Scientific Visit to Bureau of Meteorology

Under the project:

Applying water accounting concept in Nile Delta for ideal water management

JESOR---Development

Joint collaborative **E**fforts of Egyptian expatriates and **S**cientific **O**rganizations towards tackling national **R**&**D** Challenges

Project Objectives

- A key aim of the proposal is increasing public confidence in water management. The international cooperation (bureau of Meteorology) helps to achieve this aim.
- The specific objective of the proposal is preparing a strategy for the Nile Delta contains the total water resource, the volume of water available for abstraction, the rights to abstract water and the actual abstraction of water for economic, social, cultural and environmental benefit, in water use regions.

Objectives of the visit

- Know the activities and capabilities of Bureau of Meteorology in Australian
- Training on river model “AWRA-R”.
- Training on landscape model “AWRA-L”.
- Training on water accounting approach.
- Visit climate change department.
- Field trip for a distribution water facility “Goulburn – Murray Water”

Australian Water Resources Assessment (AWRA)

AWRA Modelling System

Objective:

- To provide seamless water balance information and data for the nation for the past and present, using observations where available, and modelling otherwise.

Outcomes:

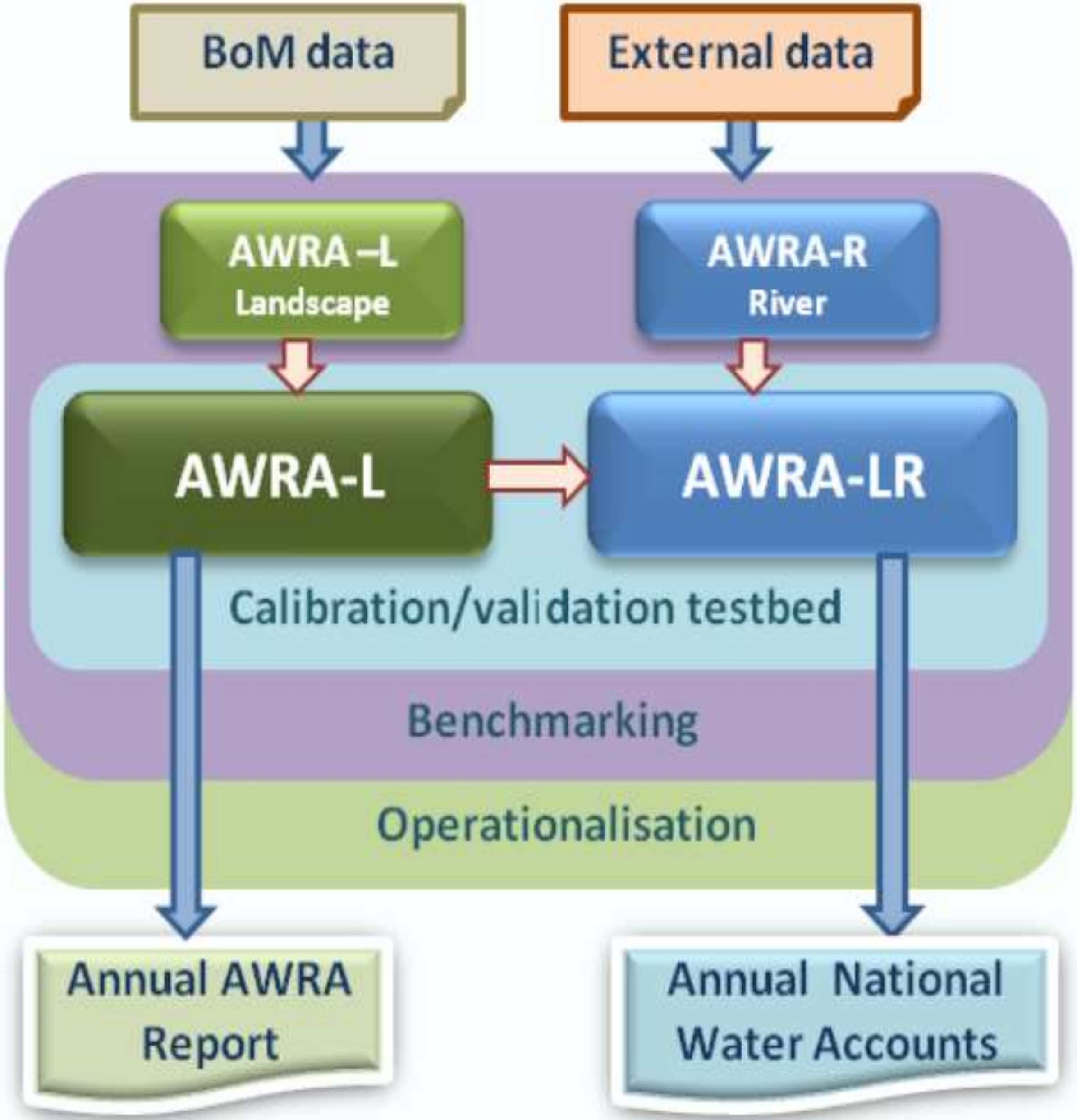
- Consistent, accurate and robust continental scale modelling to underpin the Australian Water Resource Assessment Report and the National Water Accounts.
- Water management and water market informed by accurate and timely annual water accounts.
- A national picture on water availability over time (spatial and temporal trends across the continent) which will help guide the significant water reforms that are happening across Australia and to support national resources policy.

AWRA Modelling System - Components

Two major components:

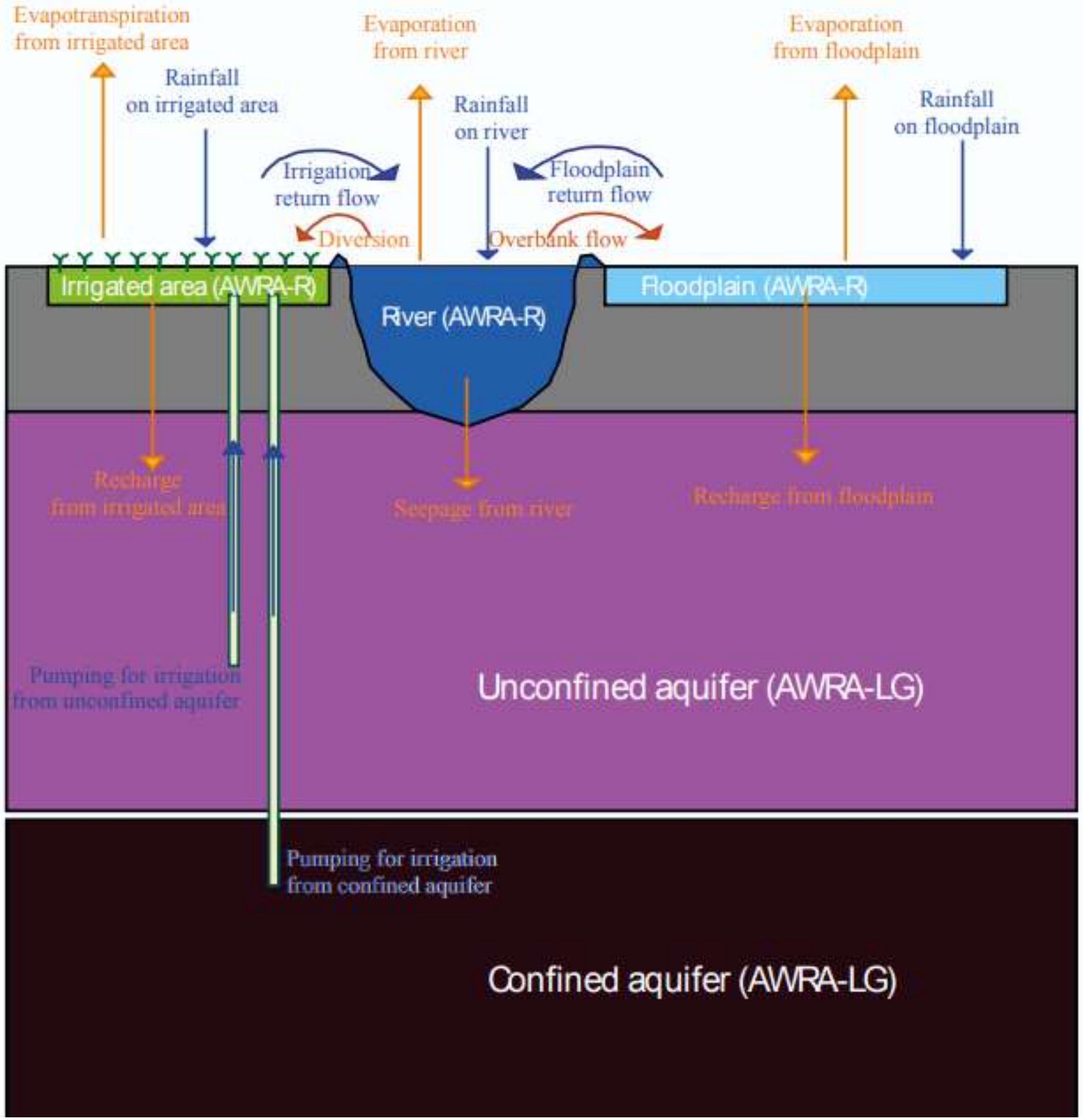
AWRA-L (Landscape model)

AWRA-R (River system model)



Interaction between AWRA-L and AWRA-R

Total runoff from all the AWRA-L grid cells in the river reach are added as inflow into the river store.



