

Basin Futures 2.0

A global, ML-based platform for basin-scale water security assessment and climate adaptation planning

Peter Taylor, Ashmita Sengupta, Carmel Pollino | CSIRO Environment
In collaboration with Google Research

Australian Water School webinar | 17th Sept, 2026

Supported by



● Water Security Assessment

● Climate Change Vulnerability

● Planning and adaptation

Basin Futures 1.0

A long-standing CSIRO investment, developed and maintained in-house over several years.

A comprehensive global platform for basin-scale water resource assessment to support sustainable water management.

- Preloaded datasets and cloud computing minimise resource requirements
- Basinpedia- understanding your basin
- Integrated hydrological modelling and scenario analysis
- Decision support tool for stakeholder engagement

Application

Regional planning

Supporting water resource planners in developing long-term strategies for basin management and allocation

Policy Development

Informing evidence-based policy decisions for sustainable water use and environmental protection

Stakeholder Consultation

Facilitating transparent communication between agencies, communities, and water users

What to expect today

1 What is new in 2.0

- Machine learning runoff model (EA-LSTM) with transfer learning for data-sparse basins
- Benchmarked global datasets (CARAVAN)
- Climate change vulnerability assessment and adaptation planning
- Interactive dashboard with AI-generated summaries

2 Where you can apply it

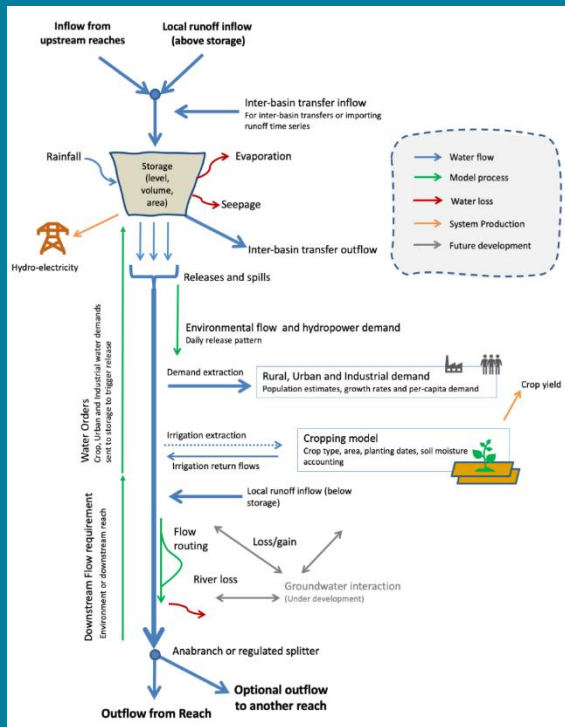
- Any basin, anywhere: global preloaded data, no local modelling setup
- Regional water planning, scenario testing, policy development and stakeholder consultation,
- Applications: Rufiji Basin (Tanzania), Upper Bhima (India), Ramsar wetlands (Australia), IHE Delft (education)

3 How to access it

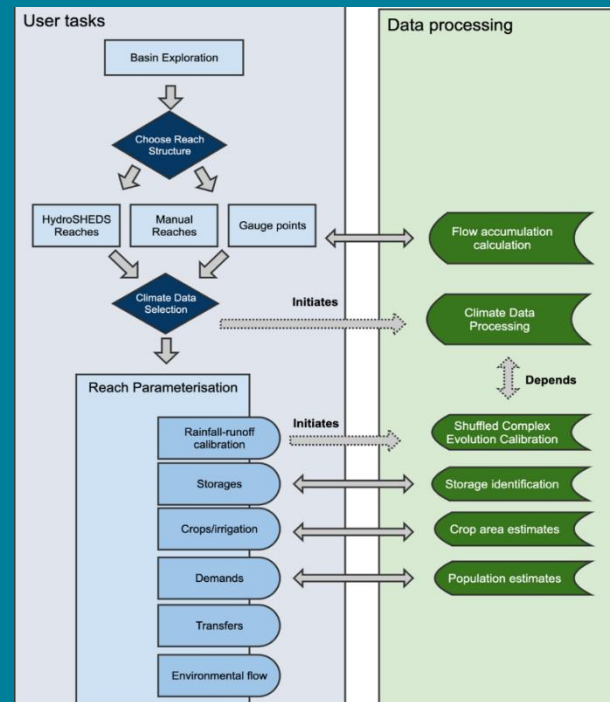
- Browser-based platform, cloud compute, no software to install
- Build a basin, run scenarios and export results in a single session
- See contact details to request access.

