

# HYDROLOGICAL SERVICES

## OBJECTIVE

To provide an effective national source of hydrological and hydrometeorological data and advice and to meet the needs of the general public, emergency services and other specialised users for effective, reliable flood warning services.

## OUTPUT

Publications, reports and data sets on Australia's surface water resources and their utilisation and on the links between weather, climate and surface water; along with a comprehensive national flood warning service for coastal and inland rivers provided, according to local arrangements, in collaboration with relevant state and local government agencies; and advice to public and private sector organisations on the use of hydrometeorological information in design, construction and other applications.

## OUTCOME

Enhanced community safety and well-being through the effective use of hydrological and related services by the general public and other major social and economic sectors.

Hydrological Services include water resources assessment, the provision of flood forecasting and warning services and hydrological and hydrometeorological advice for design. These services depend heavily on the information collected through the Bureau's basic national meteorological observation networks. The Flood Warning Service also operates a special purpose network of rainfall and river level stations in cooperation with state and local government agencies.

Hydrology Sections, incorporating Flood Warning Centres, exist in all Regional Offices of the Bureau. Overall coordination is provided by the Head Office Hydrology Unit which also provides some services. Regional service delivery depends on close cooperation with State and Territory water and emergency service authorities and local government agencies.

## Highlights

Major achievements in 2001-02 included:

- improvements to the Bureau's flood forecasting system in support of a more timely and accurate flood warning service to the community, through an enhanced flood modelling system and development of catchment models for several river basins;
- implementation of an automated data quality monitoring system;
- an increase in the range of products generated, particularly web-based products; and
- completion of the Generalised Tropical Storm Method Revision project.

Table 12. Hydrological Services expenses and revenue (\$'000) and staff level for 2001-02 compared with the actuals for 2000-01 and the 2001-02 Budget and Budget plus Additional Estimates appropriations.

	ACTUAL	BUDGET	BUDGET &	ACTUAL
	2000-01	2001-02	BUDGET &	2001-02
	(\$'000)	(\$'000)	ADD. EST.	(\$'000)
			2001-02	
			(\$'000)	
<i>FINANCIAL</i>				
<b>EXPENSES</b>				
Employee Expenses (Appropriation)	3,812	3,727	3,727	3,803
Employee Expenses (Section 31)	193	150	150	211
Supply of Goods and Services (Appropriation)	1,246	973	973	1,085
Supply of Goods and Services (Section 31)	187	143	143	183
Operating Lease Rentals	517	597	597	497
Depreciation	369	371	371	357
Other Goods and Services Expenses (WMO Contribution)	0	0	0	0
<b>TOTAL EXPENSE*</b>	<b>6,324</b>	<b>5,961</b>	<b>5,961</b>	<b>6,136</b>
<b>REVENUE</b>				
Appropriations	5,521	5,591	5,589	5,554
Sale of Goods and Services	171	325	640	640
Miscellaneous - other	2	0	0	2
<b>TOTAL REVENUE*</b>	<b>5,694</b>	<b>5,916</b>	<b>6,229</b>	<b>6,196</b>
<i>STAFFING</i>				
Staff Years (actual)				
- Funded from Employee Expenses (Appropriation)	52.7	55.1	55.1	48.8
- Funded from Supplier Expenses (Appropriation)	0.5	0.2	0.2	1.6
- Funded from Section 31 Receipts	3.8	3.9	3.9	3.0
- Funded from Capitalised Salaries (Asset Replacement)	6.2	6.0	6.0	6.6
<b>TOTAL</b>	<b>63.2</b>	<b>65.2</b>	<b>65.2</b>	<b>60.0</b>

\*The operating result (Total Revenue less Total Expense) provides funds required to pay the Capital Use Charge as a dividend from Equity on the Balance Sheet. The Bureau's dividend is some \$20m per annum.

## Resource Use

The resources committed to Hydrological Services in 2001-02 are summarised in Table 3 (pg 37) and are given in more detail in Table 12.

## Performance

Performance during 2001-02 was assessed at two levels in terms of the:

- quality, quantity and price of the outputs directed to the achievement of the planned outcome relative to agreed target levels; and the
- contribution to the achievement of the planned outcome.