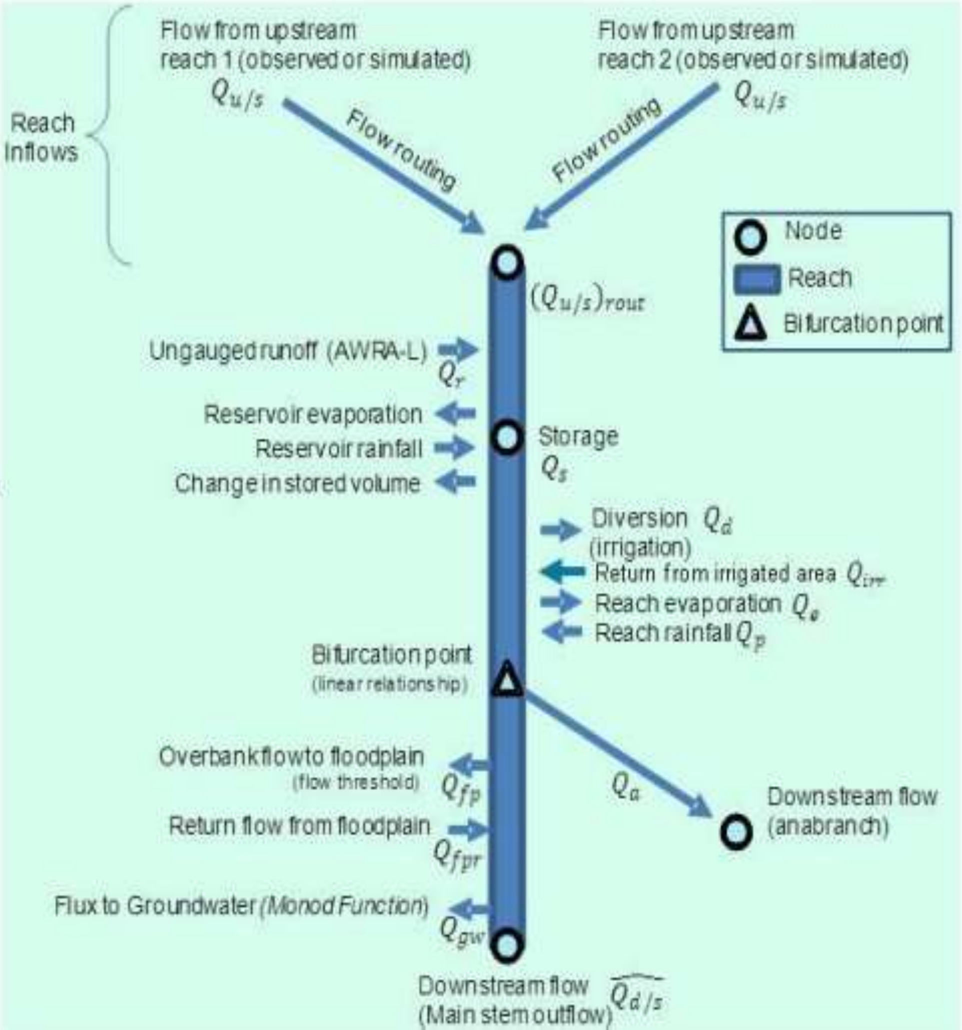
AWRA-R current version - components

The general form of the water balance equation used in the model calibration:

$$\widehat{Q_{d/s}} = (Q_{u/s})_{rout} + Q_r + Q_s - Q_d + Q_{irr} - Q_u + Q_p - Q_e - Q_a - Q_{fp} + Q_{fpr} - Q_{gw}$$

Where,

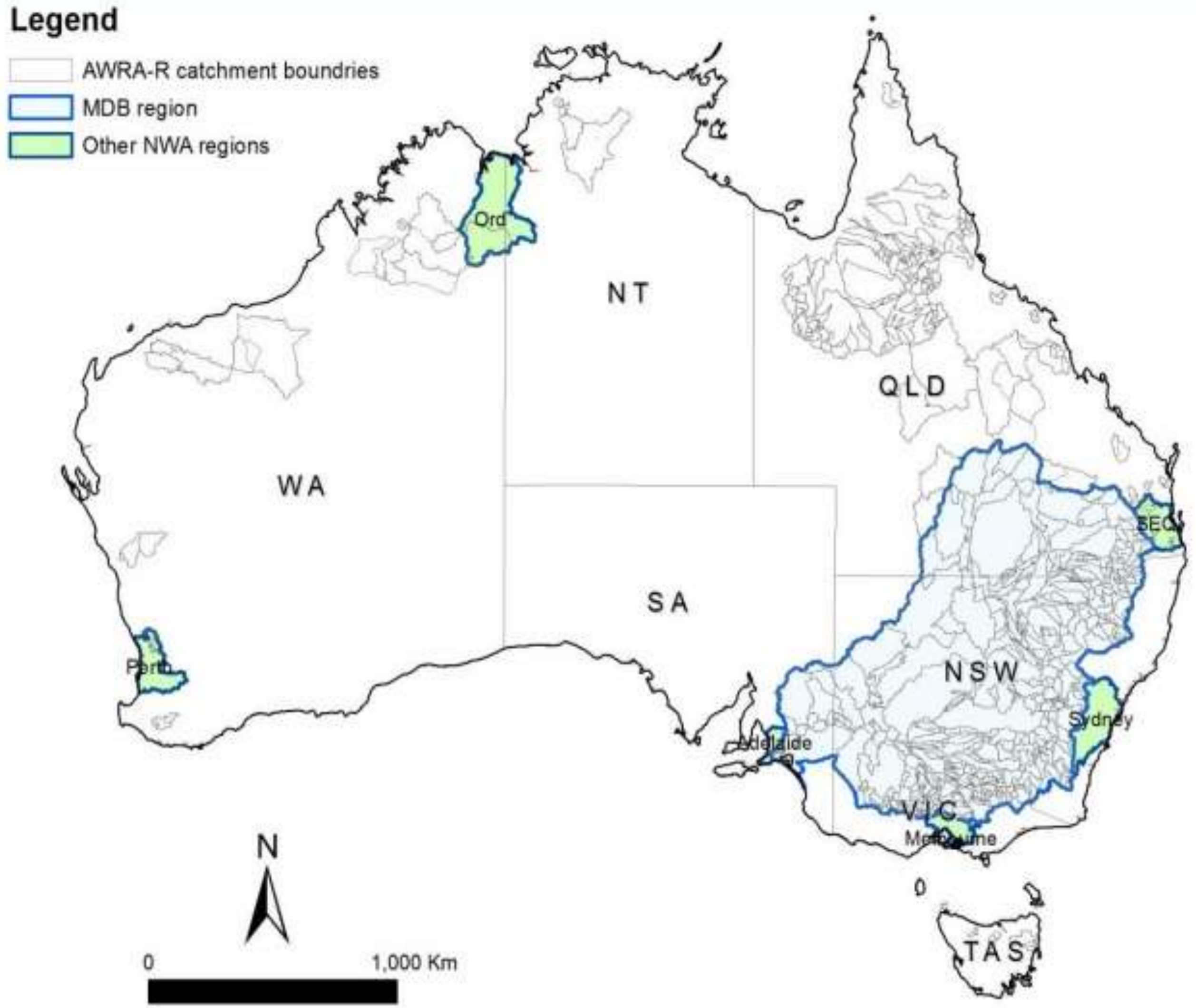
$\widehat{Q_{d/s}}$ → : *estimated flow at the downstream gauge,*
$(Q_{u/s})_{rout}$ → : *concurrent flow at the upstream gauges (including gauged tributaries) following routing (Muskingum routing),*
Q_r → : *runoff locally generated,*
Q_s → : *contribution from any storages including rainfall on storage area, evaporation from storage area and change in storage volume,*
Q_d → : *loss due to irrigation diversion,*
Q_{irr} → : *total return from irrigated area.*
Q_p → : *flux to river due to rainfall,*
Q_e → : *flux from river due to evaporation,*
Q_a → : *flow diverted to anabranches*
Q_{fp} → : *overbank flow to floodplain,*
Q_{fpr} → : *return flow from floodplain,*
Q_{gw} → : *flux from river to groundwater,*



AWRA-R Implementation

The model has been so far implemented in 9 regions (covering 41 large catchments with a total area of over 1.6 million km^2):

- Three NWA regions
  - MDB
  - SEQ
  - Melbourne
- 6 other regions



Inputs

1. Time Series Data:

Temporal variable (symbol)	Unit of input data	Resolution	Purpose
Rainfall at river (P_s)	mm/day	daily	Model input
Evaporation from river (E_s)	mm/day	daily	Model input
Rainfall at floodplain (P_{fp})	mm/day	daily	Model input
Evaporation from floodplain (E_{fp})	mm/day	daily	Model input
Irrigation diversion (Q_d)	m^3/s	daily	Model input/ calibration
Irrigation return flow (Q_{irr})	m^3/s	daily	Model input
Urban diversion (Q_u)	m^3/s	daily	Model input
AWRA-L runoff (Q_r)	m^3/s	daily	Model input
Reservoir volume (S)	m^3	daily	Model input
Reservoir area (a)	m^2	daily	Model input
Depth to groundwater (d_{gw})	m	daily	Model input
River water depth (h_{rivw})	m	daily	Model input
River water width (X_{rivw})	m	daily	Model input
Reservoir net diversion ($Q_{net\_transfer}$)	m^3/s	daily	Model input
Other river diversion	m^3/s	daily	Model input
Inflow from each of the upstream nodes	m^3/s	daily	Model input
Rainfall at reservoir (P_s)	mm/day	daily	Model input
Evaporation from reservoir (E_s)	mm/day	daily	Model input
Outflow at downstream nodes	m^3/s	daily	Model input/ calibration

