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Seasonal Streamflow Forecasts: Assisting decision-making in water resource management

Perkins J, Jayasuriya D, Peatey T, Plummer N, Robertson D, Schepen A, Shin D, Wang QJ, Zhou S, Hawksworth C

19 October 2011

APEC Climate Symposium 2011, Honolulu



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Presentation Outline

- Potential applications
- The current operational service
- User engagement and how it influenced our service
- Research and development
- Next steps and future developments



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Potential applications

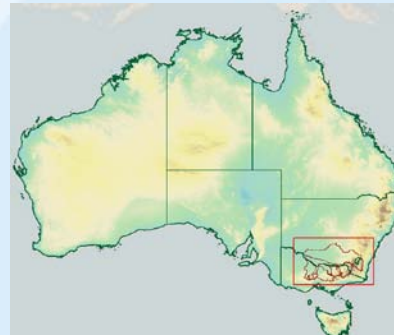
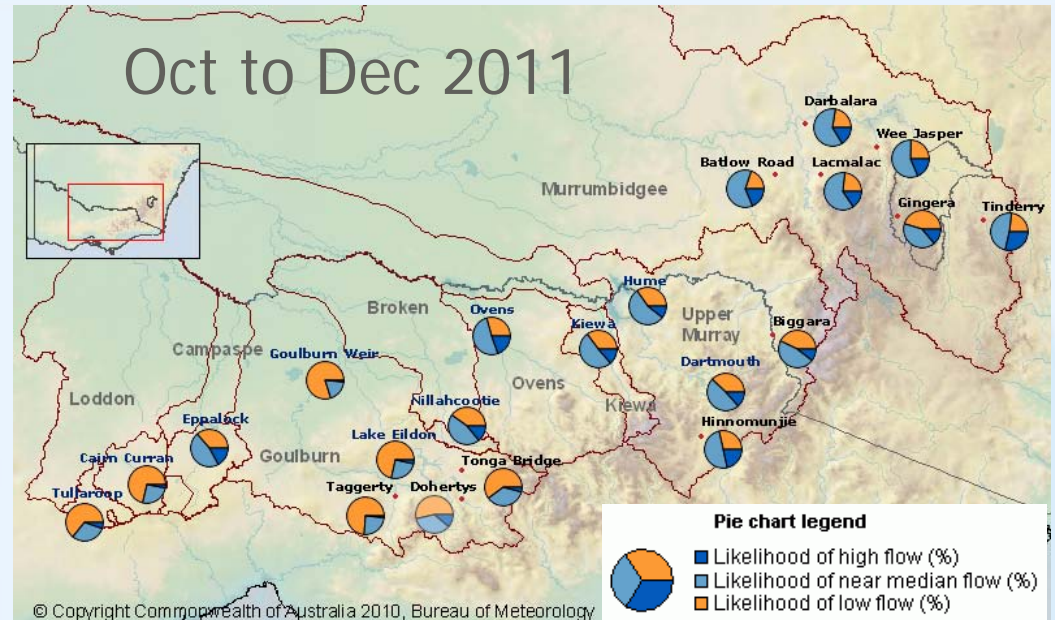
- Integrating seasonal forecasts with River Operator and River Manager modelling suite
- Improving water allocation announcements in key irrigation basins
- Enhancing the decision making process for announcing and lifting urban water restrictions
- Optimising water trading between agencies (rural and urban) and moving water around the Victorian (in south-east Australia) Water Grid
- Improving management of environmental flows
- ... Need to understand how users make decisions and influence changes in decisions