The measures used as a basis for performance assessment were as published in the Portfolio Budget Statements 2001-02 for the Environment and Heritage Portfolio (Budget Related Paper No. 1.7). The performance for 2001-02 against each of the performance measures and targets for quality, quantity and price of outputs is summarised in Appendix 11.

The contribution to achievement of the planned outcome during 2001-02, assessed in terms of the indicators listed in Appendix 12, is reviewed below for each of the individual outputs (Water Resources Assessment, Flood Warning Service and Hydrometeorological Advice), drawing on the performance information summarised in Appendix 11.

## Water Resources Assessment

Water Resources Assessment coordinates the Bureau's input on various issues and projects related to the assessment and management of Australia's water resources.

Relevant activities include the assessment, design and development of data collection networks, development of information systems, development of water management decision support tools and monitoring climate variability and trends that may impact on future water resource availability. Water Resources Assessment also acts as a focus for Australian input to, and dissemination of information from, the international hydrology and water resources programs of the World Meteorological Organization and UNESCO.

During 2001-02, considerable effort was directed to the development of a national data bank of stochastic climate and streamflow models, as part of a project being undertaken within the Cooperative Research Centre for Catchment Hydrology (CRC-CH) Climate Variability program. Following the completion of literature reviews and a workshop last year, significant progress was made on the assessment and further development of existing models. The assessment of daily rainfall generation models using data from 21 sites across Australia was completed. Several CRCCH reports were published to present the details of this work, which demonstrated the relative performance of the various models for different applications.

Users were given the opportunity to make improved water management decisions by evaluating the impacts of climate variability and El Niño Southern Oscillation influences, as a result of a tool developed as part of the RAINMAN Streamflow-Runoff Project. This collaborative project was funded by Land and Water Australia and completed in collaboration with the Queensland Department of Primary Industries, the University of Melbourne and the Queensland Department of Natural Resources.

Information about Australia's environmental monitoring networks was made more accessible to the community through a web-based searchable database called 'Rain Gauge Information, Australia'. The

on-line database contains rainfall stations operated by the Bureau and State and Territory water agencies, and complements Stream Gauging Information, Australia, which was released last year. The coverage of 'Stream Gauging Information, Australia' was improved in 2001-02 with the inclusion of information about stations operated by Sydney Water and Brisbane City Council. Both catalogues will be improved, as updated or new station information is made available by the urban and rural water agencies.

The Bureau highlighted its concern with water issues through its major sponsorship of the 27<sup>th</sup> Hydrology and Water Resources Symposium, held in Melbourne in 2001-02. The Symposium was organised by the Institution of Engineers, Australia and had as its theme 'The Water Challenge – Balancing the Risks'.

Activities undertaken to fulfil the national and international components of Water Resources Assessment during the year included coordination of Bureau input to participation in the ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand) and subsequently the NRMCC (Natural Resource Management Ministerial Council) structure, national representation on the WMO Commission for Hydrology and the UNESCO International Hydrological Programme.

National activities aimed at ensuring that the needs of the Australian water industry were met, through the projects undertaken and priorities identified, included:

- membership of the Australian National Commission for UNESCO Science Network and of various ARMCANZ and subsequently NRMCC Committees and Working Groups; and
- input to documents, such as the *National Water Quality Management Strategy* and the *High Level Steering Group on Water*, emphasising the importance of climate

influences on water resource issues and national water resources assessment issues.

Input was provided by the Bureau to international projects, and dissemination of information from Australia was promoted at an international level, through a range of activities including:

- Australian representation at the meeting of the UNESCO International Hydrological Programme Regional Steering Committee for South-East Asia and the Pacific, in Vietnam;
- participation in the 15th session of the UNESCO Intergovernmental Council for the International Hydrological Programme in France;
- fulfilment of obligations under the UNESCO-sponsored Asian Pacific FRIEND (Flow Regimes from International, Experimental and Network Data) Project and its associated scientific program;
- management of the WMO Hydrological Operational Multipurpose System National Reference Centre for Australia;
- membership of the WMO Commission for Hydrology Advisory Working Group;
- Australian representation at the WMO Region V Working Group on Hydrology meeting in New Zealand;
- participation in the sixth Assembly of the International Association of Hydrological Sciences in the Netherlands; and
- participation in a workshop on the Analysis and Use of Looped Rating Curves, held in Hanoi, Vietnam. As part of its contribution to the workshop, the Bureau also funded the purchase of computing equipment to improve the resources available in the Hydrometeorological Service of Vietnam for the processing, analysis and archival of hydrometeorological data.