Inputs

2. Spatial/static Data

Parameter (symbol)	Unit	Purpose
River area alpha (α)	-	Model input
River area beta (β)	-	Model input
Flood beta (C_{fp})	m^{-1}	Model input
Anabranch partition factor (C_a)	-	Model input
Anabranch exponent (B_a)	-	Model input
Total river length (L)	m	Model input
River depth alpha	-	Model input (to determine h_{rivw})
River depth beta	-	Model input (to determine h_{rivw})
Overbank flow threshold (OT) [calibrated]	m^3/sec	Model input
Floodplain surface layer conductivity (K_c)	m/sec	Model input
Aquifer specific yield (S_y)	-	Model input
Aquifer hydraulic conductivity (K_{aq})	m/sec	Model input
Aquifer thickness (d_{aq})	m	Model input
Surface layer thickness (d_c)	m	Model input
River bed conductivity (K_{rivc})	m/sec	Model input
Area of residual catchment	m^2	Model input
Length of reach inflow stream	m	
Flood return flow coefficient (FR) [calibrated]	-	Model input
Monod parameter (M_1) [calibrated]	m^3/sec	Model input
Monod parameter (M_2) [calibrated]	m^3/sec	Model input
Runoff correction factor (SF) [calibrated]	-	Model input
Lag [calibrated]	sec	Model input
K [calibrated]	sec	Model input
X [calibrated]	-	Model input

Outputs

Variables (symbol)	Symbols used in non-routing states file	Unit	Reference equation
Outflow ($\widehat{Q_{d/s}}$)	outflow	m^3/sec	Equation 1
Overbank flow (Q_{fp})	overbank.flow	m^3/sec	Equations 1, 37
Floodplain volume (V_{fp})	floodplain.volume	m^3	Equation 42
Flood plain area (A_{fp})	floodplain.area	m^2	Equations 39, 40
Flood plain return flow (Q_{fpr})	floodplain.returnflow	m^3/sec	Equations 1, 41
River rainfall flux (Q_p)	river.rainfall.flux	m^3/sec	Equations 1, 32
River evaporation flux (Q_e)	river.evap.flux	m^3/sec	Equations 1, 33
Floodplain rainfall flux	floodplain.rainfall.flux	m^3/sec	Equation 36
Floodplain evaporation flux	floodplain.evap.flux	m^3/sec	Equation 36
Floodplain groundwater loss (GWR_{fp})	floodplain.groundwater.loss	m^3/sec	Equations 36, 43
River groundwater loss (Q_{gw})	river.groundwater.loss	m^3/sec	Equations 1,
Anabranch loss (Q_a)	top.anabranch.loss, bottom.anabranch.loss	m^3/sec	Equations 1, 35
Reservoir rainfall flux	reservoir.rainfall.flux	m^3/sec	Equation 6
Reservoir evaporation flux	reservoir.evap.flux	m^3/sec	Equation 6
Reservoir contribution (Q_s)	reservoir.contribution	m^3/sec	Equations 1, 5
River water volume	river.volume	m^3	
Floodplain groundwater max change storage (ΔS)	floodplain.groundwater.max.change.storage	m^2/sec	Equation 43
Floodplain groundwater outflow (Q)	floodplain.groundwater.outflow	m^3/sec	Equation 43
Floodplain groundwater max potential infiltration (I)	floodplain.groundwater.max.infiltration	m^2/sec	Equation 44

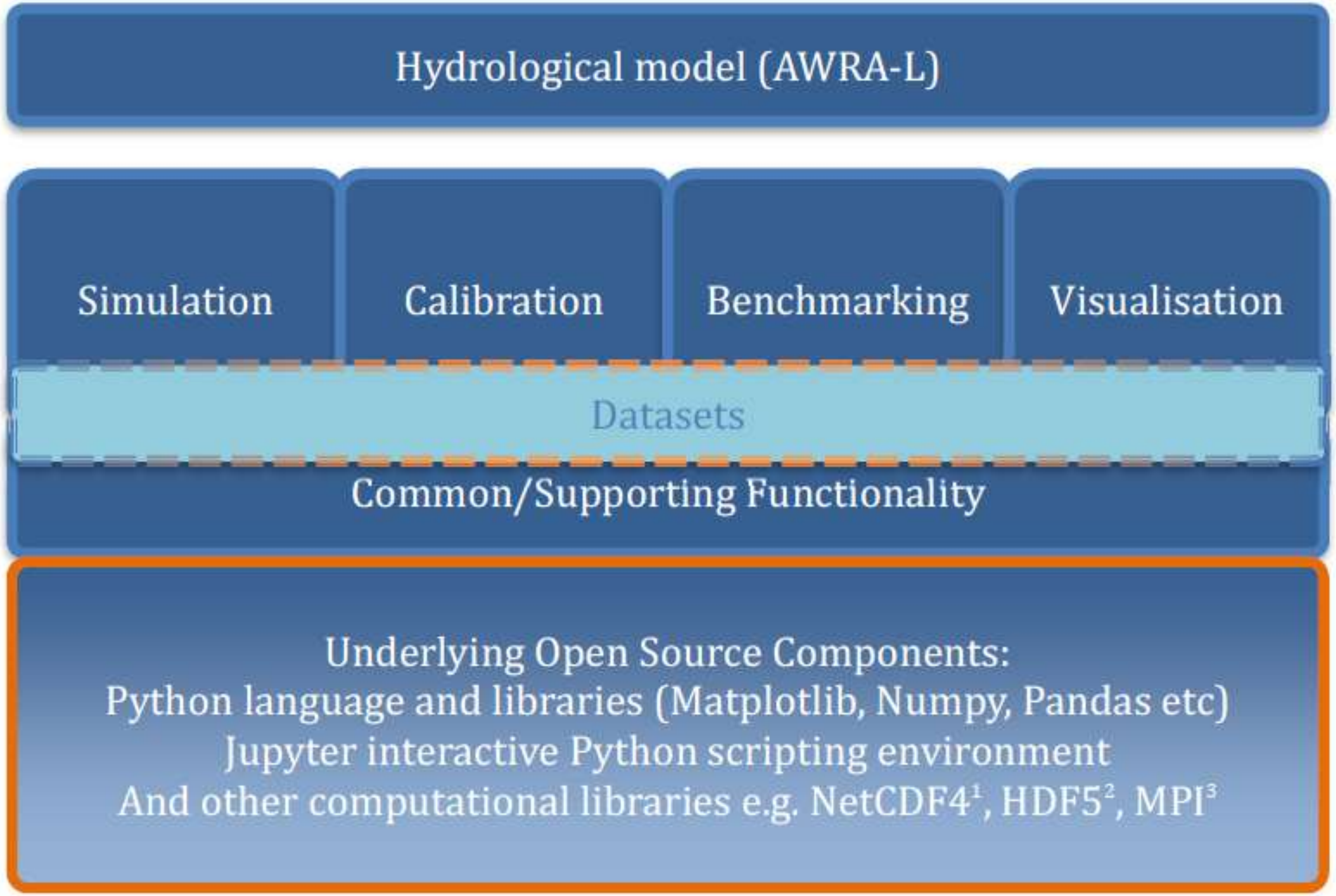
AWRA-L Model

AWRA-L, the landscape component of the AWRA system, is a daily grid-based biophysical model of the water balance between the atmosphere, the soil, groundwater and surface water stores.

The model aims to produce interpretable water balance component estimates, so that they agree as much as possible with water balance observations, including point gauging data and satellite observations.

The model is intended to be parsimonious rather than comprehensive, appropriate to the needs of the AWRA and NWA reporting.

