

Advances in the development and application of forecasts in water sector



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Acknowledgement



Contents of this talk are based upon collaborative work and wide ranging consultations over more than a decade. In particular, colleagues from the following agencies are acknowledged:

- Bureau of Meteorology, Australia
- Australian research sector: CSIRO, University of Adelaide, University of Newcastle, University of Melbourne, UNSW
- Industry partners: WaterNSW, Murray-Darling Basin Authority, eWater, Goulburn-Murray Water and other regulatory and operational agencies in Australia
- International partners: WMO Secretariat and SMEs, CEH UK, ECMWF, NCAR USA, RIMES Thailand and Indian agencies – NCMRWF, IITM, IMD, NIH

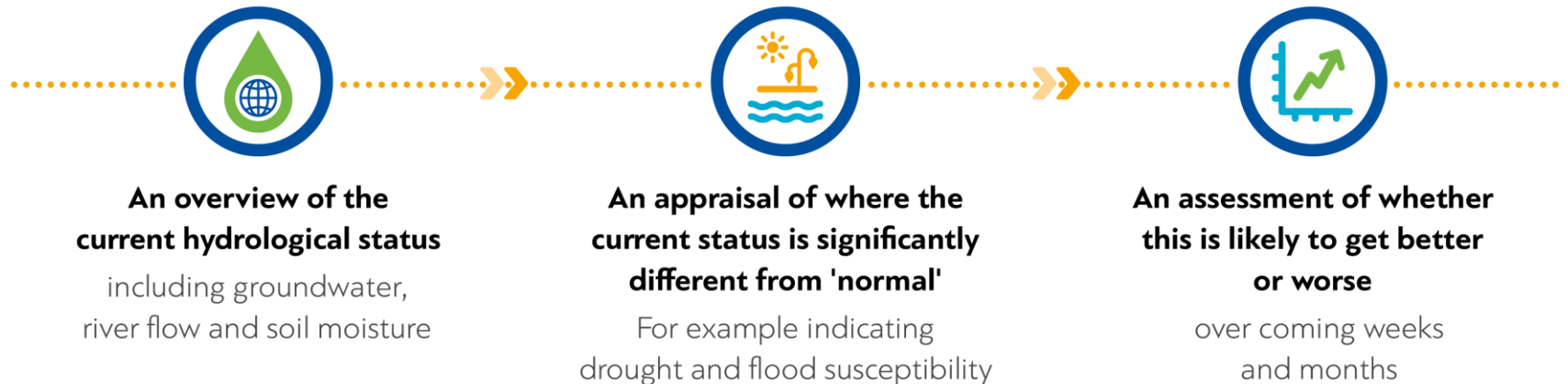
Outline



- Overview of the WMO HydroSOS initiative
- Global and local scale models – comparative assessments
- Water forecasting services development in Australia
 - reflections from the Australian experience over a decade
- Water sector needs, challenges and pain points
- Concluding remarks

HydroSOS – Global Hydrological Status and Outlook System

What will HydroSOS provide?