Operational Seasonal Streamflow Forecasts

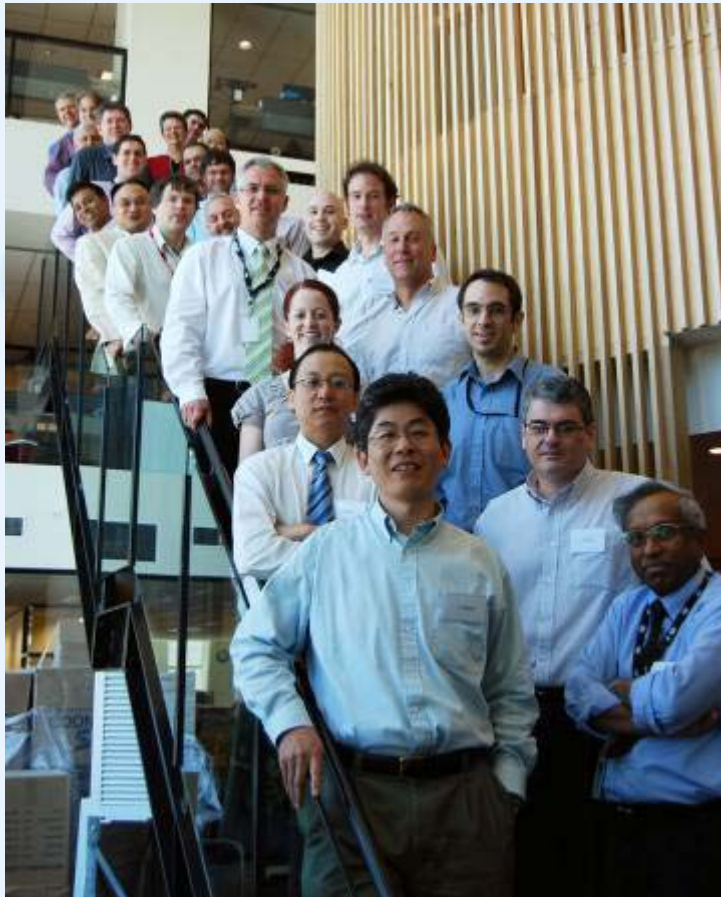
- Started December 2010
- Initial target catchments in south east Murray-Darling Basin
 - 21 locations (8 storages)
- Public release via Bureau website
- Using CSIRO Bayesian Joint Probability Model
- Zero lead time 3 month forecasts
- Use statistical/dynamic modelling to extend nationally





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It started with stakeholder engagement



- Planning started in January 2009
 - Users, researchers, service providers
- Three workshops
 - Planning and requirements
 - Experimental products
 - Final product design
- Stakeholder meetings with over 20 agencies across Australia
- Experimental website starting December 2009



Stakeholder influence

- two stage release of new sites and models

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Seasonal Streamflow Forecasts

Date: July to September 2011

Near median flows most likely for July to September period

Conditions in the tropical Pacific Ocean are neutral and below average rainfall occurred in June over much of inland New South Wales and Victoria. Although the majority of forecast locations reported streamflows that were above median for June, they were closer to median than during May. For the July to September period, near median to low flows are the most likely outcome for the Loddon and Campaspe basins, near median flows are most likely for the Murrumbidgee, Broken and Kiewa basins and near median to high flows are most likely for the Ovens, Goulburn and Upper Murray basins.

Click on the pie charts to go directly to the latest forecast.

South-east Murray-Darling Seasonal Streamflow Forecasts for July to September 2011

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Note: The locations on the map are either [site-based forecasts](#) or [total catchment inflow forecasts](#). [Forecast site information](#) provides details on which locations are site-based or total inflow forecasts. For more details about how the pie chart forecasts are displayed go to the [Frequently Asked Questions](#).

Seasonal forecasts

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- Hits and misses summary
- FAQs
- Glossary

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- Update history
- Streamflow forecasting
- Climate information
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Experimental Seasonal Streamflow Forecasts

Date: July to September 2011

The **experimental** Seasonal Streamflow Forecasting service began in December 2009. Twenty-one of the **experimental** forecast sites have now transitioned to the operational service launched on Tuesday 14th December 2010. These forecasts are available at www.bom.gov.au/water/sf. This experimental service provides stakeholders with experimental forecasts for new locations. These experimental forecasts are used for testing new forecast locations and allows stakeholders the opportunity to provide feedback. For further background information go to [About Seasonal Streamflow Forecasts](#).

Experimental forecasts are now provided for ten new locations: [Richmond River at Wangarée](#), [Coxs River at Island Hill](#), [Shoalhaven River at Warr](#), [Maragle Creek at Maragle](#), [Jinolic Creek at Jinolic](#), [Muttama Creek at Coolac](#), [Tarcutta Creek at Old Barambula](#), [Abercrombie River at Hadley No.2](#), [Halls Creek at Binqara](#) and [Turon River at Sofala](#).