AWRA-L Modelling System Components



Input data

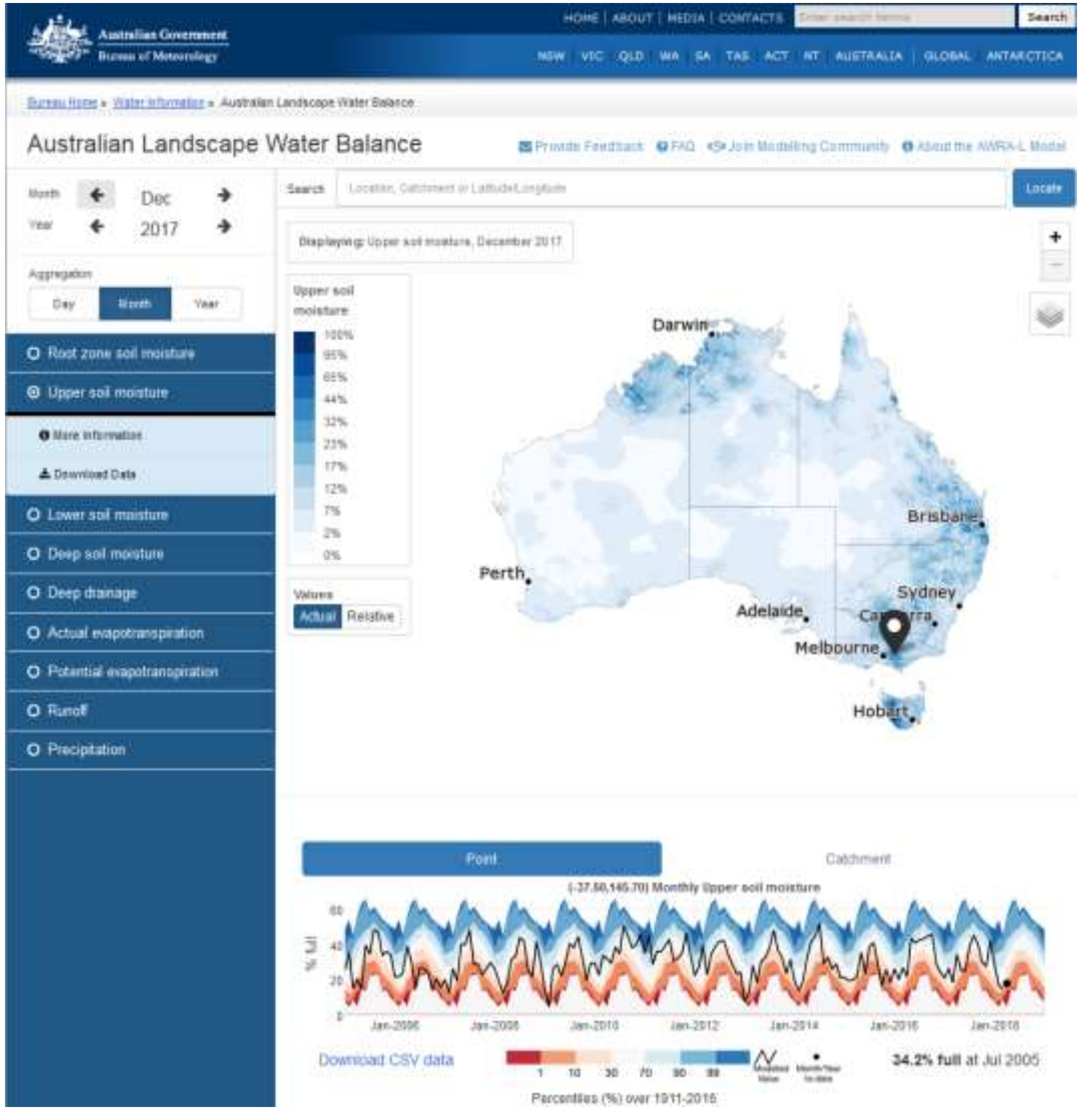
No.	Output	
1	f_tree	Fraction tree (0-1) 1 means all area trees
2	height	Hypsometric curve (different between highest value and lowest value in the cell)
3	hveg_dr	Height of Vegetation Canopy
4	k0sat_v5	Hydraulic saturation conductivity (top)
5	k_gw	Groundwater drainage coefficient
6	kdsat_v5	Hydraulic saturation (deep)
7	kssat_v5	Hydraulic saturation (shallow)
8	lai_max	Max leaf area index
9	meanPET	Mean potential evapotranspiration
10	ne	Effective porosity (0-1)
11	pref	Reference value pf precipitation
12	s0fracAWC	Water holding capacity in surface soil
13	slope	Slope of the land surface
14	ssfracAWC	Water holding capacity in shallow soil
15	windspeed	Wind speed at height 2 m

Accessing the website

- **The Australian Landscape Water Balance website can be accessed using the URL:**

www.bom.gov.au/water/landscape/

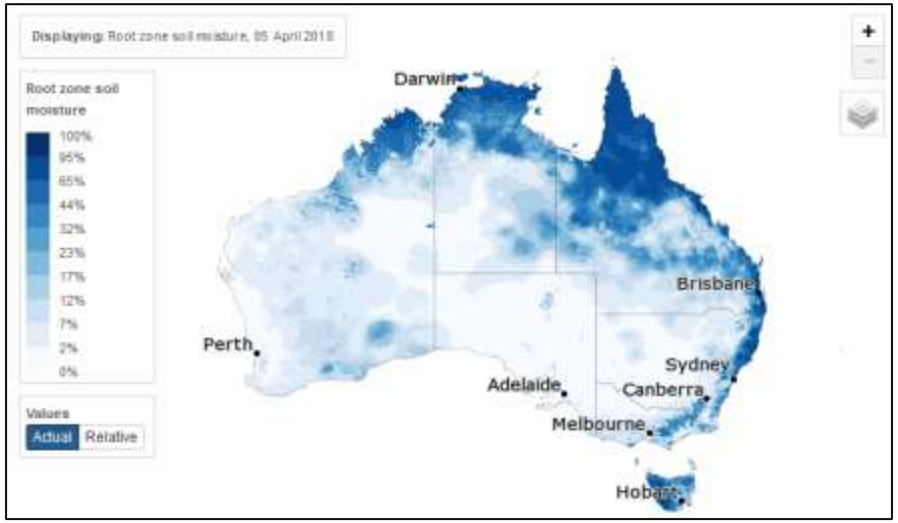
- **Demo of website functionality:**
  - 'About the AWRA-L Model'
  - Time steps
  - Time series plotting and downloading
  - Website bookmarking
  - Variables 'More information'



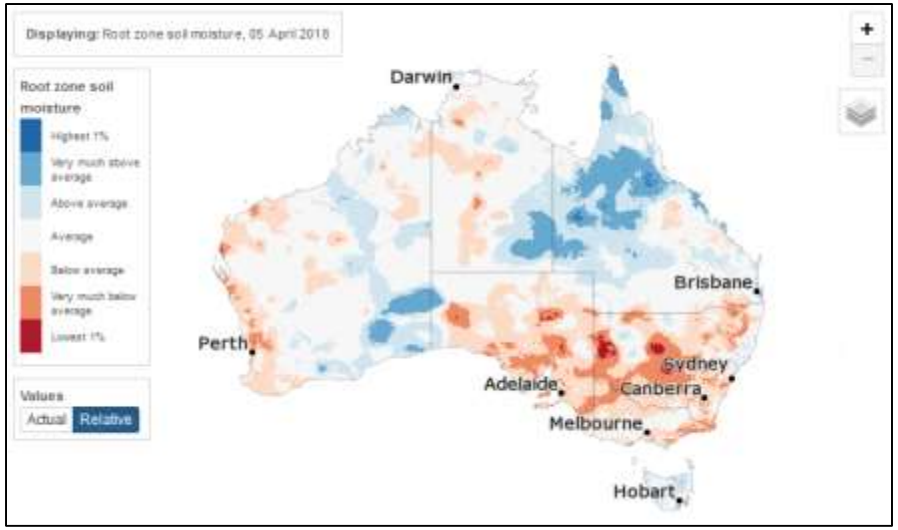
Types of Data Available

- **Variables:**
  - Root zone soil moisture (0-1m depth)
  - Upper soil moisture (0-0.1m depth)
  - Lower soil moisture (0.1-1m depth)
  - Deep soil moisture (1-6m depth)
  - Deep drainage
  - Actual evapotranspiration
  - Potential evapotranspiration
  - Runoff
  - Precipitation

- **Variable types:**
  - Actual values (mm/pct)
  - Relative to historical (deciles 1911-2016)



Actual

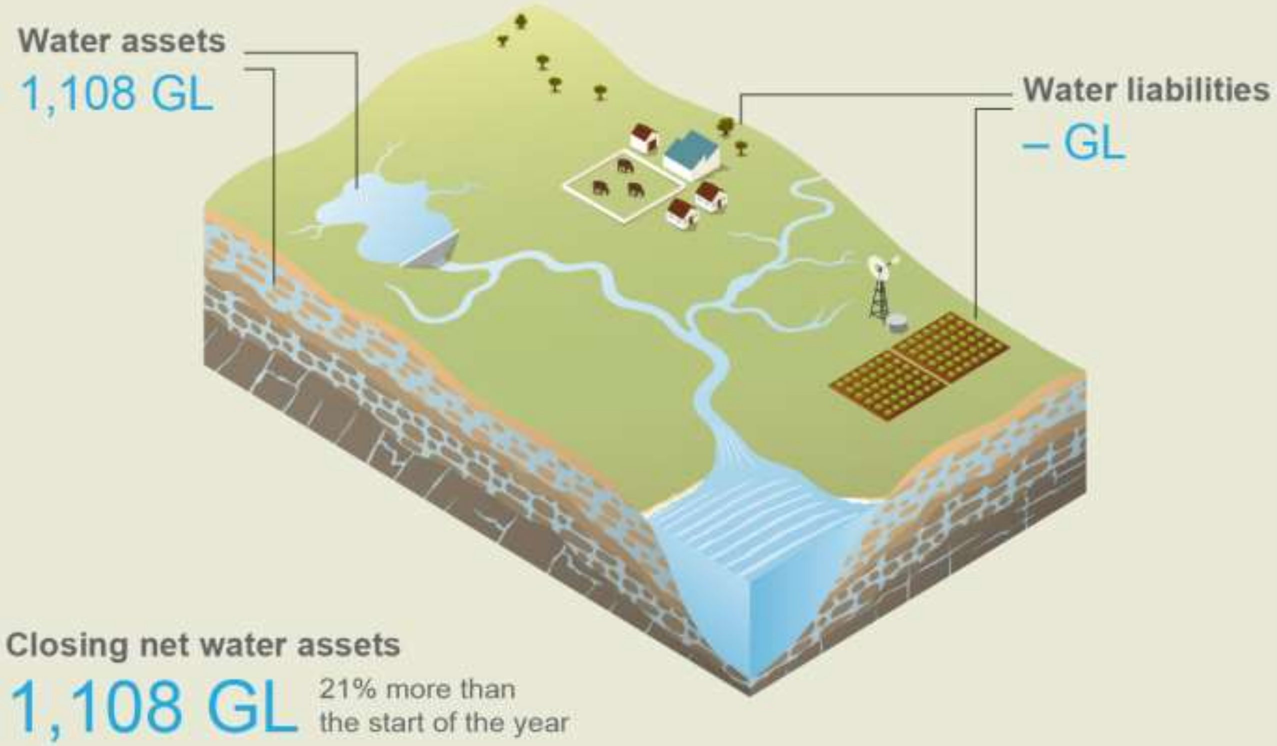


Relative

National Water Account

Water Assets

- Water availability in the Fitzroy region's storages increased by 21% during 2016–17.
- Water availability is represented by the net water assets, which are the volume of water in storages minus the water liabilities.