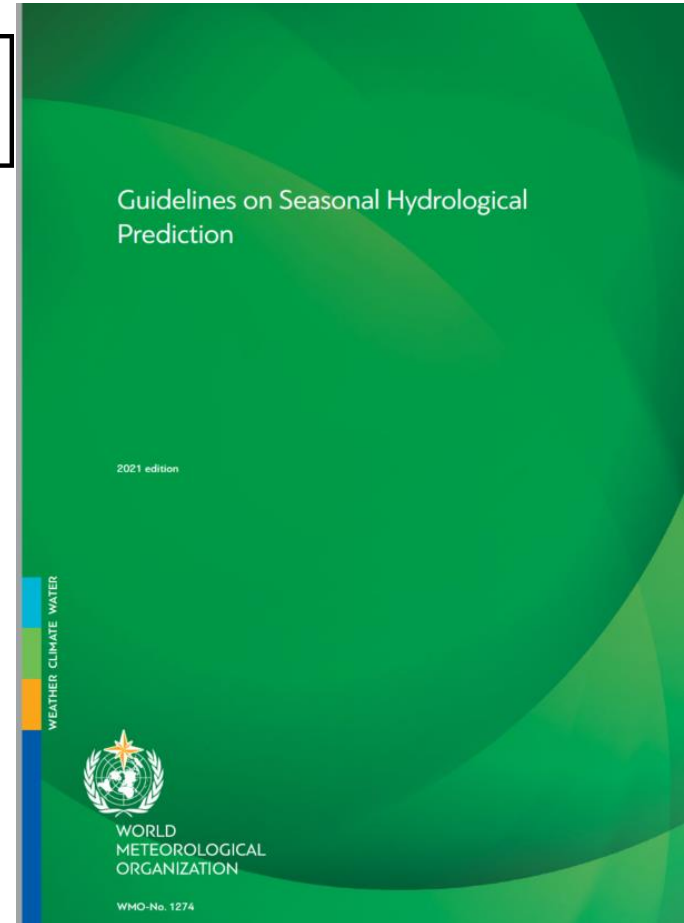
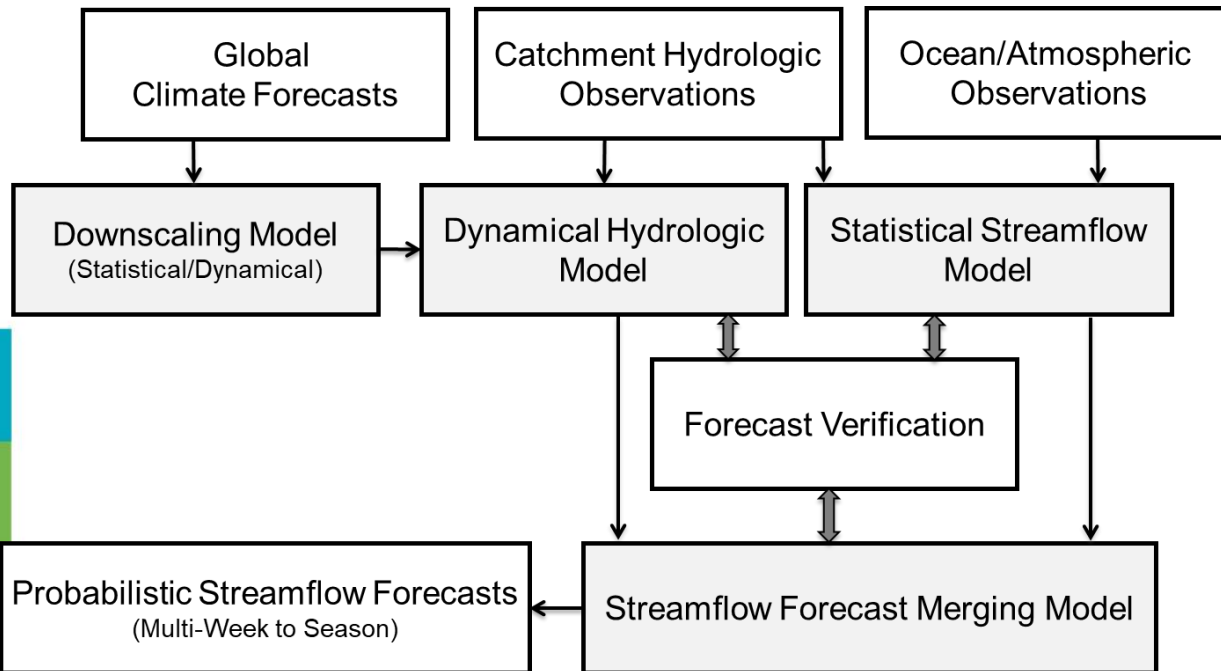
WMO OMM