Select Map: [Southern](#) [Central](#) [Northern](#) [Barren](#) [Burdakin](#)

Click on the pie charts to go directly to the latest forecast.

Southern Seasonal Streamflow Forecasts for July to September 2011

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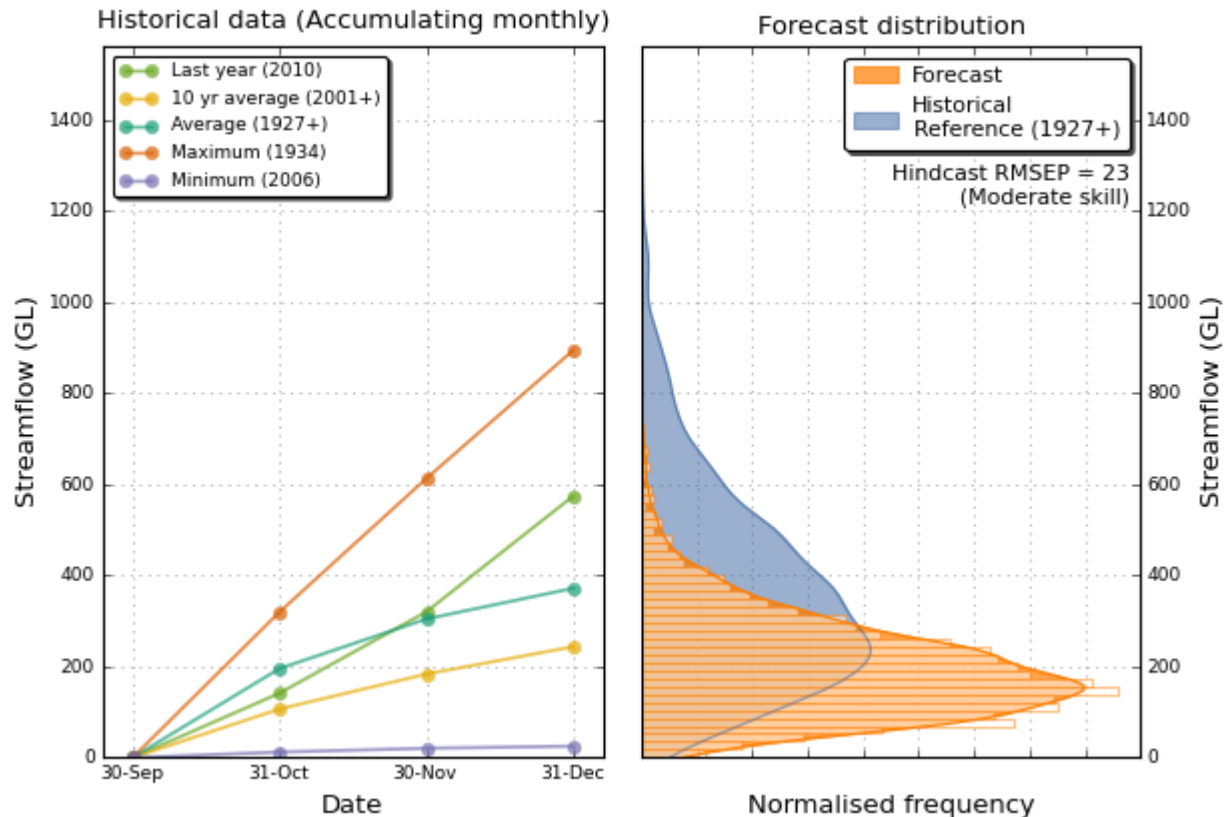
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Stakeholder influence - product design