Demo: walk through model creation and result analysis

Schematic



User Workflow



● Water Security Assessment

● Climate Change Vulnerability

● Planning and adaptation

Rainfall-runoff modelling: two options

Option 1: GR4J

Traditional conceptual model

What it is

- Lumped, four-parameter rainfall-runoff model (Perrin et al. 2003)
- Inputs: rainfall and potential evapotranspiration
- Parameters calibrated per catchment against observed flow

Strengths

- Well understood, widely used in Australian water planning
- Fast, transparent, easy to explain to stakeholders
- Adapted to handle snow/glacier melt

Limitations

- Needs a gauged record to calibrate
- Parameters do not transfer well to ungauged or data-sparse basins

Option 2: EA-LSTM

Machine learning rainfall-runoff model

What it is

- Entity-Aware LSTM (Kratzert et al. 2019), the architecture behind Google Flood Hub
- Inputs: rainfall forcing plus static catchment attributes
- Trained across 671 catchments (CAMELS AU, BR, CL, NZ, US and GRDC)

Strengths

- Learns regional behaviour, so it runs in ungauged basins
- Transfer learning for data-sparse regions

Limitations

- Needs large training datasets and cloud compute
- Less interpretable than a conceptual model

Either option can be selected per basin. Both use the same climate forcing and feed the same river network routing and sectoral demand model.

River routing, storages and demands

River network routing

- Reaches built from HydroSHEDS or drawn manually, with gauge points for calibration
- Runoff from each sub-catchment enters its reach and is routed downstream
- Inter-basin transfers in and out
- River losses and downstream flow requirements at each reach
- Outflow from reach passes to the next reach or an optional outlet

Storages

- Dams and reservoirs placed on any reach
- Dead and maximum volume, evaporation and seepage
- Releases driven by downstream demand, environmental flow and hydropower
- Spills when capacity is exceeded
- Storage change tracked every time step

Demands

- Rural, urban and industrial demand from population and per-capita use
- Irrigation demand from a cropping model: crop areas, planting dates and cropping intensity
- Environmental flow and hydropower release patterns

Scenarios

Climate futures

What changes under a drier, hotter climate?

CMIP6 ensembles, four emission pathways
Near, mid and late century windows
Climate storylines for selection of models

Storages and hydropower

Does this dam make sense?

Capacity options, on-farm storages
Reliability and generation reported

Crops and irrigation

What if we grow something else?

Crop mix, double cropping, efficiency
Irrigated area from a new storage

Towns and industry

Can supply keep up with growth?

Population growth, urban and rural
Industrial users, demand vs supply

Environmental flows

What does the river need downstream?