HydroSOS is the link between monitoring and decision making



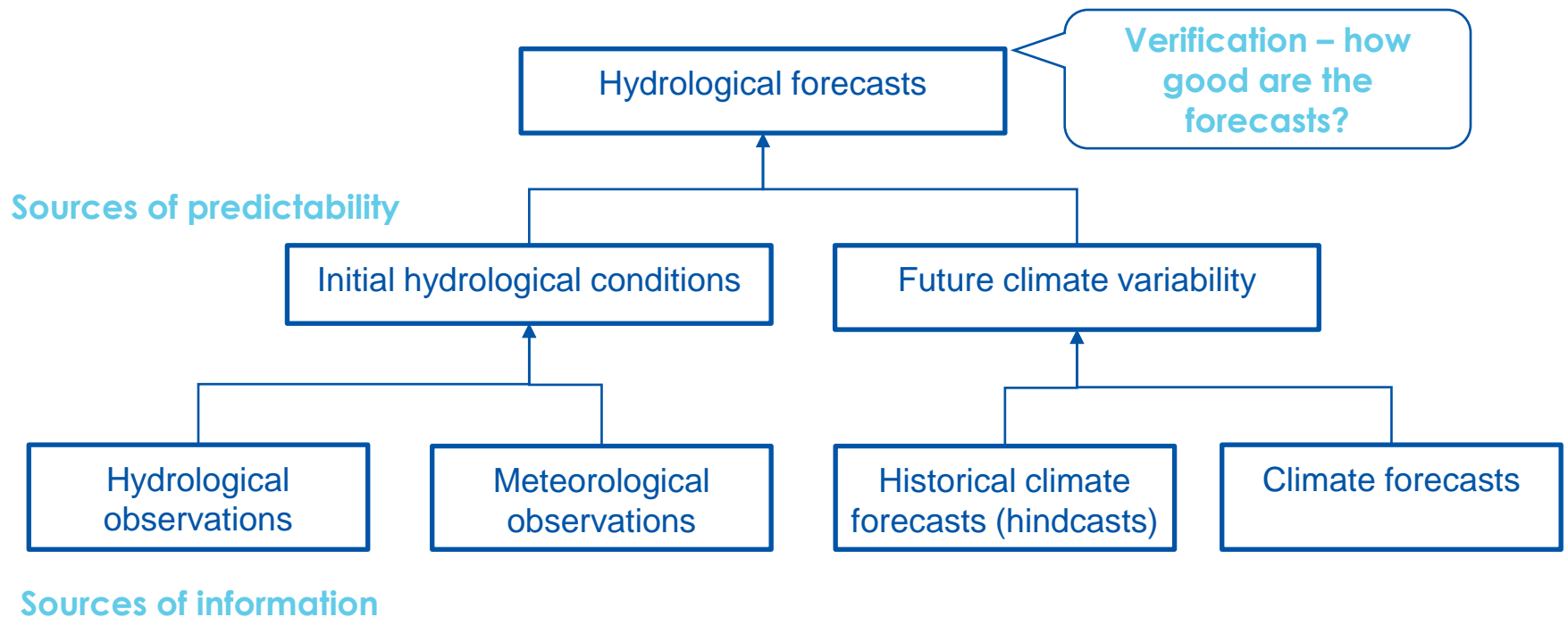
WMO OMM

WMO Seasonal Hydrological Prediction Guidelines

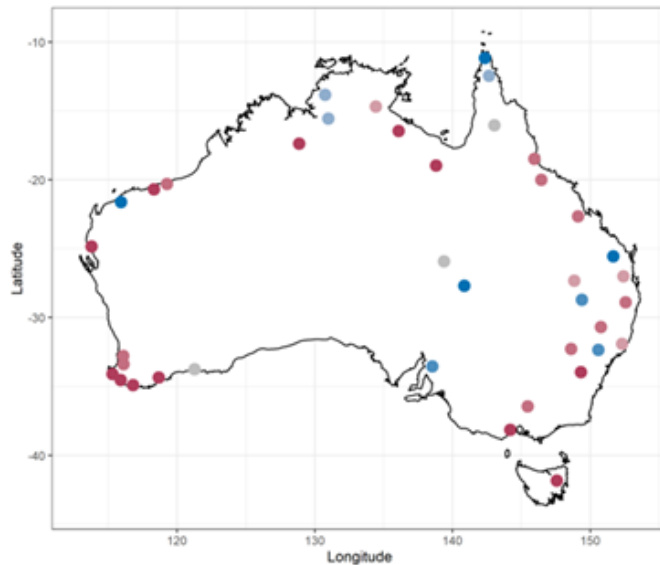


WMO OMM

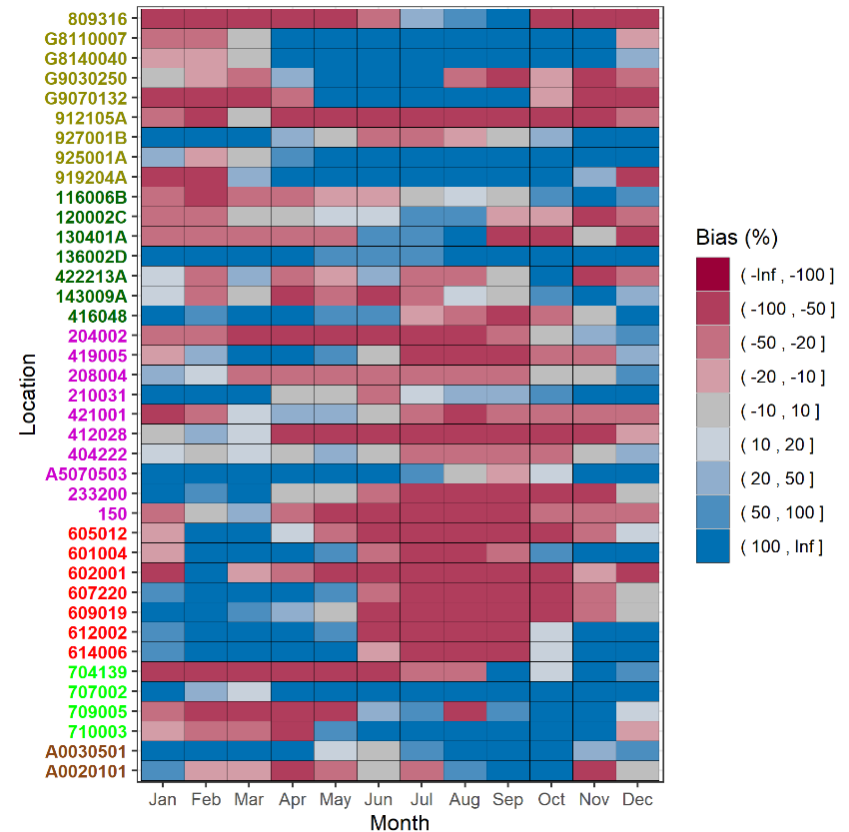
Sources of predictability



Reanalysis data at the catchment scale



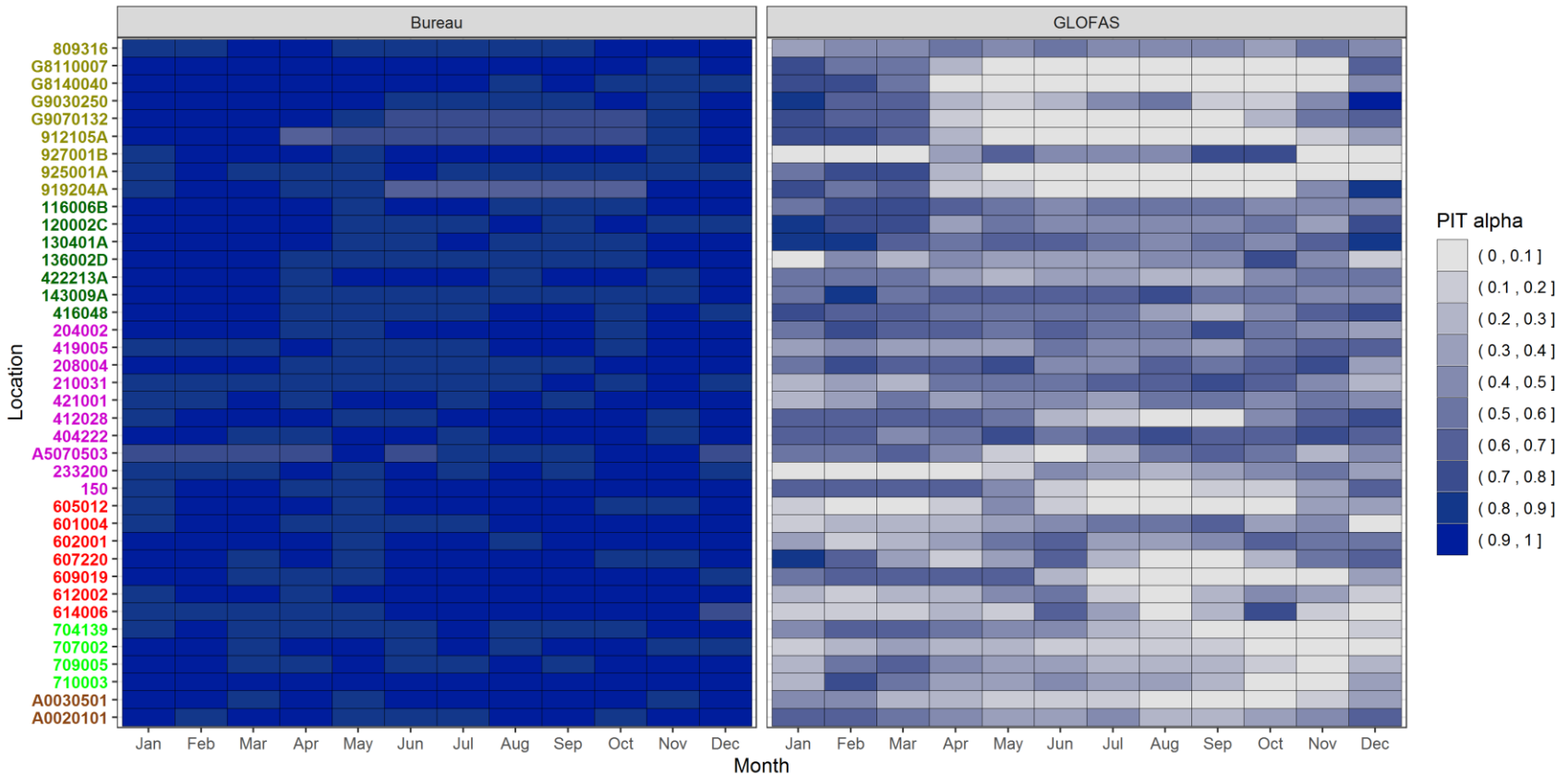
- Global models show large biases at catchment scale
- Too low in wet seasons and too high in dry seasons



WMO OMM

Benchmarking sub-seasonal streamflow forecasts from locally-calibrated and global hydrological models at the river basin scale

Reliability expressed as PIT-alpha index



WMO OMM

- Reliability: PIT-alpha index by forecast month and catchment for the local and global model
- Sharpness: Global model forecasts are sharper than those from local model (Inter Quartile Range, 5th and 95th percentile)
