers during heavy rainfall and floods is critical to gathering the information for defining the river height-to-flow relationship (the rating curve) that is so important to the Bureau's role in water data and resources assessment.

The Bureau has provided Melbourne Water with $160,000 to install travellerways at 13 critical points along rivers in the Melbourne area. The travellerway consists of a cable stretched above the river between two structures. Measuring equipment, such as an acoustic doppler unit, is winched across the width of the river to take water depth and flow speed measurements or gaugings.

That data is transmitted via blue tooth technology to a computer operated by a hydrographer on the riverbank. The hydrographer can also operate the travellerway from the riverbank and capture data on the passing flows at all points of a cross-section of the river.

This Program has enabled Melbourne Water to significantly improve its hydrologic monitoring capabilities and processes through several enhancement projects such as the travellerway upgrades.

Gauges at Yarra River at Yerring, Victoria.

"We hope that the new design travellerways improve safety and may also assist those in the water industry that use travellerways to collect stream flow data."

PAUL RASMUSSEN, TEAM LEADER, HYDROLOGY AND FLOOD WARNING, MELBOURNE WATER, VICTORIA.

The water volumes and speeds measured are used to model river behaviour under different flow conditions and to forecast flows that will impact on downstream communities under flood conditions. As stream levels rise and fall channel cross-sections rapidly change. River gaugings must be taken at different water levels during a flood. This information is used to provide more accurate flood forecasts and improve the safety of downstream communities.

The travellerways not only allow for the use of acoustic dopplers to provide higher quality flow data but they enable safer data collection. In the past, the common method of taking readings was to put hyrdographers in a boat and send them into the fast flowing water to take measurements with hand-held stream gauging equipment.

Travellerways, or cables crossing waterways, replaced boat stream gauging methods in the Melbourne Water catchment in the 1960s. When a recent health and safety audit found that most of Melbourne Water's ageing travellerways were no longer up to health and safety standards, the cables were removed until a new design could be developed.

Upgrading the Melbourne Water travellerways has resolved the safety issues and enabled river gaugings to be recommenced at these sites.

Melbourne Water Hydrology Specialist Peter Waugh at the Yerring travellerway during installation.

Case Study 5:
Measuring water in remote regions

The Kimberley Region contains some of Australia's largest water resources, with the Ord River one of the highest yielding catchments in the country. Most of the flow in these Kimberley river systems occurs during the wet season, when river levels can rise by up to 17 metres and flood plains can stretch across more than 20 km. For instance, eighty-six per cent of upper Ord River flows occur in January, February and March.

Understanding the behaviour of these major waterways is critical to assessing the level of water resources available and can also assist in the provision of flood warnings. However, measuring water flow in remote rivers in Western Australia's Kimberley region during the wet season carries a range of problems including the chance that heavy rain will close roads, making it impossible for hydrographers to access or leave measuring locations for days or weeks.

The Department of Water in Western Australia has received $85,000 to fund two portable monitoring stations that can be picked up and transported to remote sites before the wet season.

Above: Department of Water (DOW) Hydrographer Duncan Palmer unloading equipment from the container.
Centre: DOW Hydrographic staff Scott Zahn and Duncan Palmer gauging the flow of the Negri River with boat mounted ADCP.

"This will be an important update to the Ord catchment's hydrologic modelling, particularly as Ord Stage Two irrigation development is underway and water resources will become tighter between competing users."

DUNCAN PALMER, DEPARTMENT OF WATER, WESTERN AUSTRALIA.

All necessary equipment, including boats, measuring devices and camping equipment, is loaded into shipping containers, which are placed at strategic locations each year. This removes the need to establish a wet season camp at each gauging station.

The fully self-contained mobile gauging units allow hydrographers to visit the established locations by helicopter when conditions look favourable for high flow or flood events. The hydrographers can remain on-site undertaking high flow river gaugings, important for the preparation of accurate rating tables to enable calculation of accurate river flows.

Over the next five years, the two mobile shipping containers will be alternated across ten sites in the Kimberley region. Each of these sites will have one comprehensive medium to high flow rating review every five years.