*Participants in the workshop on Analysis and Use of Looped Rating Curves held in Hanoi, Vietnam in May.*

## Flood Warning Service

The Bureau of Meteorology Flood Warning Service contributes to enhanced community safety and well-being through the provision of effective and efficient flood warning services, in close cooperation with state, territory and local government agencies.

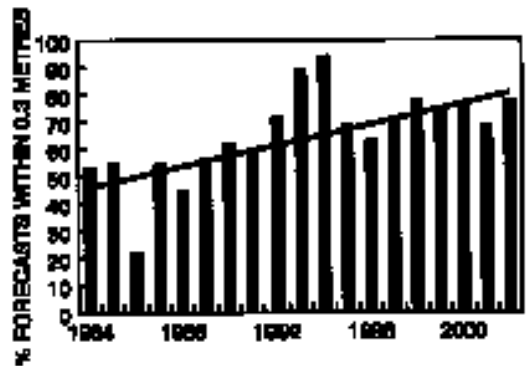
Users of flood warning services include emergency management agencies and members of the public, particularly those in flood prone areas. The Bureau disseminates flood warnings and information to the public (via the media, Internet and fax) as well as direct to flood response agencies for more detailed interpretation and dissemination. The Bureau is one part of what is referred to as the Total Flood Warning Service. User satisfaction with the functioning of the Flood Warning Service was gauged through the following activities:

- *Debriefings* - feedback from flood-affected communities during formal debriefings with other agencies involved in the Total Flood Warning Service;
- *Flood Warning Consultative Committees* - feedback from agencies involved in the Total Flood Warning Service through the Flood Warning Consultative Committee (FWCC) in each

State/Territory. The FWCC sets the priorities for development of the Flood Warning Service;

- *Reports* - formal assessments of service performance following specific major flood events where problems were experienced. The reports usually investigate and make recommendations for the Total Flood Warning Service, and their preparation often includes surveys of users;
- *Formal Reviews* - feedback provided through formal reviews of components of the Bureau's Hydrological Services;
- *Conferences, workshops and meetings* - ongoing feedback from users at conferences, workshops and meetings; and
- *Systematic user surveys* - questions pertinent to flood warning services are included in the routine user surveys undertaken for public weather services.

Feedback on the Bureau's flood warning services gathered through the above activities revealed a high level of satisfaction with services in general during 2001-02. The relatively low level of flooding through the year meant there were no major special purpose reviews undertaken, with feedback mainly coming from FWCC processes and debriefings. Flood warning accuracy is an important indicator of the Bureau's performance in the Total Flood Warning Service and the trend in this indicator continued to improve during the year (Figure 49).



*Figure 49. Trend in flood warning accuracy in New South Wales.*

A chronological description of the flooding that occurred through the year is given in Appendix 7. However, two of the more significant and extended flood related weather events, which occurred in February, were associated with:

- a monsoonal low that originated over the Northern Territory and moved across to the Kimberley and East Pilbara in Western Australia. This weather system caused widespread heavy rain and flooding and the Fitzroy River recorded some of the highest flood levels in history. Many towns including Kununurra were isolated by floodwaters and several Aboriginal communities required evacuation. Significant stock losses were reported; and
- an active monsoon trough with a deep slow-moving low over the 'Top End', which lasted almost two weeks. The resulting heavy rainfall produced floods in the Katherine-Daly, Waterhouse-Roper and Victoria River systems. The Stuart, Victoria, Roper and Arnhem Highways were all cut for various periods. Major flooding in the Wickham River tributary of the Victoria River produced the highest ever recorded flood level. The rest of the catchment reported moderate flooding, with the Victoria Highway to Western Australia closed to traffic for a week. The Waterhouse River reported major flooding, with some 300 people moved to higher ground when the community was flooded for the fourth time in the last five years. Further downstream, approximately 200 people were evacuated after the Roper River broke its banks.