- Accuracy: Global model forecasts are less accurate than those from catchment models (CRPS skill score)

7-day flow forecasts

Australian Government Bureau of Meteorology

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7-day Ensemble Streamflow Forecasts

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Station selector

State: Victoria

Basin: Ovens

Station: Ovens River at Wangaratta (403242A)

Nearby stations:

- Ovens River at Peechelba East (403241)
- Hurdle Creek at Bobinawarrah (403224)
- Fifteen Mile Creek at Greta South (403213)

Ovens River at Wangaratta (403242A)

Quick facts

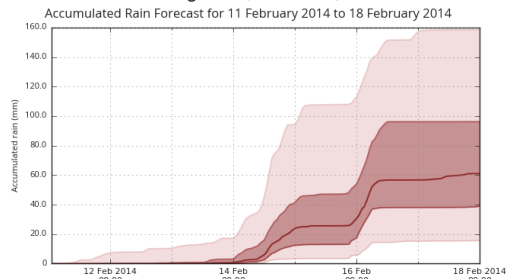
Upstream Catchment

- Area: 5138 km²
- Longest stream: 147 km
- Climate type: Temperate

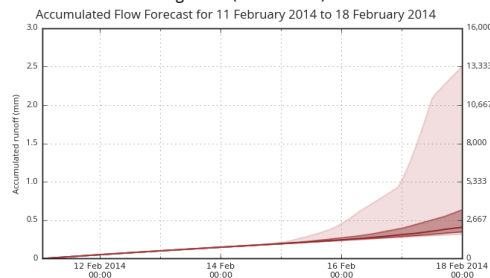
Streamflow Analysis

- Start date: 01-01-1995
- End date: 31-12-2017
- Daily max: 119 GL
- Daily average: 2788 ML

