



www.csiro.au

# A water resource monitoring and early warning system for Australia (and beyond?)

Albert van Dijk, Luigi Renzullo, Edward King, Juan Pablo Guerschman, Steve Marvanek, Garth Warren, Randall Donohue, Jamie Vleeshouwer and many others in CSIRO

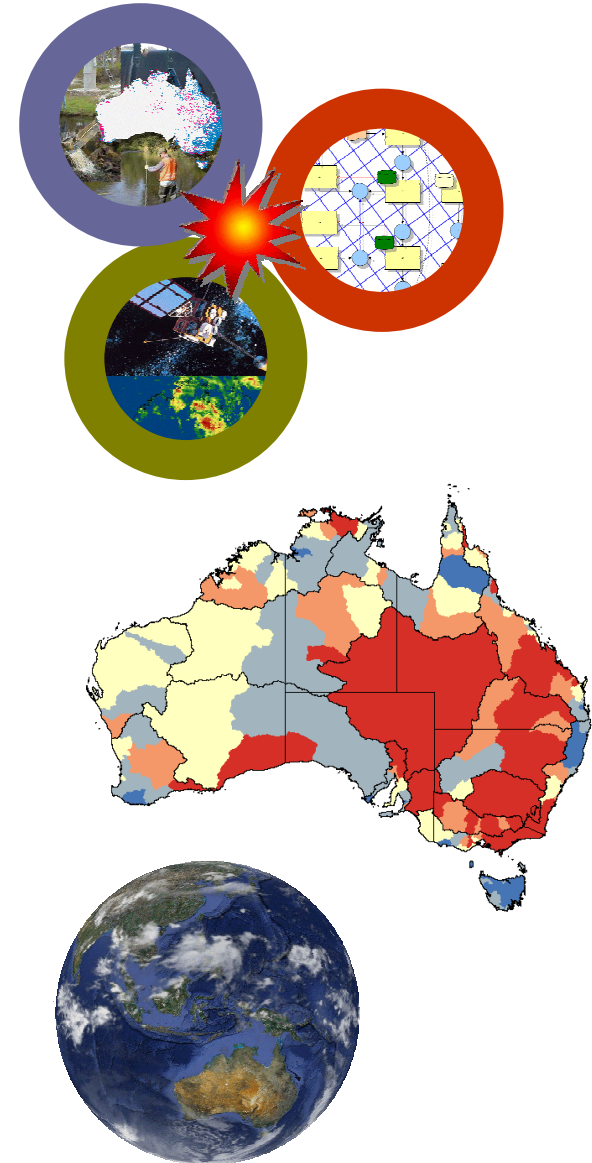
Fifth GEF Biennial International Waters Conference  
Global Changes and Water Resources Workshop, 24 October 2009