Total inflow to Lake Eildon Forecast period: Oct 2011 - Dec 2011





Stakeholder influence – product design

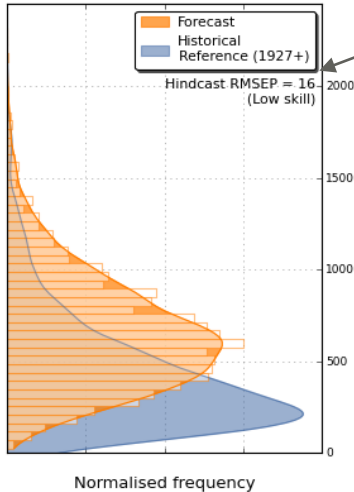
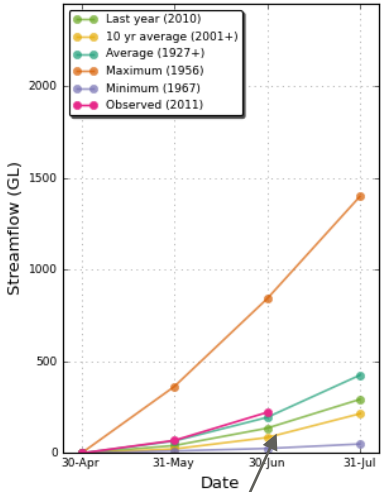
**Total inflow to Lake Eildon
Forecast period: May 2011 - Jul 2011**

Historical data (Accumulating monthly)

Forecast distribution

Include skill score

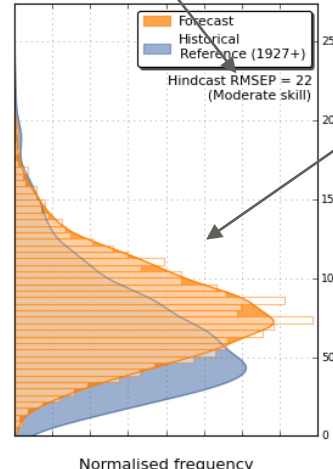
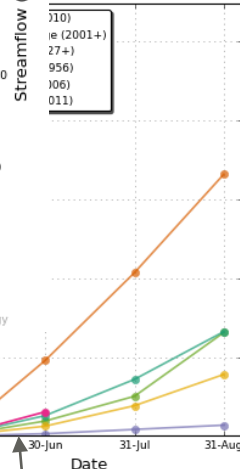
Visually compare forecast and historical probability distributions and exceedance probability curves



**Total inflow to Lake Eildon
Forecast period: Jun 2011 - Aug 2011**

(Accumulating monthly)

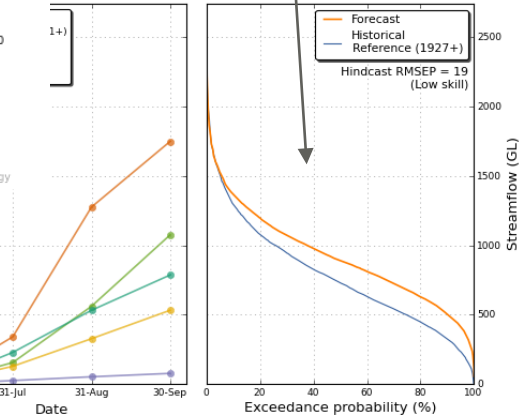
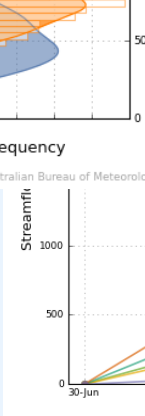
Forecast distribution



**Total inflow to Lake Eildon
Forecast period: Jul 2011 - Sep 2011**

(Accumulating monthly)