Ovens River at Wangaratta (ID: 403242A)

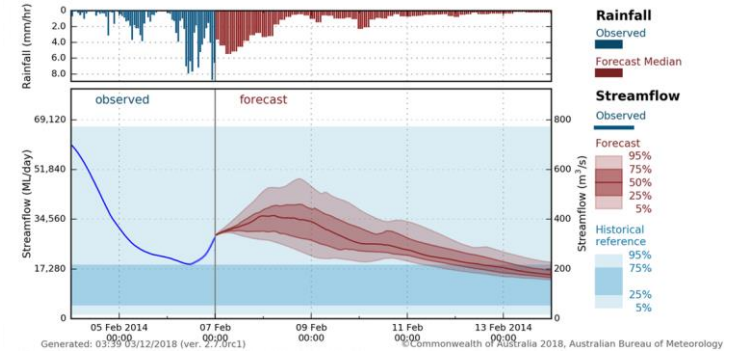


Ovens River at Wangaratta (ID: 403242A)



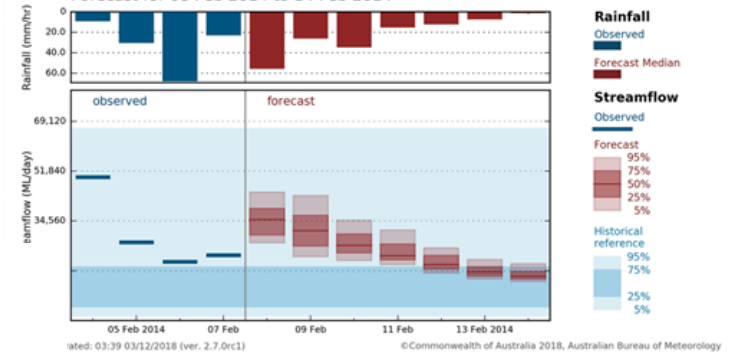
Tully

Forecast for 07 Feb 2014 to 14 Feb 2014



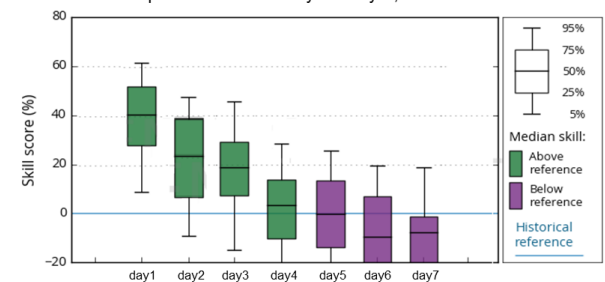
Tully River at Euramo (ID: 113006)

Forecast for 08 Feb 2014 to 14 Feb 2014



Seven Creeks at Euroa (ID: 405237)

Forecast performance for day 1 - day 7, 2015-2017



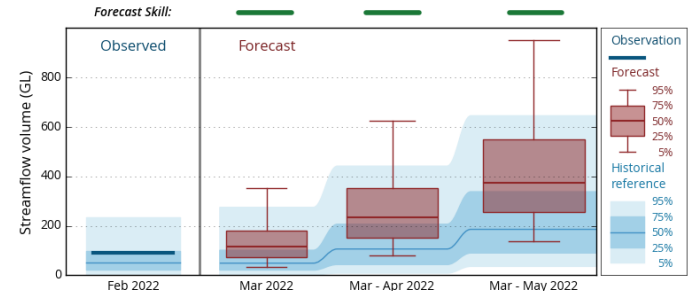
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Seasonal flow forecasts

Unregulated inflow to Hume Dam

Forecast for Mar 2022 – May 2022

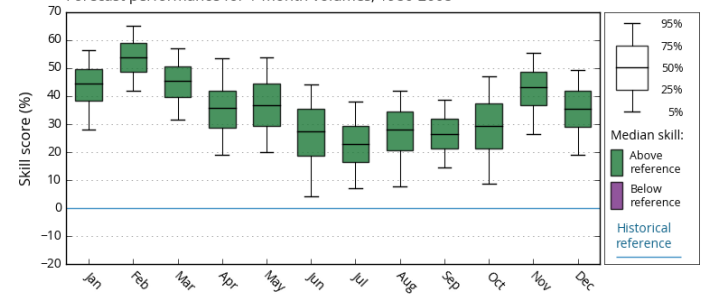


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Unregulated inflow to Hume Dam