The Statement of Water Assets and Water Liabilities is provided in the table below. The statement presents the volume of *water assets*, and *water liabilities* at the start and end of the reporting year.

Water Assets

Water assets		
Surface water		1,093,119
Groundwater		14,624
Total water assets		**1,107,743**

Water liabilities		
Surface water liability		–
Groundwater liability		–
Total water liabilities		

Opening net water assets	**918,575**
Change in net water assets	**189,168**
Closing net water assets	**1,107,743**

Water Inflows/Outflows

Surface water flows

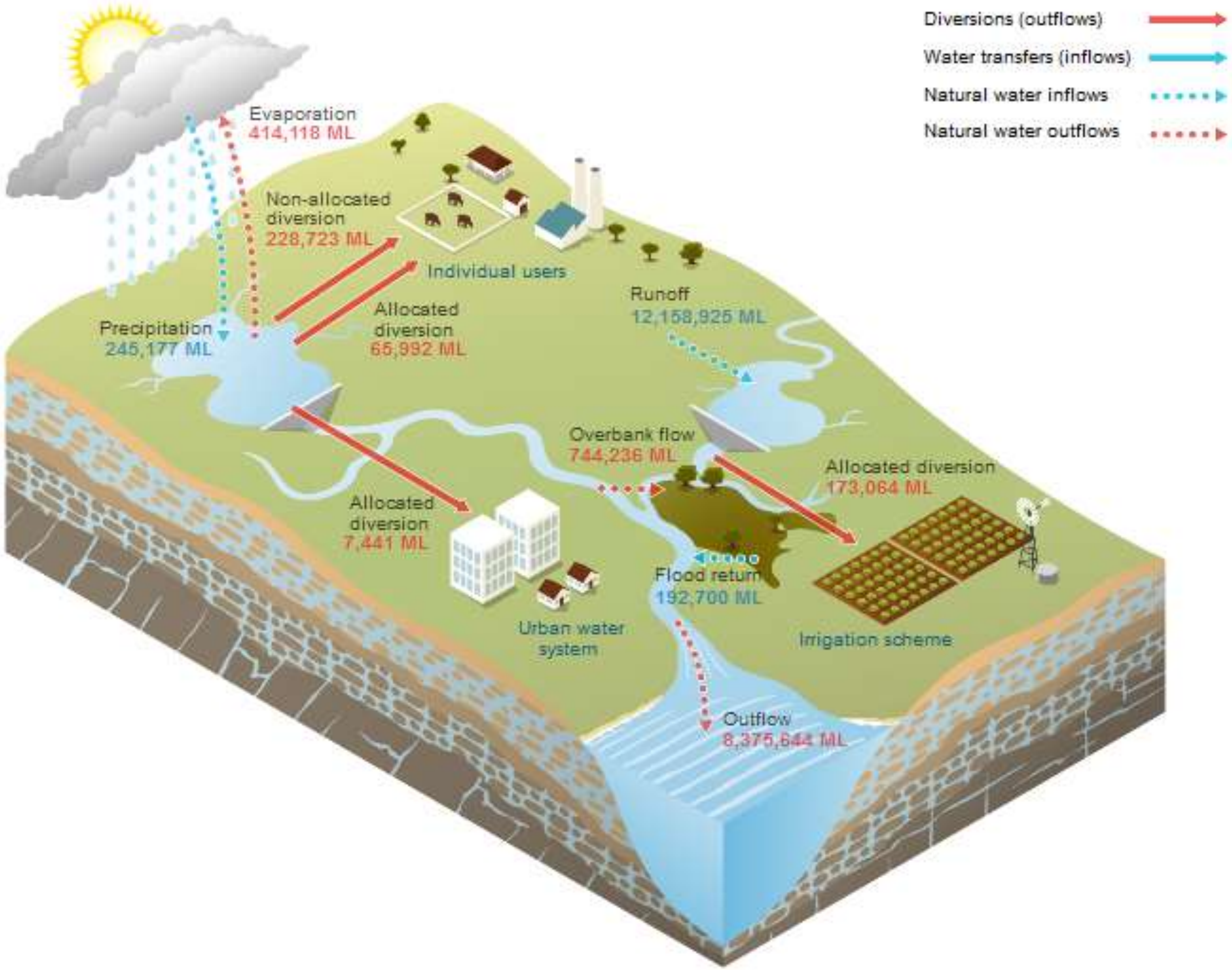


Figure S2 Water inflows and outflows for the Fitzroy region's surface water store during the 2016–17 year

Water Inflows/Outflows

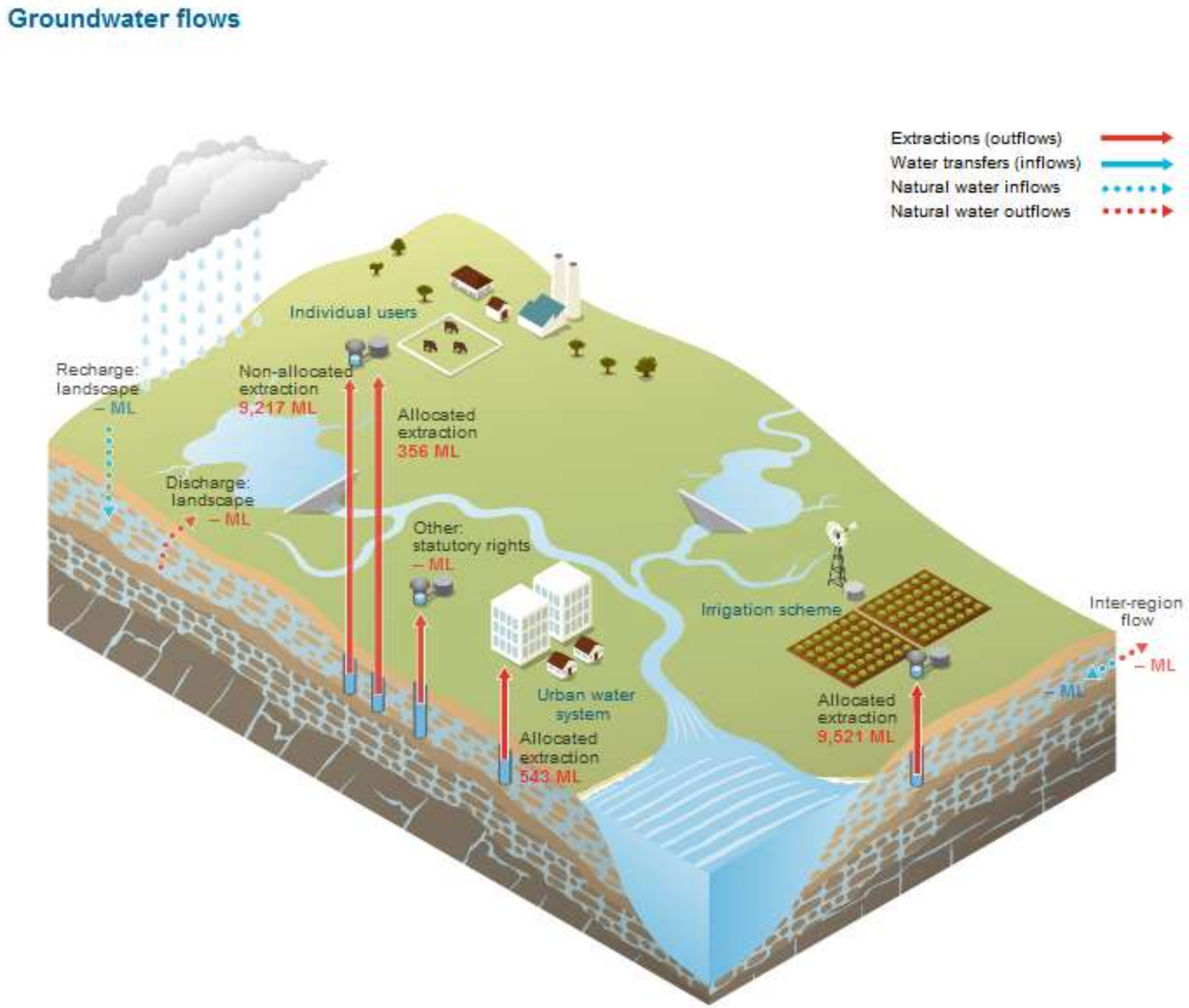
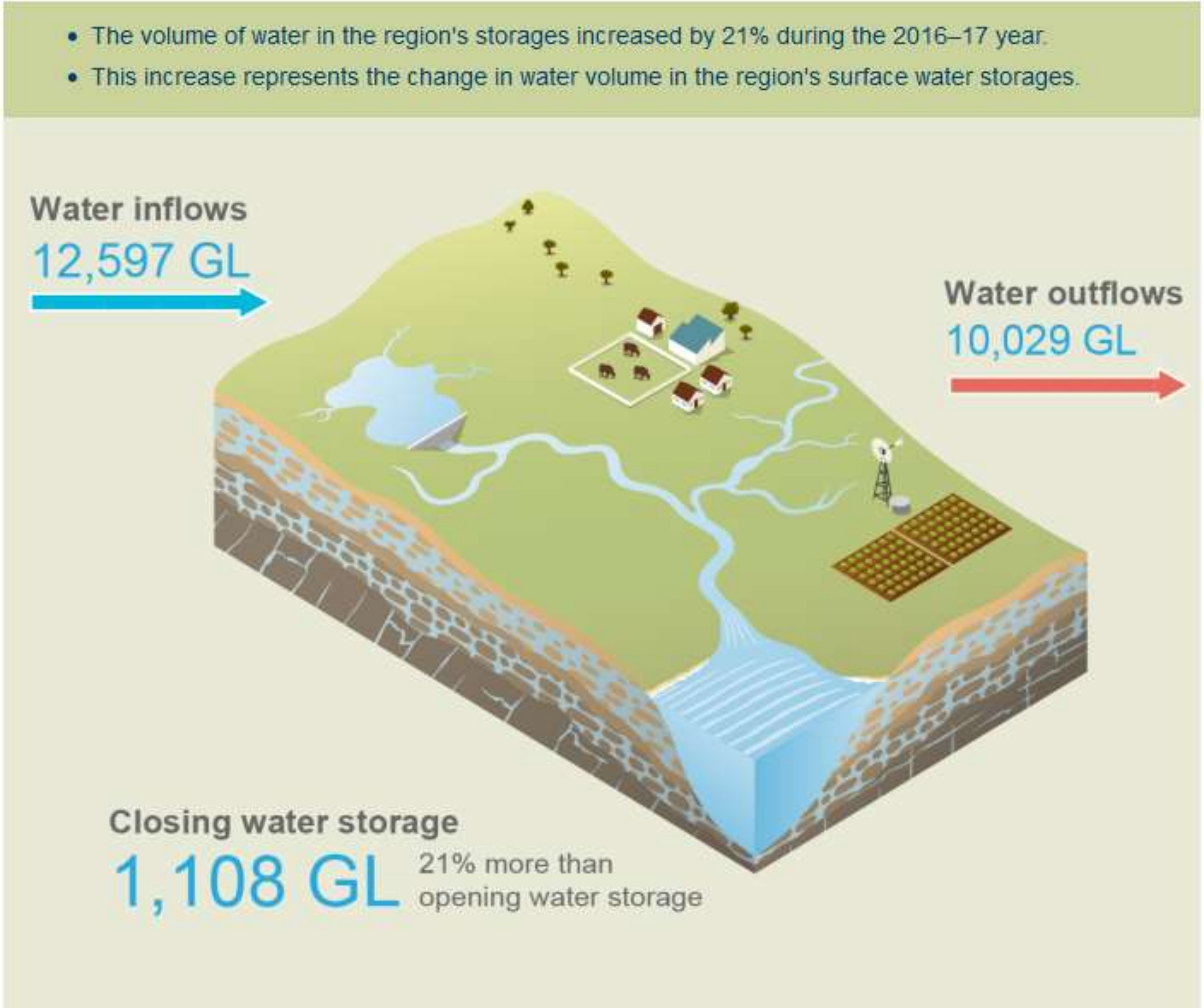