The Flood Warning Service covered communities in all States and the Northern Territory and included flooding in streams as well as in the longer slow flowing inland river systems. The warning products included early alerts to the possibility of flooding, site-specific forecasts of river

height and the expected impact in terms of minor, moderate or major flooding in specific river basins and more generalised products issued on a regional basis.

April 2002 marked the 40<sup>th</sup> anniversary of the first quantitative flood warning that was issued by the Bureau in Australia. The warnings were issued for the Macleay River in the mid-north coast of New South Wales (NSW). To highlight this landmark, a paper on the history of flood warning services in NSW was presented to the annual NSW Floodplain Management Conference held in May.

During 2001-02, 1 039 flood warning messages were issued and, of these, about 20 per cent were initial advices or preliminary warnings of developing flood situations well ahead of the actual event. Tasmania was the only state to experience frequent flooding, contributing more than a third of flood warnings issued for the year.

The number of flood warning messages for 2001-02 was well below the long-term average. To enable the provision of a more responsive and timely flood warning service to the community, the Bureau took advantage of the relative lull in flooding to upgrade and expand the flood warning network in several states. This work, which was done in collaboration with local government agencies, included:

- upgrade of the radio telemetry data collection systems on the Burdekin and Houghton rivers in Queensland;
- implementation of new radio telemetry systems on the Tully and Murray rivers and the Logan and Albert Rivers (Queensland);
- ALERT radio telemetry upgrades for the Johnstone Shire, Noosa Shire, Maroochy Shire and Gold Coast;
- network upgrades in the Wallis Lake and Scone catchments and along the Macintyre, Bell and Shoalhaven rivers of New South Wales;
- equipment upgrades and additional sites in the South Esk catchment of

Tasmania;

- establishment of a flash flood warning system, using radio telemetry data collection, in Glenorchy, Tasmania;
- development of the Hobart Rivulet radio telemetry system;
- establishment of a radio telemetry system in the Busselton area of Western Australia; and
- the establishment of two repeaters that will provide coverage for radio telemetry field stations for the 'Top End' of the Northern Territory.

The flood warning observation network was enhanced through the inclusion of data monitoring networks of other agencies. A data transfer process to accept data from external agencies was implemented in the New South Wales Regional Office. In addition, the Bureau completed the extensive testing of a data collection software system (ENVIROMON) and the trial of commercial software to manage the polled telephone telemetry component of the data collection network.

Involvement in the research activities of the Cooperative Research Centre for Catchment Hydrology continued this year, with a particular focus on rainfall modelling and radar rainfall estimation and forecasting. A project was also undertaken to assist Melbourne Water to evaluate the design of its sewerage network. Work on quantitative radar rainfall measurement continued this year through joint projects with the University of New South Wales and the Technical University of Catalonia, Spain.

During 2001-02, Bureau staff worked towards maintaining and enhancing real time data access (from external organisations) for flood warning, through participation in ongoing reviews of the hydrological gauging station networks carried out by agencies in each State. However, continuing changes to water agencies, as a result of the water reform process, have created some uncertainty about the future

of gauging stations required for flood warning purposes.

The Bureau continued to contribute to the development of regional flood policies. The State Government of South Australia initiated the development of a state-wide flood policy framework and the Bureau contributed substantially to the process. The Bureau continued to work towards the resolution of issues related to the provision of flood warning services in Western Australia and the Northern Territory, where the State water agencies have direct responsibility for the flood prediction component of the flood forecasting and warning systems. In the Northern Territory, an experimental implementation of a joint operational flood warning centre staffed by the Bureau and Northern Territory Government flood forecasters was trialled during the past wet season. In Western Australia, initial guidelines for the possible establishment of a joint warning centre were drafted.

The Bureau continued to promote hydrological services and strengthen user liaison. Bureau staff gave several presentations to State Emergency personnel, were involved in public meetings dealing with flood related problems and participated regularly in workshops held on flood management issues. Staff from the New South Wales Regional Office participated in 'Flood Awareness' weeks at Lismore and Grafton. These were useful opportunities to share expertise, and Bureau presentations were generally well received by the community.