Forecast exceedance probability



Historical analogues give context

Plot latest streamflow for verification



Stakeholder influence - present and explain skill



Moderate to high skill



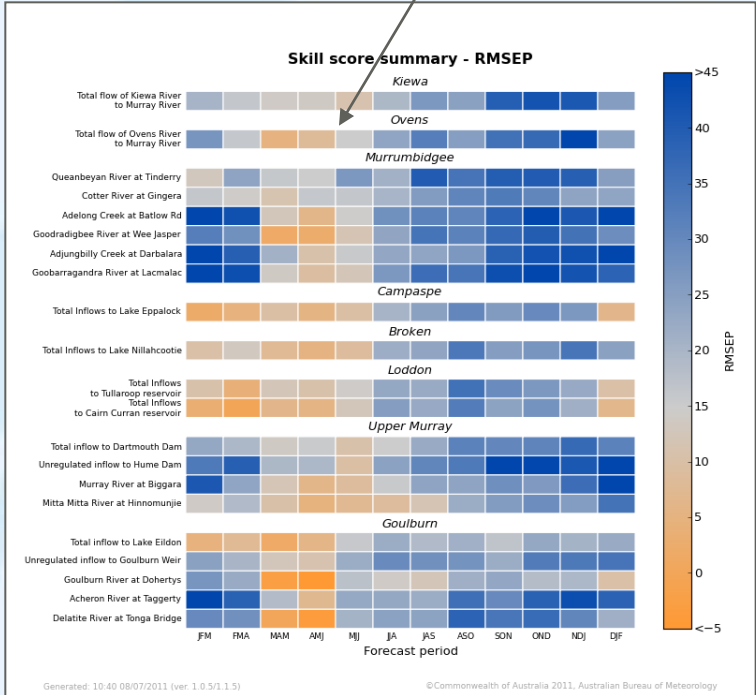
Low skill



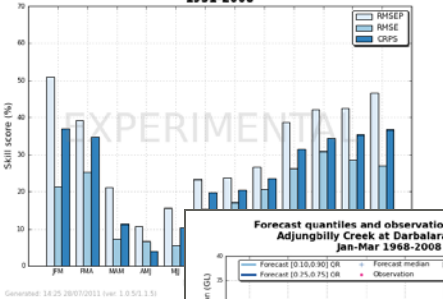
Very low skill
(using historical probabilities)

Skill varies between months and sites

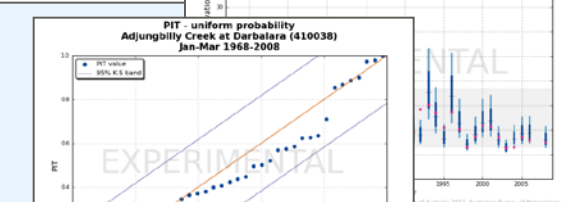
Use historical probabilities for very low skill



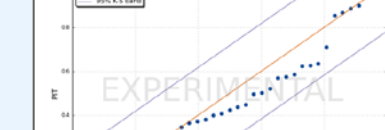
Skill scores
Adjungbilly Creek at Darbalara (410038)
1951-2008



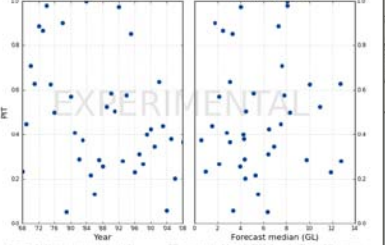
Forecast quantiles and observations versus year
Adjungbilly Creek at Darbalara (410038)
Jan-Mar 1968-2008



PIT - uniform probability
Adjungbilly Creek at Darbalara (410038)
Jan-Mar 1968-2008



PIT - time and forecast median
Adjungbilly Creek at Darbalara (410038)
Jan-Mar 1968-2008



Skill and reliability are important



Stakeholder influence

- data behind the products

Historical Observations					
	Average (1967+) (GL)	Last year (2010) (GL)	Minimum (2006) (GL)	10 yr average (2001+) (GL)	Maximum (1974) (GL)
Jul	11.8	9.4	1.7	4.9	28.4
Jul-Aug	25.9	25.9	3.1	11.9	60.1
Jul-Sep	38.9	44.5	4.1	19.7	91.9