Figure S4 Water inflows and outflows for the Fitzroy region's groundwater store during the 2016–17 year

Water Inflows/Outflows



Water Inflows/Outflows

		2017 ML
Water inflows		
Surface water inflows		12,596,802
Groundwater inflows		–
Total water inflows		12,596,802
Water outflows		
Surface water outflows		10,009,218
Groundwater outflows		19,637
Total water outflows		10,028,855
Unaccounted-for difference		(2,378,779)
Opening water storage		918,575
Change in water storage		189,168
Closing water storage		1,107,743

Allocated Surface Water

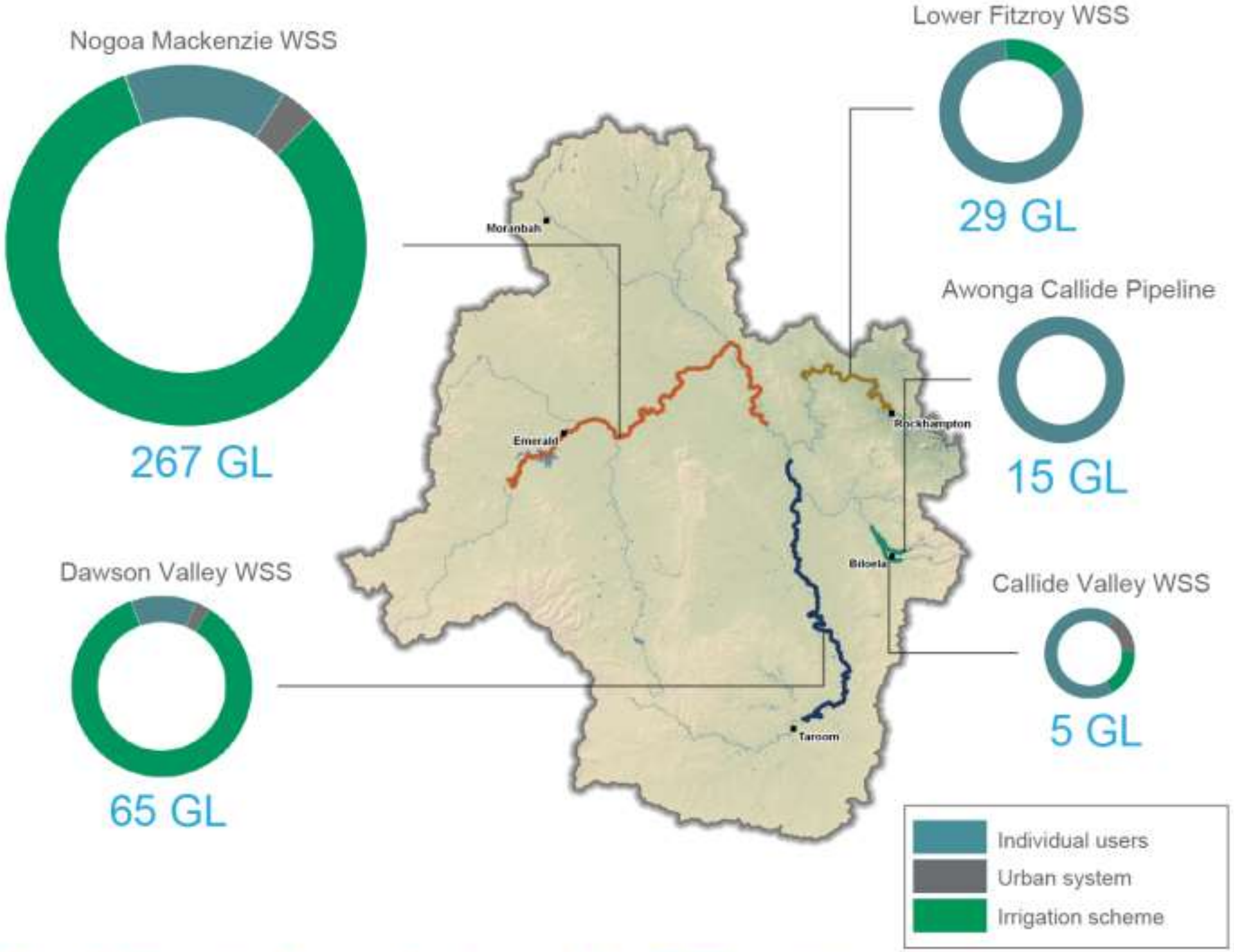
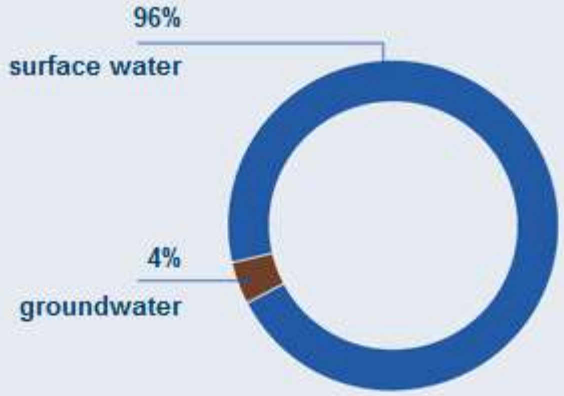


Figure S3 Allocated surface water diversions during the 2016–17 year in the region's key water management areas

Water Status

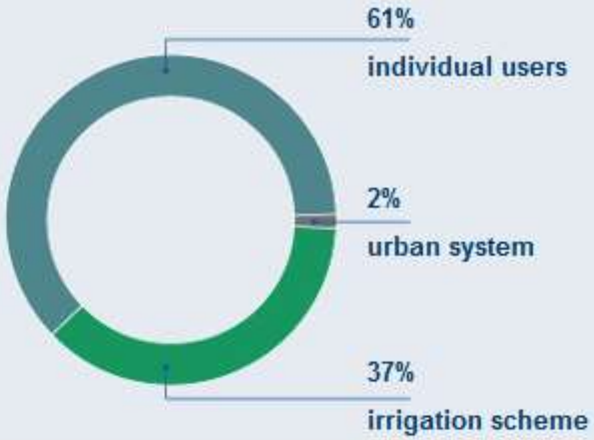
Water use

Water sourced



Water supplied

494,857 ML



Water status

Allocations

395 GL

total surface water and groundwater allocations

Water assets

1,108 GL

closing net water assets at 30 June 2017

Outlook

Decrease

in storage expected during the 2017–18 year

⬇

Climate Change Department

7 Day Streamflow Forecast

The 7-day streamflow forecasting service will provide streamflow forecasts with a lead time of up to seven days to assist river users with decision-making, This forecasting service has been developed to support solutions of the following water management problems:

- optimal irrigation and reservoir management.
- environmental flows.
- minimisation of transmission and evaporation losses which can be considerable under stressed conditions.