Forecast performance for 1-month volumes, 1980-2008

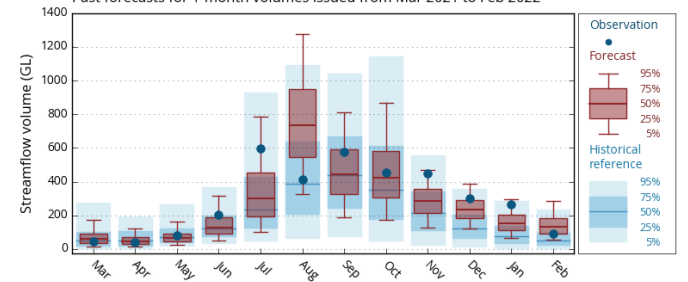


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Unregulated inflow to Hume Dam

Past forecasts for 1-month volumes issued from Mar 2021 to Feb 2022



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Seasonal Streamflow Forecasts

Station Selector

Drainage Division: Murray-Darling Basin

River Region: Upper Murray River

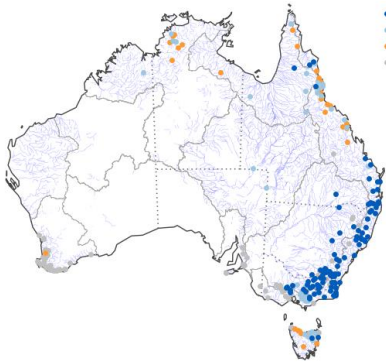
Location: Unregulated inflow to Hume Dam

Nearby stations: Total flow of Kiewa River to Murray River, Billabong Creek at Walbundrie (410091), Billabong Creek at Aberfeldy (410097)

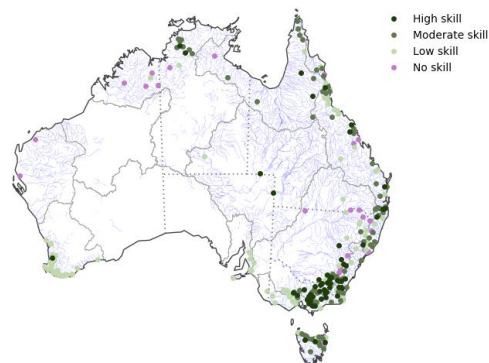
Unregulated inflow to Hume Dam

Quick facts: Catchment area: 11754 km²; Climate type: Temperate; Annual Rainfall: Period 1900-2021, Average 1048 mm; Annual Streamflow: Period 1900-2021, Average 2498 GL, Minimum 205 GL, Maximum 8749 GL.