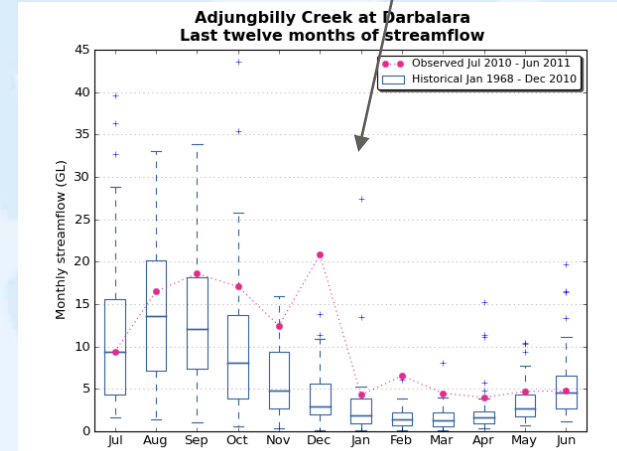
A	B	C	D
No.	Streamflow Forecast	Historical Reference (GL)	
1	0.7	0	
2	2.4	0	
3	2.6	0	
4	2.7	0	
5	2.8	0	
6	2.9	0	
7	2.9	0	
8	3.1	0	
9	3.2	0	
10	3.4	0	
11	3.7	0	
12	3.8	0	
13	4	0	
14	4.1	0	
15	4.3	0	
16	4.3	0	
17	4.3	0	
18	4.4	0	
19	4.4	0	
20	4.6	0	
21	4.7	0	
22	4.7	0	
23	4.8	0	

All ensemble members for input to other models

Trends in streamflow

Basic statistics

Basic Statistics		
	Streamflow Forecast (3 month total flow in GL)	Historical Reference (3 month total flow in GL)
25% Quartile	21.3	20.9
Median	30.8	35.0
Mean	34.9	38.8
75% Quartile	44.4	52.4
Interquartile Range	23.2	31.4





Stakeholder influence

- increase understanding with support information

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Frequently Asked Questions

Before you spend time writing us an email, you might find your question has already been answered. Look at the list below to find out. If you still want more information, please use the [feedback link](#).

Expand all / Collapse all

- Who will use Seasonal Streamflow Forecasts?
- How do I interpret the tercile forecasts?
- What is the difference between a site-based forecast and a total catchment inflow forecast?
- Why are the pie chart forecasts on the tercile summary map faded or grey?

The pie charts are displayed differently to indicate the [skill scores](#) of the site forecasts for each season. Forecasts with moderate to high skill are represented by a coloured pie chart. The forecasts with low skill for a particular season are displayed as a faded or transparent pie chart on the tercile summary map. The forecast is still provided. Site forecasts with very low skill or skill the same as the historical reference forecasts are replaced with a grey scale pie split into equal thirds representing the historical reference. For these very low skilled site forecasts the historical reference forecasts are used and the BJP forecasts have been removed.

For example, in the tercile summary map below the site forecast for Darbalara is displayed as a coloured pie chart as it has moderate to high skill for that season. The forecast for the Kiewa catchment is displayed as a faded pie chart to represent that it has a low skill score. The very low skill forecast for Doherty's is shown as a grey pie chart.

Service backed by peer reviewed research

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Glossary

This glossary defines the key terms used on the seasonal streamflow forecasts site (listed in alphabetical order).

Expand all / Collapse all

- 25% quartile
- 75% quartile
- Bayesian Joint Probability (BJP)
- catchment
- Continuous Ranked Probability Score (CRPS)

The Continuous Ranked Probability Score (CRPS) is calculated in the original met and the observation is converted to a cumulative density functions. In the case function. The area between the two functions is the single CRPS value, which is

Break down the complexity

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Research papers

Please select from the following papers:

- [A Seasonal Water Availability Prediction Service: Opportunities and Challenges \(PDF\)](#) (Plummer, N., Tuteja, N., Wang, Q.J., Wang, E., Robertson, D., Zhou, S., Schepen, A., Alves, O., Timbal, B., and Puri, K. 2009)
- [Selecting predictors for seasonal streamflow predictions using a Bayesian joint probability \(BJP\) modelling approach \(PDF\)](#) (Robertson, D.E. and Q.J. Wang 2009)
- [An investigation into the selection of predictors and skill assessment using the Bayesian joint probability \(BJP\) modelling approach to seasonal forecasting of streamflows. \(PDF\)](#) (David E. Robertson and Q.J. Wang 2008)
- [A Bayesian joint probability modeling approach for seasonal forecasting of streamflows at multiple sites](#) (Q. J. Wang, D. E. Robertson, and F. H. S. Chiew 2009)
- [Multisite probabilistic forecasting of seasonal flows for streams with zero value occurrences](#) (Q. J. Wang and D. E. Robertson 2011)
- [Monthly versus daily water balance models in simulating monthly runoff](#) (Q. J. Wang et al. 2011)