These reviews will enable more accurate operation of water storages, such as Lake Argyle in the Ord scheme, during a range of climatic conditions. This will be particularly important as the Ord irrigation scheme expands and greater demands are placed on the available water resources.

Helicopter carries gauging boat to the river.

Case Study 6:
Groundbreaking technologies

River flows in the Kimberley and Pilbara regions are highly seasonal and can convey enormous volumes of water. In these regions, rivers are remote and access to gauging stations to obtain actual flow measurements is limited. To more accurately model river flow through the development of synthetic rating tables, hydrographers need a clear picture of the physical characteristics of these river channels.

In the past, the only way to obtain this information was by combining manual surveys of multiple river cross-sections. But aerial laser surveys are now helping water managers to build three-dimensional images of river sections. These images improve the accuracy of flow estimation along rivers by allowing the cross-sections to be utilised in hydraulic models to produce synthetic rating tables for the sites.

The Bureau has granted $149,000 of M&E Program funding to the Department of Water in Western Australia for commissioning Light Detection and Ranging (LiDAR) surveys of gauging reaches—sections of the river that are regularly monitored under different flow conditions—in the Kimberley and the Pilbara.

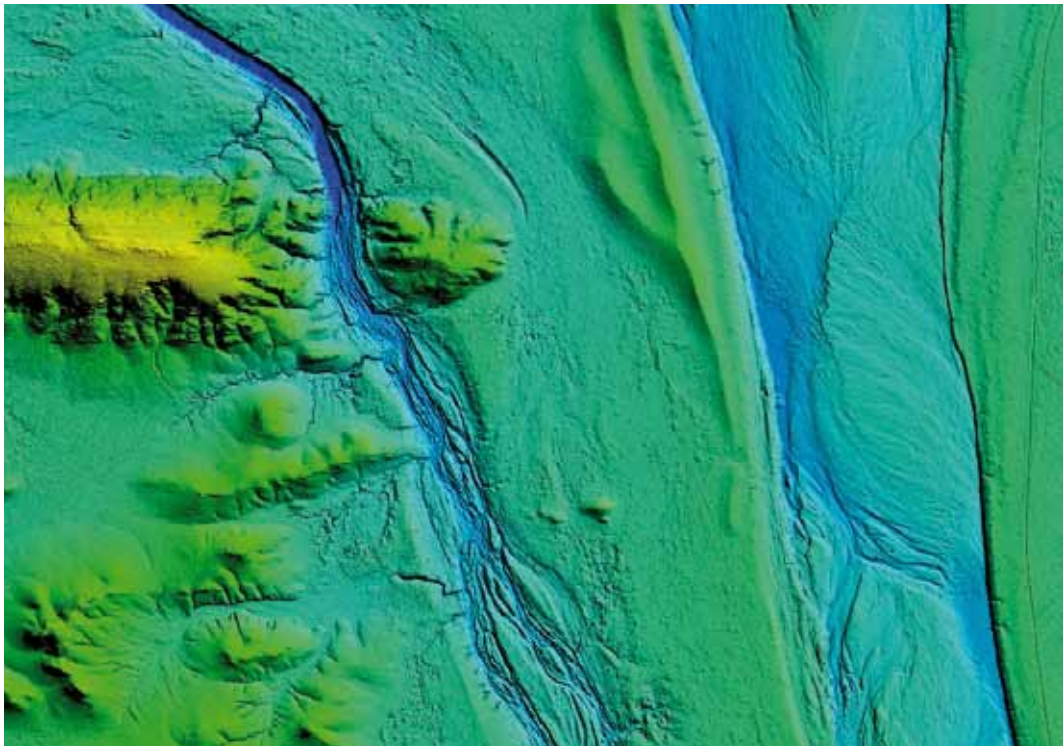
Above: Cadastral boundry survey, Kimberley region, Western Australia. Photographer Max Hore, Fugro Survey Pty Ltd.
Centre: Aircraft used for Aerial LiDAR surveys.

"In future, knowledge developed through the use and analysis of LiDAR data from the selected gauging stations will be useful for applying to many other rivers in Western Australia."

ROSS DOHERTY, DEPARTMENT OF WATER, WESTERN AUSTRALIA.