Streamflow forecast for March 2022



Forecast skill for March



Water System Operations priorities

Flood operations

Dam airspace operations

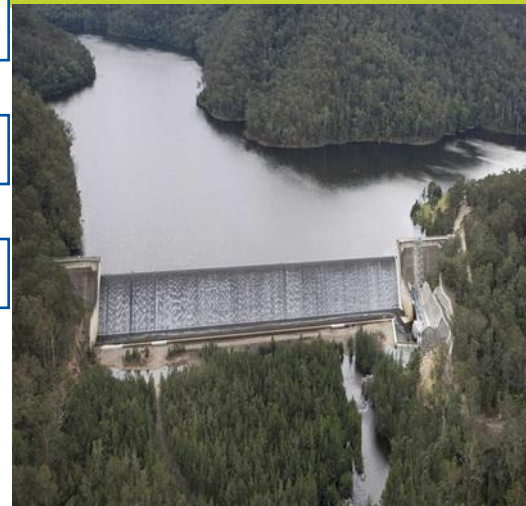
River operations

Water demand forecasting

Dam and valley inflows

Climate change impacts

Water security planning



River regulations and operational challenges



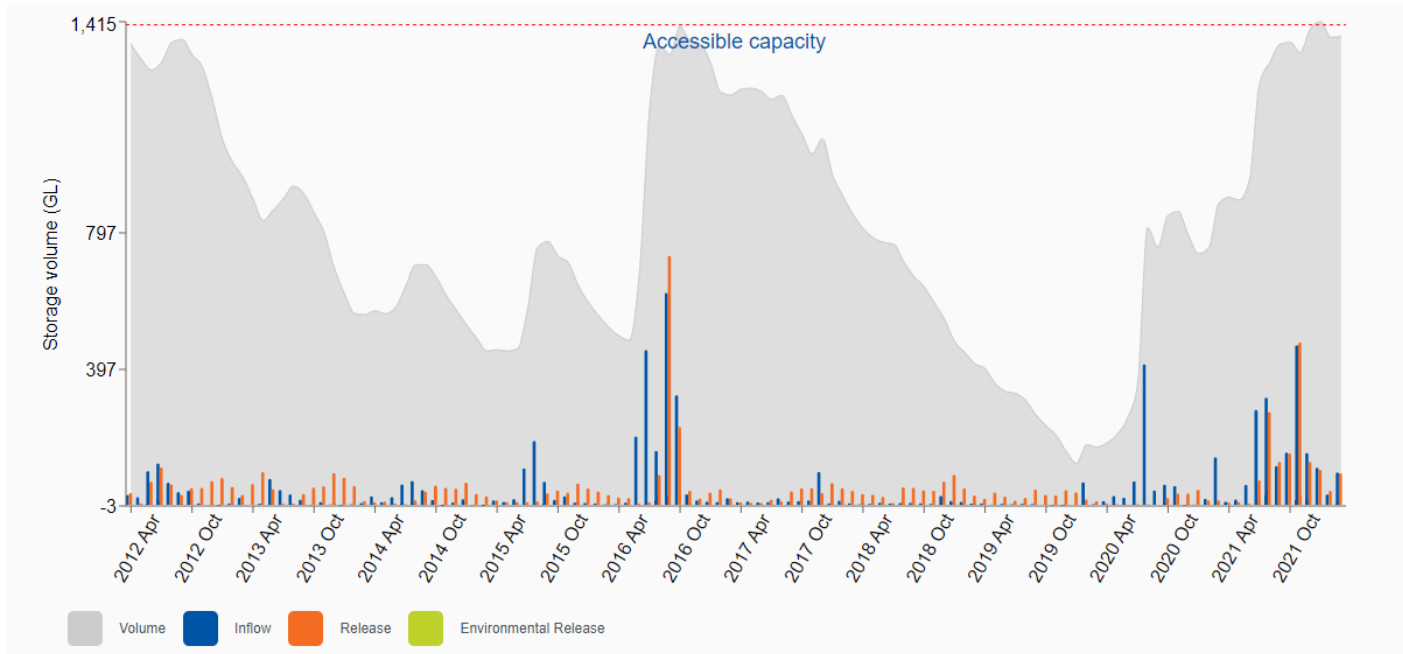
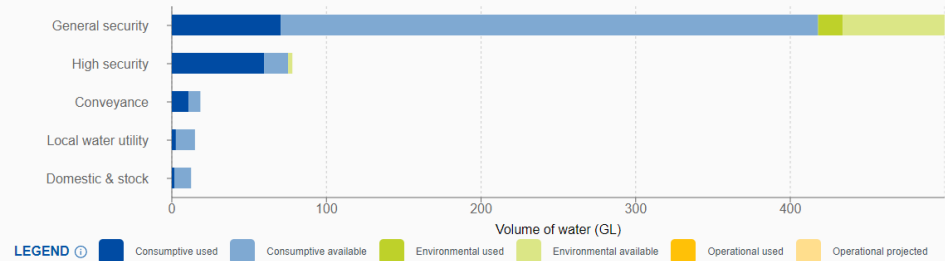
Rules	Storage	Allocation	Trading	Orders	Delivery
<p>ACCESS LICENCE</p> <p>WATER SHARING PLANS</p> <p>ACCOUNTING RULES</p>	<p>ACCESSIBLE STORAGE</p> <p>ALL DAMS AND IMPOUNDING STRUCTURES IN THE VALLEY</p> <p>NEAR REAL TIME AND HISTORICAL</p>	<p>PERCENT ALLOCATION FOR EACH LICENCE CATEGORY</p> <p>HIGH SECURITY</p> <p>GENERAL SECURITY</p> <p>TOWN WATER SUPPLY</p> <p>DOMESTIC AND STOCK</p>	<p>ALLOCATION TRADE</p> <p>ENTITLEMENT TRADE</p> <p>\$\$/ML or 1000 m³</p> <p>MARKET PRICE DEPENDS ON AVAILABILITY AND DEMAND</p>	<p>AUTOMATED SYSTEM FOR ORDERS</p> <p>WATER ACCOUNTS ADJUSTED AS PER ALLOCATIONS AND ORDERS</p> <p>OPERATOR RECEIVES ORDER EVERY DAY BUT SOMETIMES WITHIN A DAY</p>	<p>DEMAND AGGREGATED FROM END OF VALLEY TO UPSTREAM STORAGES</p> <p>INFLOW FORECASTS FOR STORAGES & TRIBUTARIES</p> <p>KNOWLEDGE OF TRAVEL TIME & LOSSES NEEDED</p> <p>MINIMISE UNUTILISED DEMAND</p>

Water delivery – when and where it matters



Water usage and remaining

This graph shows, for each licence category, the total volume of water used and remaining in water accounts and available for use or trade. It also shows how much of each category is for consumptive or environmental use. In addition, the graph shows the water held in reserves, the water expected to be lost through operations and the planned environmental water expected to be used. Reserves and planned environmental water are amounts required by the water sharing plan but also depend upon conditions (temperature, rainfall, soil condition). Losses depend very much on demand and conditions.