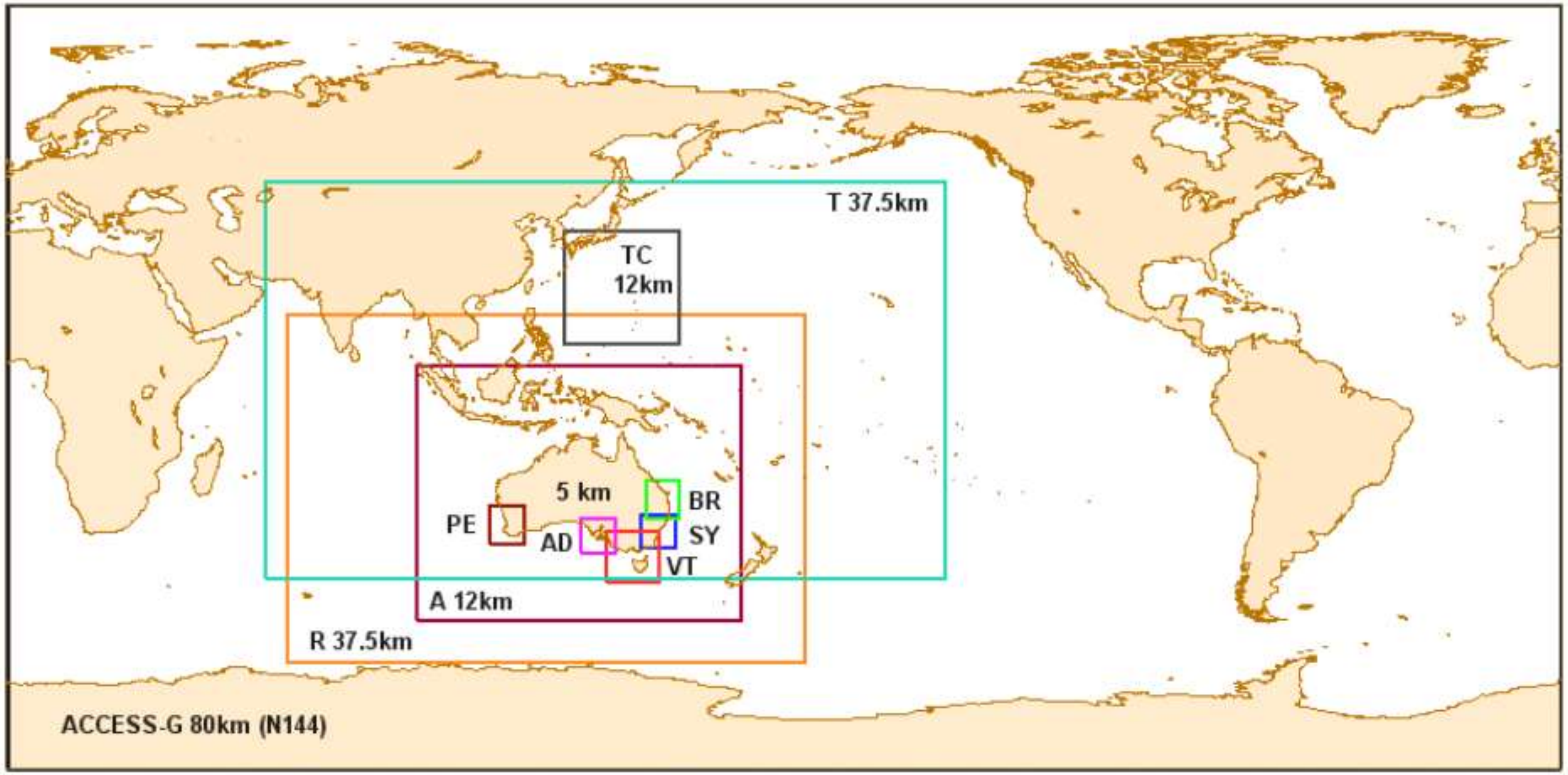
Benefits of the forecast

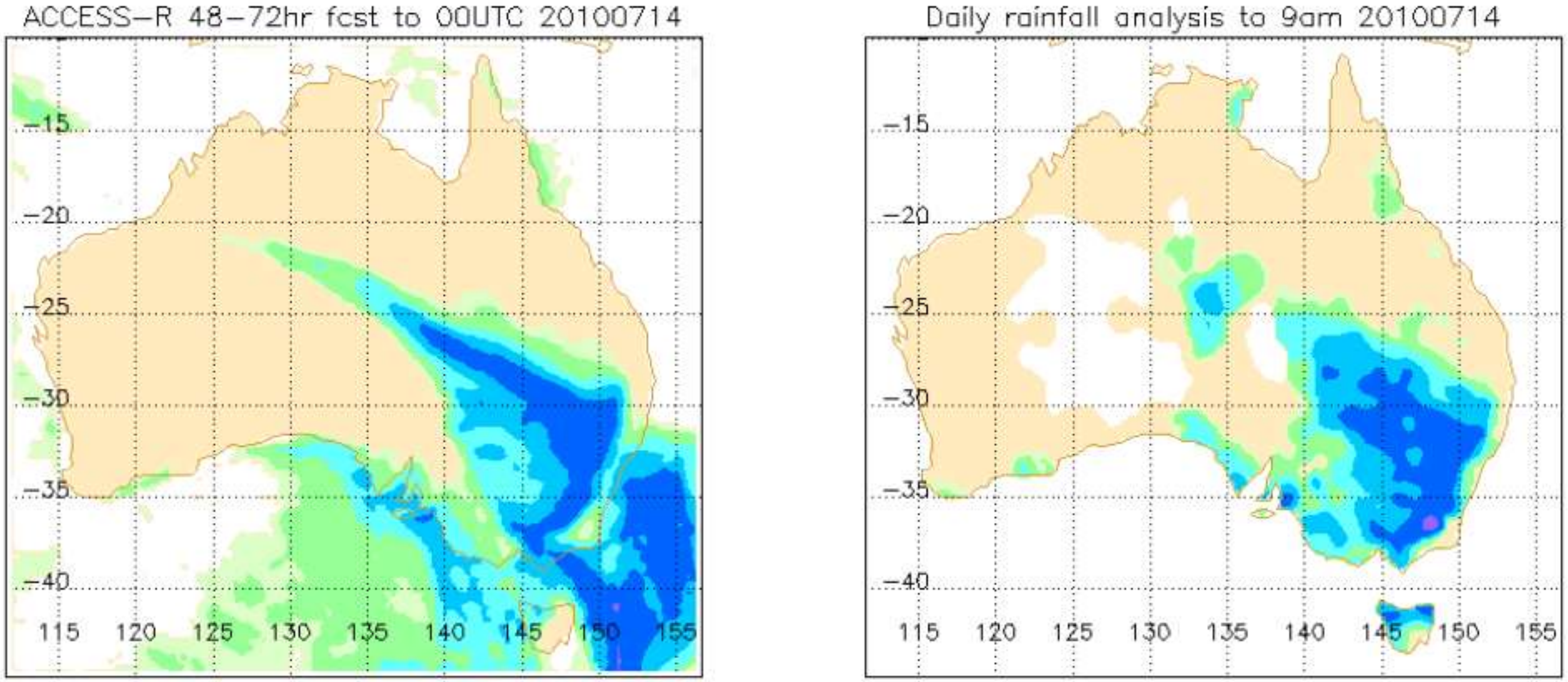
- Allow dam operators to make best use of natural flows in conjunction with managed releases to achieve environmental outcomes with less water;
- Avoid water wastage that occurs when irrigators refuse water deliveries because a rainfall event has occurred between ordering and delivery of the water;
- Support dam operators to manage dam releases in the lead up to flood and high flow events; and
- Support tourism by providing information that recreational users can access to identify when conditions are good for water skiing, canoeing and fishing etc.