Aircraft use LiDAR to digitally survey the land surface at high resolution, capturing data on river features such as channels, banks, rock bars, gorges, floodplains, roads and bridges. This information is used for better flood forecasts, operational water management decisions and water resource planning.

Better understanding of available water resources is important for improving long-term sustainable water resource planning. Initial projects in the Kimberley and the Pilbara have been completed and further work on data for flow models for Pilbara gauging stations is underway. The use of aerial surveys, while expensive, reduces staff safety risks and produces results that could take numerous years of fieldwork to achieve.



LiDAR image of Lower DeGrey River, Pilbara Rivers project. Supplied by Fugro Spatial Solutions.

Case Study 7:
Measuring river flows

Many parts of Australia experience climatic extremes including damaging flooding. Accurate river flow data is essential for flood warning and managing and assessing available water resources. Water managers need to use the most modern and accurate equipment in order to learn from flood events so that robust procedures can be developed to better predict flood activity.

Calibrated measuring devices, current meters, floating devices, hydraulic equations and stage discharge relations have been used for river and streamflow measurement for many decades. However, acoustic doppler equipment can provide more accurate readings than the conventional mechanical devices still used to measure water flow in many areas.

Acoustic Doppler Current Profiler (ADCP) technology has been used for flow measurement for over 30 years in Australia but technology improvements now make it the most effective flow measuring technique in terms of accuracy, safety, capability and affordability. The Bureau has provided $3.9 million to fund purchase and installation of 145 ADCP units under 25 projects across Australia.

Above: Sam Walker, Hydrographer, Department of Primary Industries, Parks, Water and Environment, servicing Hornet cableway.
Above Right: Sontech M9 Accoustic Doppler Current Profiler.
Centre: David Thorpe, Strategic Water Information Coordinator Tasmania and Sam Walker, operating Accoustic Doppler.

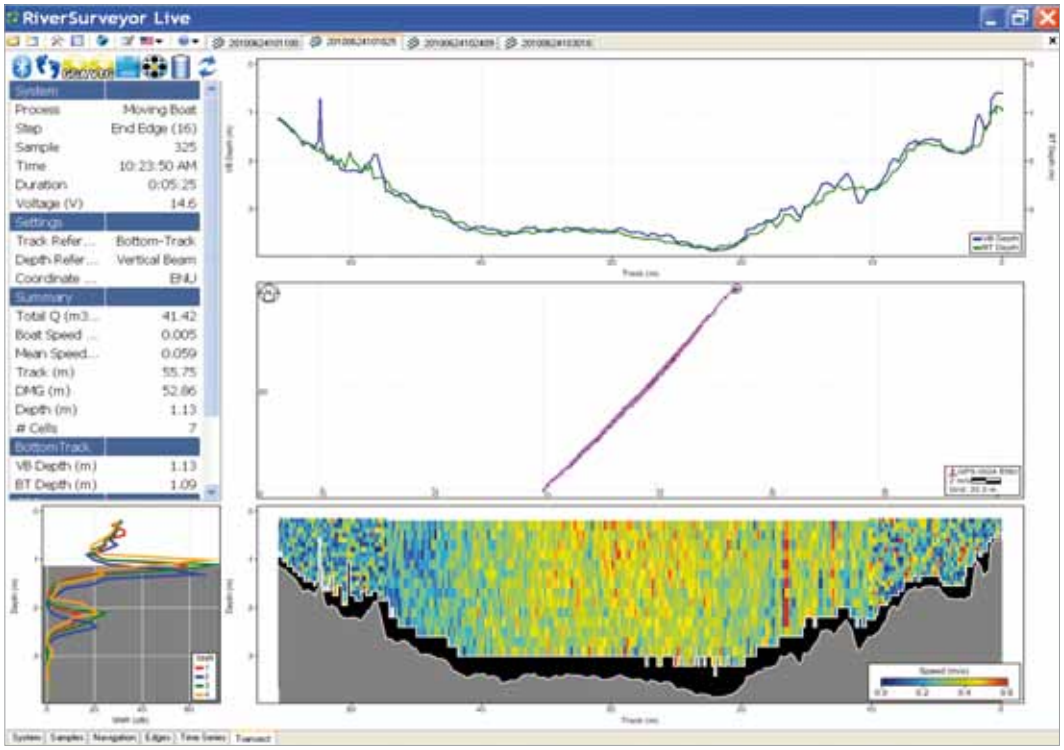
"In Tasmania, the M&E Program has provided the Department of Primary Industries, Parks, Water and Environment and other organisations with assistance to purchase acoustic doppler equipment to improve stream gauging data, and logging and telemetry equipment that will improve the functionality and reliability of data being recorded."