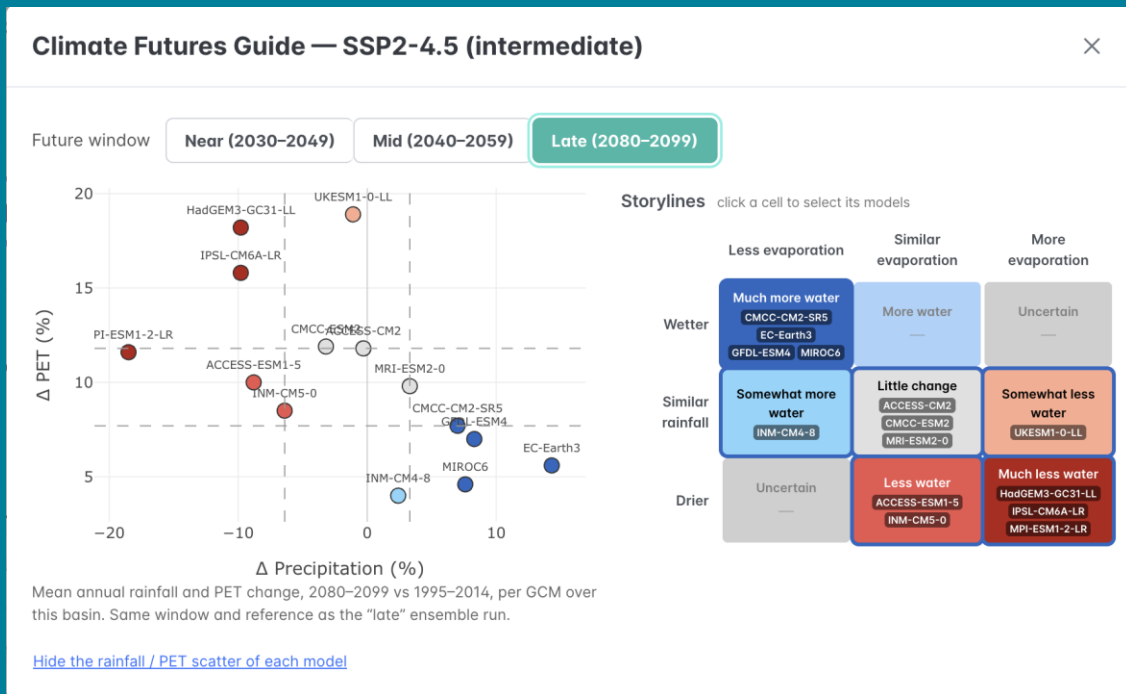
Flow targets by reach
Hydrological alteration indices

Data and calibration

How much do the inputs matter?

Swap climate products, recalibrate
Compare skill against the gauges

Future climate scenario – storyline based selection



Application: agriculture, Rufiji basin, Tanzania

Objective

Develop a proof-of-concept, low-cost decision-making system for water security in the Rufiji River basin that links smallholder irrigation practice to basin-wide water allocation decisions

How Basin Futures is used

- Runoff and river flows for a data-sparse basin
- Smallholder irrigation demand from the cropping model: crop areas, planting dates, cropping intensity
- Scenarios of irrigation expansion tested against downstream allocation and environmental flow requirements



ACIAR funded. Collaboration with ANU and Digital Earth Australia.

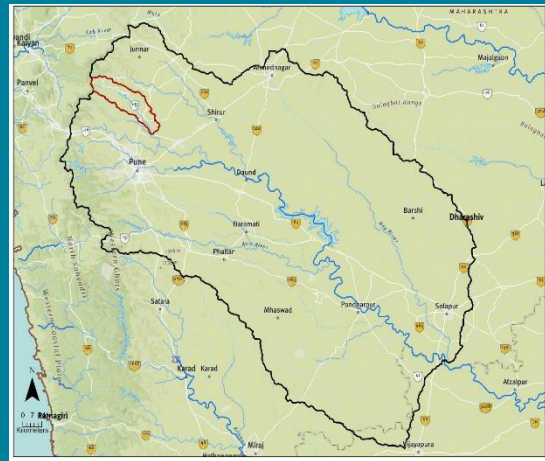
Application: environment, Upper Bhima basin, India

Objective

Assess hydrological conditions of a data-sparse intermittent river catchment under current and future climate, and use them to guide systematic conservation planning with The Nature Conservancy