Models and Resolution used in the forecast

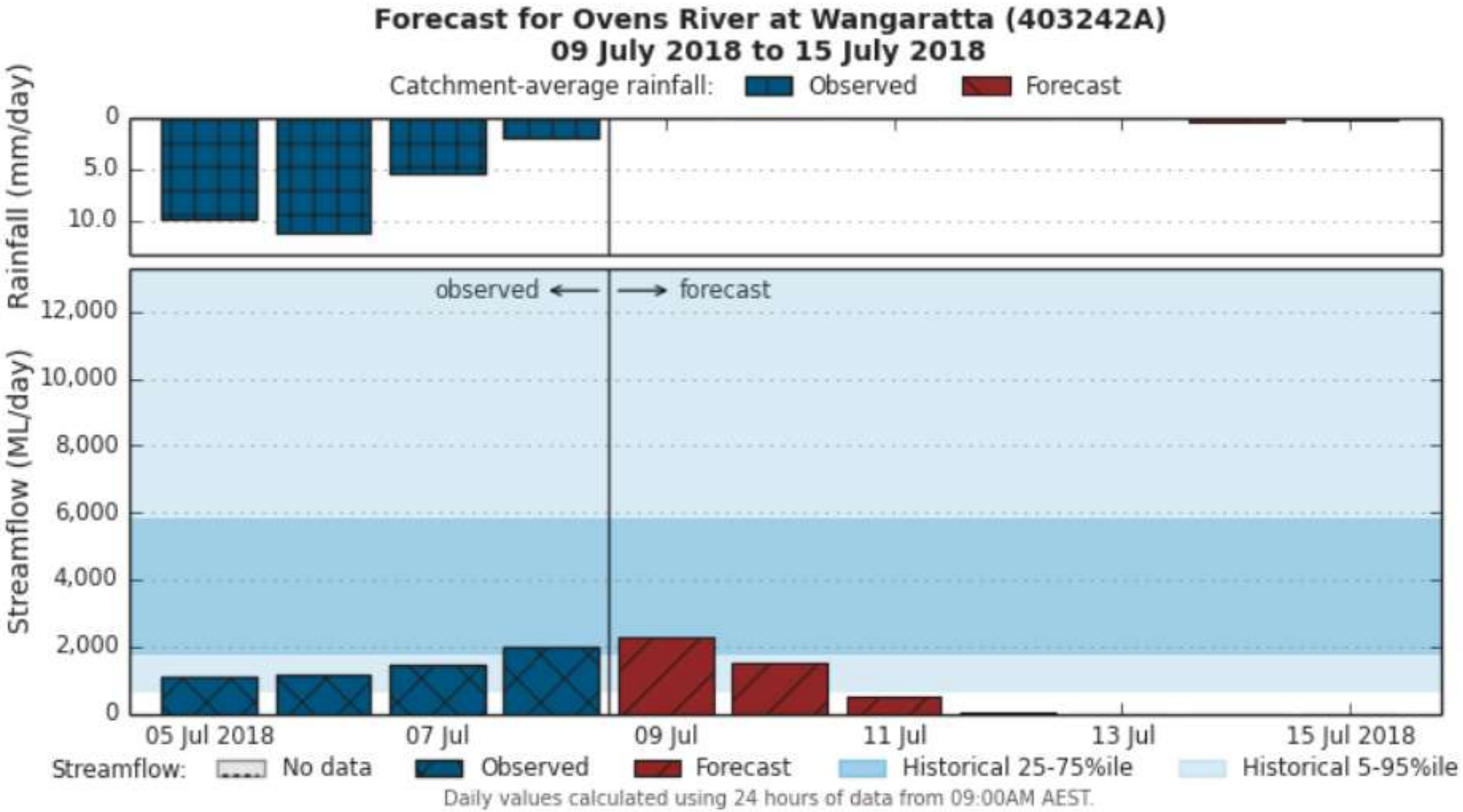
NWP system	Domain	Type	Resolution	Domain limits S-N,W-E (lat x lon)	Duration (hours)	Runs (UTC)
ACCESS-G	Global	Assim + Forc	N144 (~80km)	-90.00S to 90.00N, 0.00E to 358.75E (217x288)	+240	00, 12
ACCESS-R	Regional	Assim + Forc	0.375° (~37.5 km)	-65.00S to 17.125N, 65.00E to 184.625E (220x320)	+72	00, 12
ACCESS-T	Tropical	Assim + Forc	0.375° (~37.5 km)	-45.00S to 55.875N, 60.00E to 217.125E (270x420)	+72	00, 12
ACCESS-A	Australia	Assim + Forc	0.11° (~12 km)	-55.00S to 4.73N, 95.00E to 169.69E (544x680)	+48	00, 06, 12, 18
ACCESS-C	Brisbane	Forc	0.05° (~5 km)	-31.00S to -22.05S, 148.00E to 155.95E (180x160)	+36	00, 12
	Perth	Forc	0.05° (~5 km)	-37.00S to -28.05S, 112.00E to 119.95E (180x160)		
	Adelaide	Forc	0.05° (~5 km)	-39.50S to -30.55S, 132.00E to 141.95E (180x200)		
	VICTAS	Forc	0.05° (~5 km)	-46.00S to -34.05S, 139.00E to 150.95E (240x240)		
	Sydney	Forc	0.05° (~5 km)	-38.00S to -30.05S, 147.00E to 154.95E (160x160)		
ACCESS-TC	Tropical Cyclone	Assim + Forc	0.11° (~12 km)	Relocatable within the ACCESS-T domain: 30°x30°	+72	00, 12

Cont.Models and Resolution used in the forecast



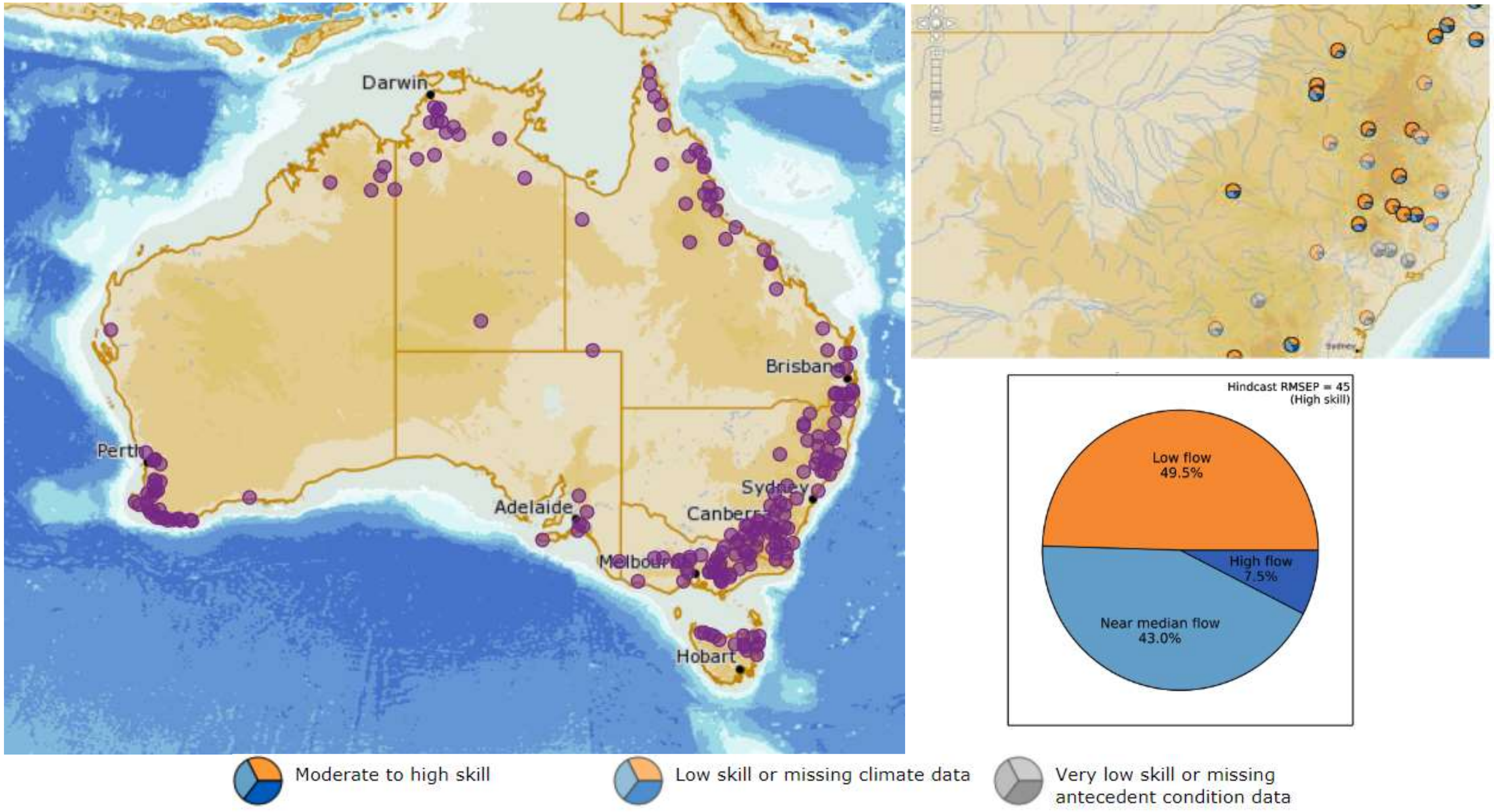


ACCESS-R 48-72 hour rainfall forecast with verifying analysis for 9am 14 July


Forecast for Ovens River at Wangaratta (403242A)
09 July 2018 to 15 July 2018
Catchment-average rainfall: Observed Forecast
Rainfall (mm/day)
0
5.0
10.0
observed
forecast
Streamflow (ML/day)
12,000
10,000
8,000
6,000
4,000
2,000
0
05 Jul 2018
07 Jul
09 Jul
11 Jul
13 Jul
15 Jul 2018
Streamflow: No data Observed Forecast Historical 25-75%ile Historical 5-95%ile
Daily values calculated using 24 hours of data from 09:00AM AEST.

Seasonal Streamflow Forecasts

- Australian streamflows are relied upon a range of water managers and users, including irrigators, urban and rural water supply authorities, environmental managers and hydroelectricity generators. Seasonal Streamflow Forecasts will help water managers and key water users improve their water management and decision making capability.
- Each month, the Bureau forecasts likely streamflow volumes for the next three months for more than 160 locations across Australia.
- This forecast applies a statistical approach, using the relationship between climate indicators, past catchment conditions, historical rainfall and streamflow at a location to forecast its total streamflow volume for the following three-month period. Forecasts are provided as the likelihood of high, near-median or low streamflows.



Streamflow forecast

Field trip for a distribution water facility “Goulburn – Murray Water”

Recommendations

- Professional planning
- Agreements for data sharing between different institution
- Provision of data
- Manual for Egyptian water account (during the project)

Many Thanks