DAVID THORP, STRATEGIC WATER INFORMATION COORDINATOR, TASMANIA.

Acoustic doppler equipment can be applied in many ways for measuring river flow. Dopplers can be used as mobile units mounted on travellerways (such as in case study 6), as in-situ units used at a monitoring sites generating a profile across the width of the river (also known as 'side-looking dopplers') for a defined time, and on manned boats (see case study 5) and radio-controlled boats.

Units mounted on radio-controlled boats are gaining favour from the perspective of staff safety. This is particularly important in western and northern Australian rivers where crocodiles are abundant and water levels can vary rapidly during flood events.

Advances in acoustic doppler technology, integrated with powerful and rugged field computing and communication technologies, provide accurate river bed and water velocity profiles. When the dopplers are used as mobile units, field crews can travel to different river monitoring sites over a flood period or a wet season to take river gaugings at a number of water levels at each site. These river gaugings can then be used to update the rating table for a river monitoring site.



Screen grab of river gauging display at South Esk River, Perth, Tasmania.

Case Study 8:
Monitoring in snow areas

Two types of rain gauges are generally used to measure rainfall across Australia. Manual rain gauges funnel rain into a cylinder with daily readings recorded by a trained observer. Tipping bucket rain gauges provide a continuous automatic 'trace' or record of the rainfall intensity measured over periods as short as one-minute intervals.

However, when it snows and the temperature falls below freezing in alpine areas, water in a gauge's collecting funnel creates an icy cap instead of running into the cylinder. Neither of the traditional gauge types can provide accurate measurements in these conditions.

The Bureau has provided $177,000 to Melbourne Water for the replacement of nine rain gauges in Victoria with new technology in snow prone areas above 1000m. In order to get a clearer picture of how much water is likely to find its way into Alpine rivers when the snow melts, water managers have previously used equipment with gas heated rims to melt the snow and let the water run into the gauge. But using gas heaters in forested and remote catchments can be hazardous for the environment and unsafe for workers.

Above: Melbourne Water Hydrology Specialist Peter Waugh and Wijedasa Alankarage, Account Manager, Bureau of Meteorology, inspect snow gauge on Mt Donna Buang, east of Melbourne.
Centre: Ice covered tipping bucket rain gauge.

"Since being commissioned, the snow gauges have provided significantly improved hydrologic data necessary for informed business decisions. Prior to their installation, the data was sometimes inaccurate due to build up of snow within the rain gauge funnel. Without this funding it is most likely that this project would not have been possible."

PAUL RASMUSSEN TEAM LEADER, HYDROLOGY AND FLOOD WARNING, MELBOURNE WATER, VICTORIA.

For the first time in Victoria, Melbourne Water is using the gauging technology used in cold climates in the Northern Hemisphere and in Antarctica, to measure precipitation falling as snow within its catchment.

This technology works by weighing snow, hail and rain rather than measuring it as a liquid. The gauges are also linked to a real-time data collection network designed to enhance run-off management and flood estimation.

In the past, snow data for water resource purposes has only been collected on an ad-hoc basis in very few areas. Increasing demands on water resources and the recent period of extended drought have highlighted the potential value of improved snowpack information for Melbourne Water's water resource management planning and operations. This data will enable better modelling of water volumes and timing of inflows to storages enabling more accurate and timely resource management decisions including seasonal water allocations.