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Built on quality research and science

- Through WIRADA (Water Information Research and Development Alliance, with CSIRO):
 - CSIRO's Statistical Bayesian Joint Probability (BJP) approach
 - Downscaling climate inputs from global climate model to hydrological model
 - Dynamic hydrological modelling approach
 - Statistical-dynamical approaches
 - Improved climate predictions from the POAMA (Predictive Ocean Atmosphere Model for Australia) seasonal climate forecasts
- BATEA Uncertainty analysis (with University of Newcastle)



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Next steps and future developments

- Service extension and development
 - Releasing 15 new sites on public website in November
 - Extend to more sites using hybrid dynamic/statistical in 2012
 - BJP/POAMA/WAPABA – monthly timestep water balance model
 - September 2012: Pilot monthly and 3-monthly forecasts from daily time step dynamic modelling
 - June 2013: Operational seasonal forecasts from blended statistical/dynamic
 - Aim to have seamless integration at user/products interface



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Thank you

Visit www.bom.gov.au/water/ssf

Neil Plummer

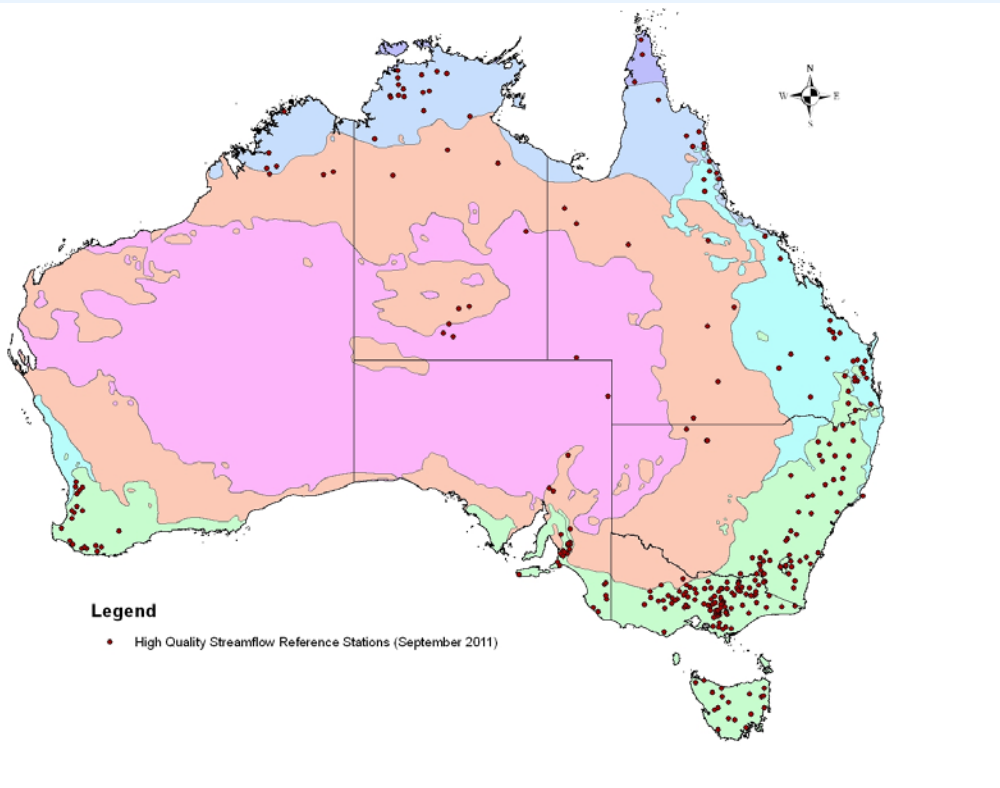
Assistant Director Climate Information Services

Bureau of Meteorology

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Stakeholder influence - site selection and extension



HQSRS Sites overlaid on climate zones

- Leveraging the stakeholder engagement for the High Quality Streamflow Reference Stations project
- Finding new test sites have less skill than existing operational sites
 - Less catchment memory
 - Need better forecast rainfall
- Targeting high quality sites upstream of storages
- Careful release based on skill and need