How Basin Futures is used

- Flow regimes for an intermittent, data-sparse catchment under current and CMIP6 climate scenarios
- Hydroclimatic metrics aligned with ecological and socio-economic values: flow seasonality, dry-spell duration, timing and magnitude of flow events
- These metrics become predictors in a species conservation model, linking modelled flow to freshwater habitat suitability
- Priority conservation areas and actions identified with community consultation



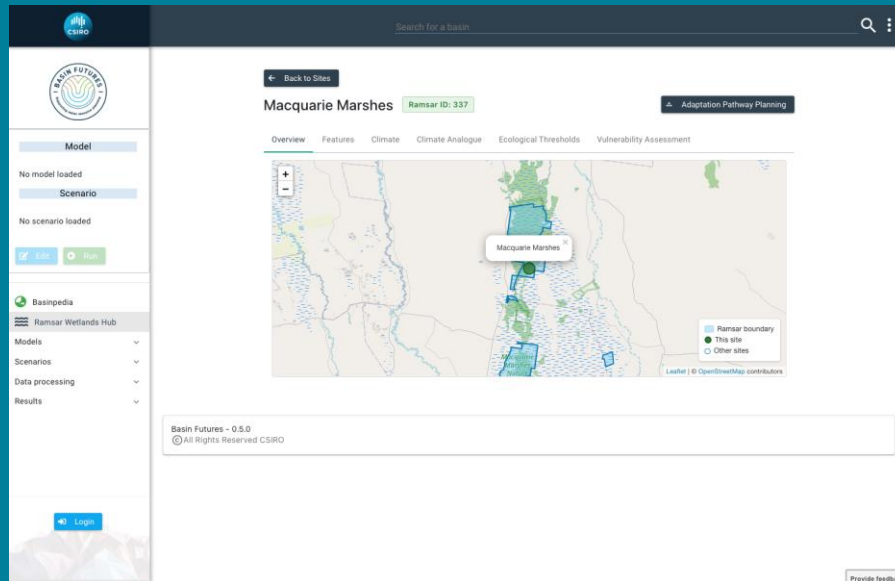
Application: climate adaptation for Ramsar wetlands

Objective

Deliver actionable, prioritised climate adaptation guidance for Australian Ramsar wetlands, with DCCEW through the Ramsar Hub

How Basin Futures is used

- Site-scale water availability under CMIP6 climate storylines
- Climate vulnerability and impact assessment against ecological character and limits of acceptable change
- Adaptation pathways with decision triggers, following the CSIRO CCVAAP methodology
- Results delivered to site managers through the dashboard



Demo

OFFICIAL

 **Basin Futures**

 **MODEL**
Not loaded

 **SCENARIO**
Not loaded

 Edit

 Run

 **BASINPEDIA**

 **CASE STUDIES**

 **GUIDES**

 **MY REPORTS**

MODELS

 New model

 Open

SCENARIOS

DATA PROCESSING

RESULTS

 **ADMINISTRATION**

 **WATER RESOURCES ASSESSMENT**

A rapid, web-based tool for assessing water resources

Model development scenarios, explore trade-offs and generate reports – all from pre-loaded global data with no setup required.

 Sign Up Now

 Explore Basinpedia

WHAT IT DOES

Everything you need for basin-scale analysis



Development Scenarios

Define and compare scenarios to explore development options within basins and understand associated hydrological impacts.



Integrated Global Data

Pre-loaded datasets – climate, land cover, species, hydrology – provide quick model setup with no data formatting required.



Rapid Decision Support

Lower the initial time for data and model setup to enable agile assessment of development options and trade-offs.



Interactive Reporting

Visual spatial and graphical views of scenario results – reach hydrology, water balance, heatmaps and more.



Basinpedia Explorer

Browse global basins – climate, river flows, land cover, protected areas, species diversity and stress indicators.



Collaboration

Share models and scenarios with team members. Run multiple scenarios in seconds to accelerate your analysis.