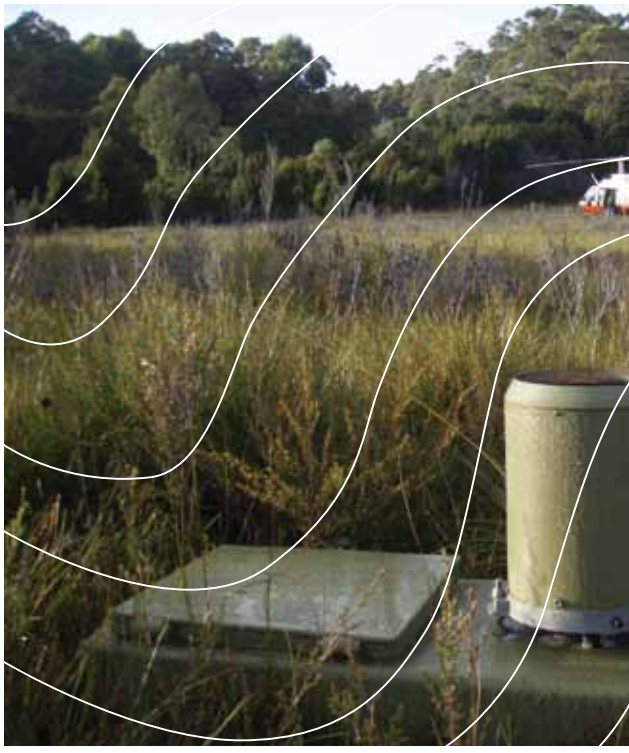
Peter Waugh maintaining new snow gauge.

Case Study 9:
Improving real-time data collection

Measuring rainfall at sites in remote areas of the north, north-west and west of Tasmania is important for improving flood warning to communities, managing hydro-generation activities and dam safety.

The Bureau has provided Hydro Tasmania with $173,000 to install and upgrade telemetry at a number of rain gauge sites, including several in the Tasmanian Wilderness World Heritage Areas that are often difficult to access. The telemetry will enable data from the sites to be downloaded via a radio or mobile phone connection.

Previously, data was manually downloaded at approximately six-monthly intervals. This meant the data could not be used to assist the Bureau in its real-time flood forecasting models or Hydro Tasmania in management of outflows from storages to minimise flood effects and maximise water retention.



Above: Hydro Tasmaina Senior Hydrographer, Mark Johnston at Bluff River Pluviograph site, Tasmania. Pictures supplied by Hydro Tasmania.
Centre: Helicopter at Doods creek Pluviograph site.

"With increasing pressure to provided accurate water data in near real-time to a variety of users, the Bureau's M&E funding has gone a long way towards equipping DPIPWE to provide quality, reliable and readily available water resource information."

DAVID THORP, STRATEGIC WATER INFORMATION COORDINATOR, TASMANIA.

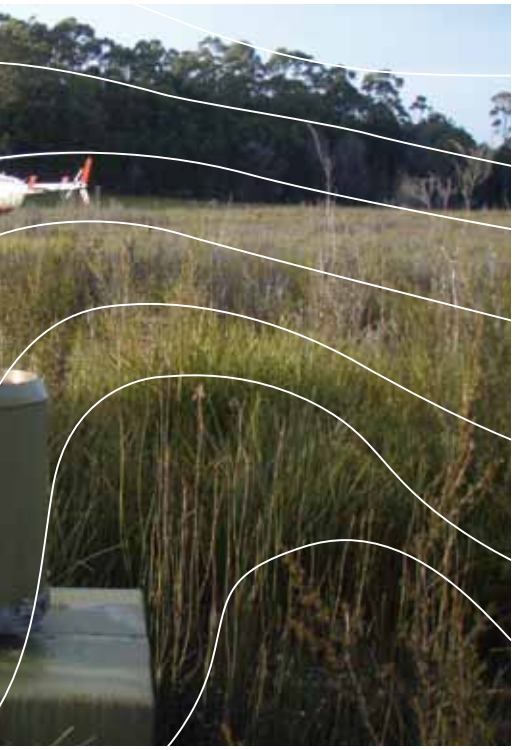
Upgrading these systems has allowed Hydro Tasmania to collect rainfall data at daily or greater frequency. The data is also fed into Hydro Tasmania's dam safety models to assist in managing the passage of floods through the various dams that make up Tasmania's hydro-generation system.

