Ensemble Hydrological Forecasting in Australia

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Water information products

www.bom.gov.au/water

Retrospective

Situational awareness

Forecasts

PAST

PRESENT

FUTURE

Decades

Years

Months

Weeks

Days

National water account

Water balance reporting

Water market website

Long-term trends

Seasonal forecasts

Sub-seasonal forecasts

Flood and 7-day forecasts
WMO specified meteorological & hydrological forecast ranges

Sources of predictability

Hydrological forecasts

Sources of predictability

Initial hydrological conditions
- Hydrological observations

Future climate variability
- Meteorological observations
- Historical climate forecasts (hindcasts)
- Climate forecasts

Verification – how good are the forecasts?
Ensemble forecast system

- Observed potential evaporation
- Observed precipitation
- Ensemble precipitation forecast
- Climatology PE
- Initial conditions
- Simulated streamflow
- Rainfall forecast pre-processing
  - Schaake shuffle
  - Calibration (BJP)
  - Catchment precipitation forecast
- Hydrological prediction post-processing - ERRIS
  - Stage 1: Data transformation
  - Stage 2: Bias-correction
  - Stage 3: Stochastic updating
  - Stage 4: Distribution refinement
- ERRIS: Error Reduction In Stages
- National Precipitation Forecast

AUSTRALIAN GOVERNMENT
Bureau of Meteorology
What makes a good probabilistic forecast?

- Water management is about “balancing risks” of extreme events (floods/droughts)
- For accurate risk estimates of extreme events, a good forecast needs to be:
  1. Reliable
  2. Precise

“Over-confident”: under-estimate risks, can’t manage extremes
“Too-conservative”: over-estimates risks => missed opportunities
Ensemble rainfall forecast data

- Ensemble mean of NWP models from: Australia, UK, USA, Canada, Europe, and Japan
- ECMWF (18 km, 51 ensembles)
- ACCESS-GE (~33km, 36 time lagged ensembles)
7-day ensemble streamflow forecast service

- Released to public in June 2020
  [http://www.bom.gov.au/water/7daystreamflow/]

**Forecast locations**

<table>
<thead>
<tr>
<th>Region</th>
<th>Forecast locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW &amp; ACT</td>
<td>58</td>
</tr>
<tr>
<td>NT</td>
<td>16</td>
</tr>
<tr>
<td>QLD</td>
<td>29</td>
</tr>
<tr>
<td>SA</td>
<td>4</td>
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<tr>
<td>TAS</td>
<td>28</td>
</tr>
<tr>
<td>VIC</td>
<td>60</td>
</tr>
<tr>
<td>WA</td>
<td>31</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>226</strong></td>
</tr>
</tbody>
</table>

Forecasts are updated daily around 10:30-11:30 AEST

Data provision via the website and FTP to key stakeholders
Upgraded 7-day ensemble forecasting system

- **HyFS**: Enterprise approach to operational flood and short range water forecasts
- All modelling tools are fully consistent with Bureau of Meteorology technology stack
- Based on FEWS system, adopted by most water utilities in Australia
- Rainfall forecasts
  - PME (1)
  - ECMWF IFS (50)
  - **ACCESS-GE3 (18)** – To be used

7-Day Ensemble Streamflow Forecast Workflows (HyFS)

- **HyFS Workflow level** (accessible in HyFS GUI)

  1. Recent Observations (streamflow, rainfall, PE)
  2. CHyPP Adapter
     - Catchment Hydrologic Pre-processor (CHyPP)
  3. Rainfall Post-Processing
  4. Create Rainfall Super-ensemble 401 Ens
  5. SWIFT2 Historical Run
  6. Run Hydro Model (Ensemble)
  7. Visualise in HyFS

**Notes:**
* Dataflow in and out of HyDS deliberately simplified in this diagram.
* Existing deterministic workflows not shown, but need to be maintained until at least mid 2019 while Ensemble system is tested with reg users.

**Legend:**
1. Task in FFW systems area
2. Task in WFS systems area

Author: Patrick Sunier
(based on Prasanthi Hapuarachchi’s diagrams)
Last updated: 28 Feb 2019
7-day streamflow forecast products

1. Tully River at Euramo (ID: 113006)
   Forecast for 08 Feb 2014 to 14 Feb 2014

2. Tully
   Forecast for 07 Feb 2014 to 14 Feb 2014

Accumulated rainfall and flow

3. Owens River at Wangaratta (ID: 403342A)
   Accumulated Rain Forecast for 11 February 2014 to 18 February 2014

4. Owens River at Wangaratta (ID: 403342A)
   Accumulated Flow Forecast for 11 February 2014 to 18 February 2014

5. Seven Creeks at Euroa (ID: 405237)
   Forecast performance for day 1 - day 7, 2015-2017
Managing releases from the Hume Dam

Travel time is 3 days

Interpreting the readings

The figures given for the weirs, Echuca Wharf, Swan Hill and Murray Bridge are water levels in metres AHD (Australian Height Datum) (Metro AHD refers to elevation above a standardised measure of mean sea level, which is taken to be zero.)

Dam storage values are in gigalitres (GL) and percentage of capacity.

All other site values are river flows in megalitres (ML) per day.
#1 Example of educational activities with dam operators

- Which of the following statements best represent the flow at Jingellic in 2-days lead-time (22/01/2020 10:00) to be as shown by the black dot in the plot below?

1. There is 75% chance of flow exceeding 2700 ML/day
2. There is 75% chance of flow not exceeding 2700 ML/day
3. There is 25% chance of flow not exceeding 2700 ML/day
4. Information provided is insufficient
#2 Example of educational activities with dam operators

Based on the catchment conditions and forecast data given below, what forecast flow percentile range at Pechelba (Ovens River) would you choose for making releases (under flood scenario) from the Hume Dam on 03/10/2016?

1. 5th – 25th percentile
2. 25th – 75th percentile
3. 75th – 95th percentile
4. Information provided is insufficient

### Catchment condition

- **Upper zone soil is saturated**
- **Lower zone soil is saturated**

### Accumulated rainfall (mm)

- 1. 5th – 25th percentile
- 2. 25th – 75th percentile
- 3. 75th – 95th percentile
- 4. Information provided is insufficient

### Accumulated runoff (mm)

- 1. 5th – 25th percentile
- 2. 25th – 75th percentile
- 3. 75th – 95th percentile
- 4. Information provided is insufficient

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**Forecast issue time:**

03/10/2016 7:00

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**Ovens River @ Pechelba East (ID: 403241)**

3 days lead-time

**Ovens River at Pechelba East (ID: 403241)**

Accumulated Rain Forecast for 03 Oct 2016 to 10 Oct 2016 (07:00 AEDT)

**Ovens River at Pechelba East (ID: 403241)**

Accumulated Flow Forecast for 03 Oct 2016 to 10 Oct 2016 (07:00 AEDT)

**Ovens River at Pechelba East (ID: 403241)**

Forecasts issued 03/10/2016 07:00 AEDT

**Observed**

- **Rainfall**
  - About 70% saturated
  - About 40% saturated

**Forecast median**

- **Streamflow**
  - 1012 m³/s

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**EXPERIMENTAL PRODUCT**

**Commonwealth of Australia 2020, Australian Bureau of Meteorology**
Thank you