The number of flood related information products available to users increased in 2001-02, with the introduction in more States of automatically generated rain and river height data. These products (Figure 50), accessible through the Bureau's website, are updated on an hourly basis and made available through a user-friendly map interface.

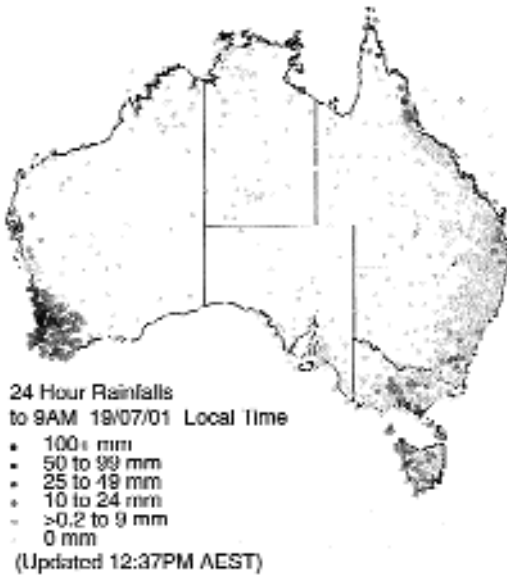


Figure 50. Example of a map display of rainfall information provided through the Bureau's web-site.

## Hydrometeorological Advice

The Hydrometeorological Advisory Service contributes to enhanced community safety and well-being through the provision of specialised hydrometeorological advice and products to the scientific and engineering communities for the safe design of a wide range of hydrological and other civil infrastructure. In particular, government and community planning for a secure water supply, and the safety of the infrastructure that supplies it, relies on credible advice about the long-term variability of rainfall. The development of robust techniques for the analysis of this element and the provision of pertinent hydrometeorological advice to planners was a major component of the Bureau's hydrometeorological services again this year. Ongoing liaison and collaboration with State water agencies ensured the relevance of the developments

and increased the likelihood that optimum use was made of the advice provided.

Hydrometeorological advice and products include estimates of Probable Maximum Precipitation (PMP) and design Intensity-Frequency-Duration (IFD) rainfall information, and a range of other statistical rainfall analyses, provided on an incremental cost recovery basis.

During 2001-02, information was provided to water resource managers in support of dam capacity assessment and related activities. PMP estimates were provided for the Moondarra Reservoir catchment in the Latrobe Valley and for the Crusoe and Spring Gully catchments near Bendigo in Victoria. A PMP was also provided for the Kenyir Dam on the Terengganu River (Malaysia) and several Bureau staff received specialised training in techniques for PMP estimation in areas outside Australia.

The main source of design rainfall information for hydrological studies in Australia continues to be the Bureau's rainfall IFD data as published in the 1987 edition of *Australian Rainfall and Runoff* (ARR). There was also demand for more specialised rainfall intensity information and analyses, for use as input to a wide range of design flood model and environmental studies including:

- the design and risk assessment of dams, bridges and drainage systems;
- the design of buildings;
- soil conservation studies; and
- the design of, and formulation of operational procedures for, satellite telecommunications links and mobile-phone networks.

Demand for IFD studies remained high during 2001-02, with some 100 Computerised Design IFD Rainfall System (CDIRS) products requested and provided.

IFD rainfall information was made more accessible through the development of a web interface and the provision of a relevant database to external organisations. The provision of IFD information through

the Bureau's internal website enabled staff in the Bureau's Regional Offices to undertake rainfall intensity analyses remotely. The New South Wales component of the CDIRS database was leased to the New South Wales Road Traffic Authority for the generation of state-wide rainfall intensity information.

The Generalised Tropical Storm Method Revision (GTSM-R) project, a major component of the Hydrometeorological Advisory Service activities, was completed in 2001-02. It was a collaborative effort between the Bureau and the major water authorities in

Western Australia, New South Wales and Queensland, from which it received significant financial sponsorship. A database of approximately 120 of the largest tropical storms in the rainfall record was analysed, and standardised depth-duration-area data extracted. The method makes allowance for the decay of the tropical storm mechanism as it propagates inland and away from tropical latitudes. The Bureau commenced preparation of an instructional manual to enable civil engineers and hydrologists to use the technique directly.