Hydro Tasmania transfers the data to the Tasmanian Department of Primary Industry, Parks, Water and Environment (DPIPWE) to assist in town water supply and irrigation assessment. DPIPWE also transfers data to the Bureau for input into flood warning models that improve the accuracy and effectiveness of flood predictions for people living in downstream areas.

Reliable and more frequent rainfall measurements from this project will provide accurate data for research on water resources and hydrology and better understanding of the spatial and temporal variability of rainfall in the mountainous region.

Real-time communication allows equipment performance to be monitored and failures detected and rectified. This reduces the period of data that is lost compared with periodic (6 to 12 month) visits to non real-time monitoring sites.

This data is also useful for the Hydro Tasmania Dam Safety team in monitoring storages for inflows, spillway performance and dam leakage.



Hydro Tasmania Hydrographer, Lukas Salkeld checking monitoring equipment at Dome Hill, Tasmania.

Case Study 10:
Strategic Water Information Coordinators

The success of the Bureau's water information Program relies on cooperation and clear communication with more than 200 agencies that collect and hold water information across Australia.

The Strategic Water Information Coordinators (SWIC) Program is helping the Bureau to forge strong relationships with our state and territory partners and data providers to promote clear understanding of our water information activities.

SWICs are appointed from the lead water agency in each state and territory to provide organisations with a focal point for two-way communication with the Bureau and assistance with questions about the Water Regulations 2008 (Regulations), data delivery or the M&E funding Program.

Above: Strategic Water Information Coordinators Front: Sabine Schreiber, Victoria; Donna Beattie, Queensland; Pauline Farrell, WA; David Thorp, Tasmania. Rear: David Malone, NSW; Linton Johnston, Bureau of Meteorology; John Barrett, SA; John Cameron, Victoria. Centre: David Malone at Lake Pamamaroo, NSW

"SWICs have made a great contribution to the Bureau's water information mission by bringing players together and getting conversations started. The enthusiasm and energy of the SWICs has helped stimulate high levels of cooperation and coordination between the variety of stakeholders."

LINTON JOHNSTON, SWIC COORDINATOR, BUREAU OF METEOROLOGY.

Each SWIC is working to determine the extent, status and capabilities of hydrologic monitoring networks in their jurisdiction. They also assist data providers to comply with the Regulations and to identify investment priorities in water information infrastructure necessary to meeting future water information requirements.

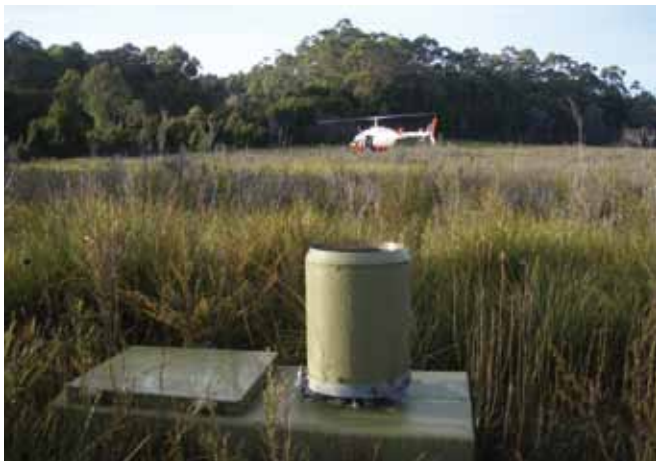
SWICs promote the M&E fund themes and objectives and coordinate joint bids between agencies and jurisdictions when there is shared interest. They also help to review bids for funding, with particular focus on bridging gaps in water monitoring networks, data management and data transfer processes that could affect a jurisdiction's ability to meet its water information requirements under the Regulations.

From 2009, SWICs have prepared annual Strategic Water Information Monitoring Plans (SWIMP), which are the blue print for future improvements in water information infrastructure for each jurisdiction. Each SWIMP contains information on the current status of water information collection and monitoring systems and gaps in networks and knowledge. SWIMPs are now contributing toward a national picture of water information activities in Australia.

The SWIC team outside the Bureau's Canberra office.

Craigbourne Dam, Tasmania.

www.bom.gov.au



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