OFFICIAL

The CSIRO logo, featuring a stylized white bar chart with five vertical bars of increasing height from left to right, above the word "CSIRO" in white capital letters, all enclosed within a blue circular background.

How much water is there, and what happens to it if things change?

- How much water does the basin produce, and where does it go: rain, evaporation, river flow, use?
- How reliable is supply in the dry years?
- What changes under a drier, hotter climate?
- What if we build a storage, expand irrigation, or set an environmental flow?
- Who is affected downstream?

Scenarios

Climate futures

What changes under a drier, hotter climate?

CMIP6 ensembles, four emission pathways
Near, mid and late century windows

Storages and hydropower

Does this dam make sense?

Capacity options, on-farm storages
Reliability and generation reported

Crops and irrigation

What if we grow something else?

Crop mix, double cropping, efficiency
Irrigated area from a new storage

Towns and industry

Can supply keep up with growth?

Population growth, urban and rural
Industrial users, demand vs supply

Environmental flows

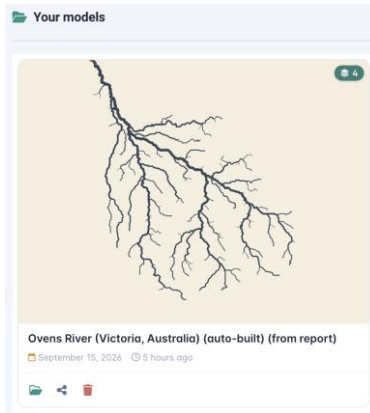
What does the river need downstream?

Flow targets by reach
Hydrological alteration indices

Data and calibration

How much do the inputs matter?

Swap climate products, recalibrate
Compare skill against the gauges



Demo

1

Choose basin

Explore basin data
Understand context
Set the questions

2

Delineate

River network, reaches
Split at gauge sites
Attach gauge records

3

Configure

Dams and reservoirs
Crops and irrigation
Demands and routing

4

Add climate

Rainfall and PET, daily
40 years observed
CMIP6 change factors

5

Validate

Runoff vs gauges
Storages vs dam records
ET plausibility check

6

Analyse

Water balance by reach
Calibration report
Scenarios side by side



Agent assist

Optional. Sets up steps 2 to 4 from a plain description and starts the calibration. Every choice is listed on screen and can be changed by hand.

70+ datasets integrated into the modelling workflow

Climate

12 products

MSWEP, ERA5-Land, CHIRPS, SILO
Daily, 1981 to 2025, any basin
CMIP6 NEX-GDDP: 4 pathways, 15 GCMs

Rivers and basins

Global, 15 arc-second

HydroSHEDS, HydroBASINS, HydroRIVERS
HydroATLAS catchment attributes
Lakes, glaciers, aquifers, protected areas

Gauges

55,000 stations

CAMELS, Caravan, GRDC, HYSETS
GSIM and ADHI monthly indices
BoM, Hydrologic Reference Stations

Dams and storage

41,000 dams

Global Dam Watch, GRanD
GloLakes, DAHITI, ResOpsUS storage records
GRACE total water storage

Land and people

17 datasets

Population: GPW, UN and SSP projections
Land cover, irrigated and paddy areas
MIRCA crop calendars, FAO-56 crops

Evaporation

2 satellite products

TerraClimate, GLEAM actual ET
Bounds the calibration water balance

Ecology and risk

3 registries

IUCN freshwater species, GBIF
WDPA protected areas
WRI Aqueduct water stress

Processed on demand

Delineation, zonal climate, gauge matching, calibration and ensembles run on demand
Every result carries its data sources and licenses

Acknowledgments and Contacts

Amit Parashar



Ashmita Sengupta

Principal Research Scientist
Future Water, Environment, CSIRO
ashmita.sengupta@csiro.au
0451602069

Peter Taylor

Principal Research Engineer
Future Water, Environment | CSIRO
peter.taylor@csiro.au | 0400 341 650