WMO Designated Global Data-processing and Forecasting System Centres

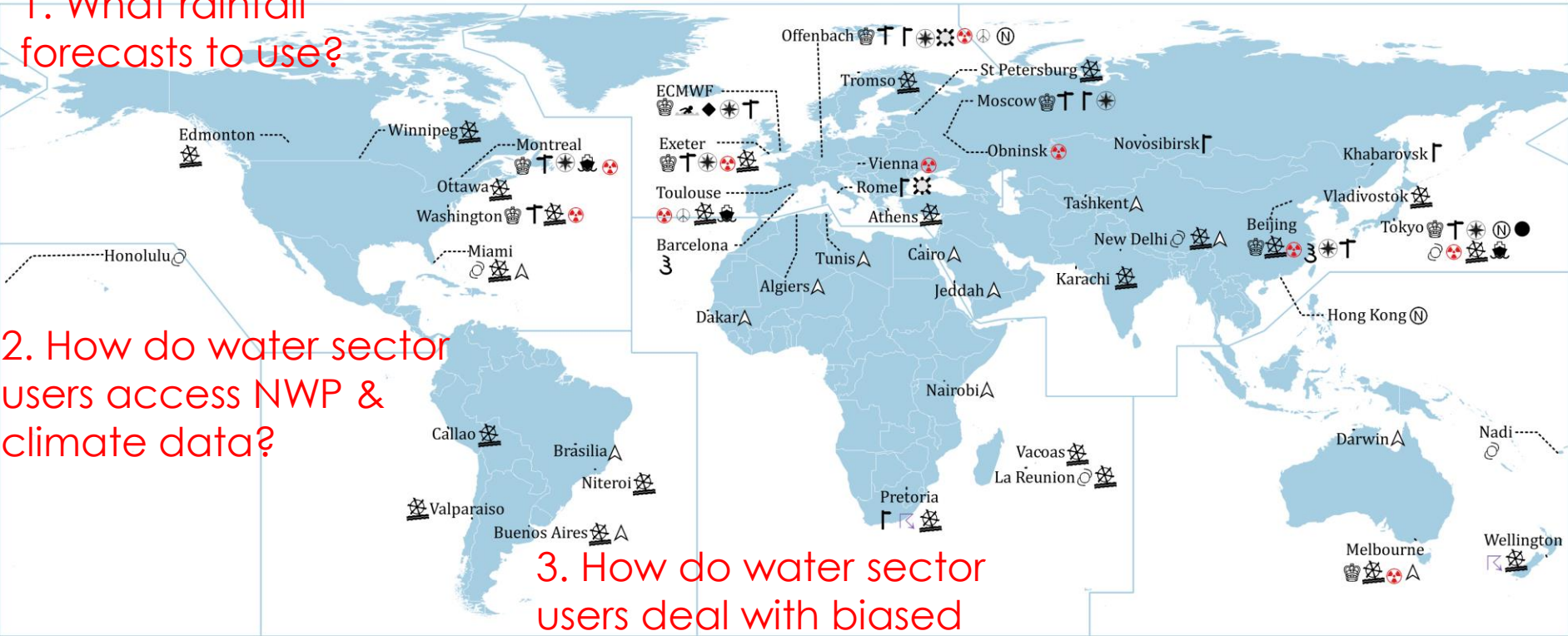
- Nowcasting and Weather Forecasting (upto 30 days)

Updated on 12 March 2019

1. What rainfall forecasts to use?

2. How do water sector users access NWP & climate data?

3. How do water sector users deal with biased global forcing data?



Legend

- ☞ World Meteorological Centres (WMCs)* (9)
- △ RSMCs Geographic (13)
- ⚓ RSMCs(NRT****) Lead Centre for Coordination of Wave Forecast (1)
- RSMCs(NRT****) Lead Centre for Coordination of EPS Verification (1)
- ◆ RSMCs(NRT****) Lead Centre for Coordination of DNV (1)
- 🌊 RSMCs Numerical Ocean Wave Prediction (3)
- 🌐 RSMCs TC (6)
- ⚡ RSMCs Severe Weather Forecasting (2)
- 🚢 RSMCs Marine Meteorological Services (24)
- ☢ RSMCs Nuclear Emergency Response** (10)
- ☮ RSMCs Non-Nuclear Emergency Response** (2)
- ☄ RSMCs Sand Dust (2)
- Ⓝ RSMCs Nowcasting (3)
- ⚡ RSMCs Limited Area Ensemble NWP (2)
- ⚙ RSMCs Global Ensemble NWP (7)
- ⌚ RSMCs Limited Area Deterministic NWP (6)
- ⌚ RSMCs Global Deterministic NWP (8)

* World Meteorological Centres are also Global Producing Centres for a) Deterministic Numerical Weather Prediction, b) Ensemble Numerical Weather Prediction, and c) Long-Range Forecasts.

** RSMC for nuclear and non-nuclear emergency response have Atmospheric Transport and Dispersion Modelling (ATDM) capabilities.

**** NRT stands for Non-Real-Time

DESIGNATIONS USED

The depiction and use of boundaries, geographic names and related data shown on maps and included in lists, tables, documents, and databases on this web site are not warranted to be error free nor do they necessarily imply official endorsement or acceptance by the WMO.

Concluding remarks



- Clarity needed for water sector users on climate forecast products to use including the rationale of fitness for purpose
- Access to NWP data including support for the enabling technologies for data harvesting over domains of interest
- The need for National Meteorology and Hydrology agencies to work with users from inception through to product design, delivery and review stages
- Understanding the role of global and catchment models for supporting needs of the water sector
- Verification is important for end user confidence – not just illustration of the metrics, rather intuitive products that demonstrate the value proposition
- While production and delivery of services for water sector are important, use of probabilistic forecasts for critical decisions is far more complex
- Water operators have compelling reasons to be risk averse, and therefore research in decision support systems warrant serious consideration

Thank you

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