National Research  
**FLAGSHIPS**

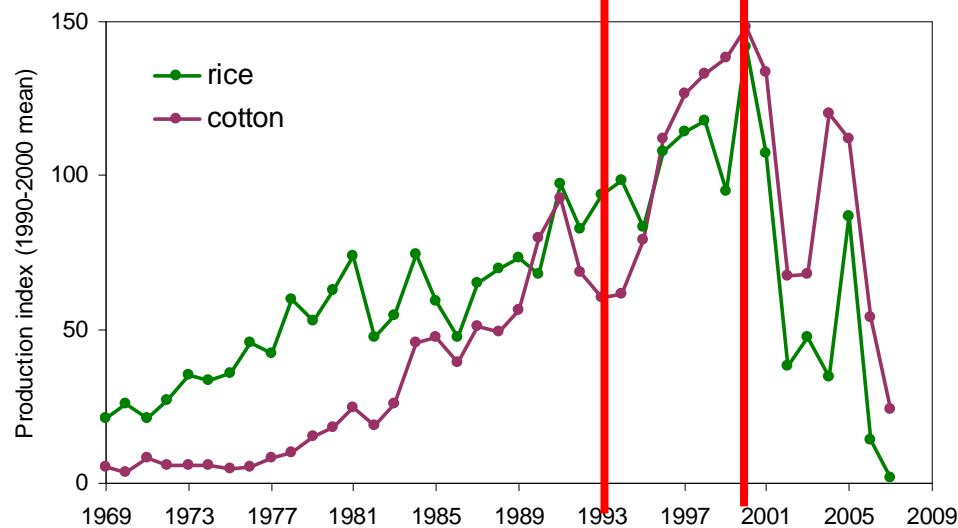
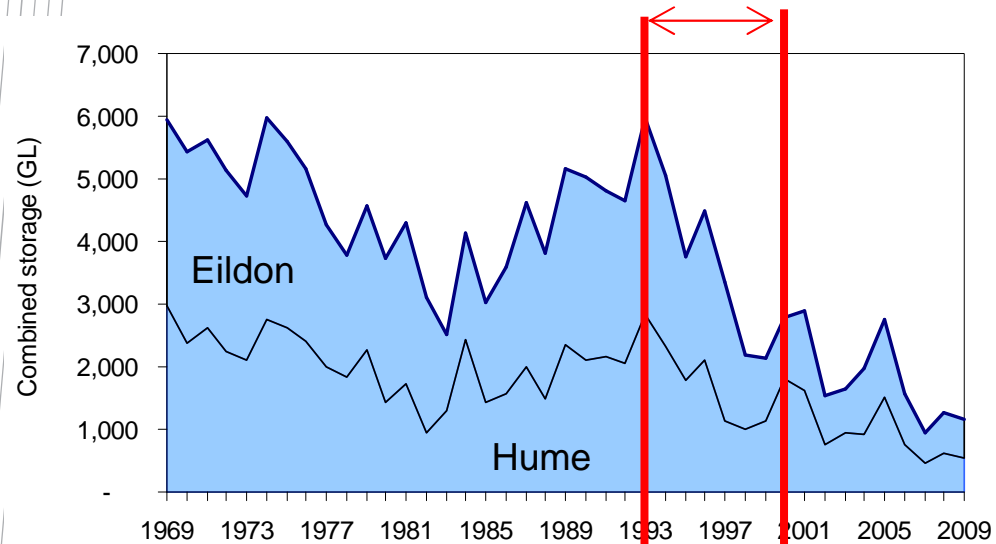


# Key points

- More comprehensive and up to date water information will benefit water management.
- A water observation system has been developed for Australia.
- The system follows a model-data fusion approach; combining on-ground and satellite observations with models.
- Results can be used for water accounting, understanding change, reporting present state and forecasting.
- CSIRO is looking for collaborators to jointly develop similar systems in other countries.



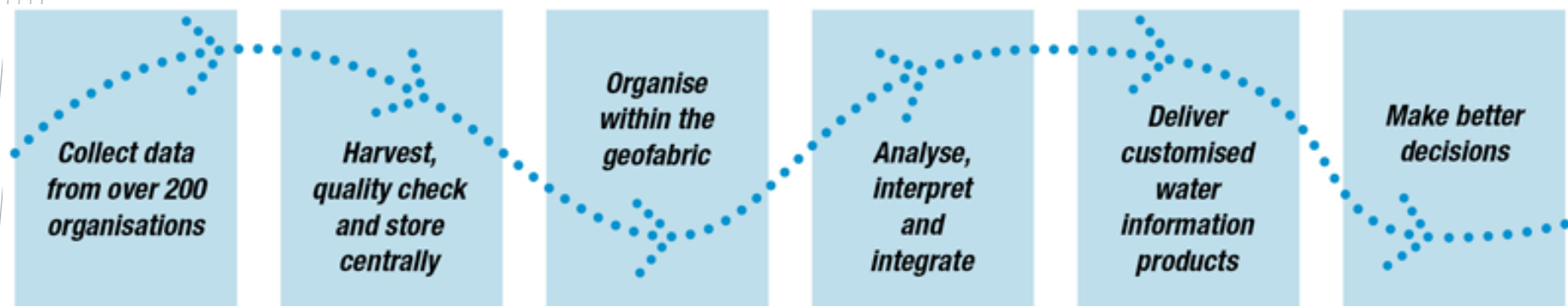
# Murray Basin: beyond reasonable drought?



sources: Goulburn-Murray Water, MDBIC, Indexmundi, 'Beyond Reasonable Drought' exhibition

# Developing water information services

- A water information agency was established within the Bureau of Meteorology to “*enhance the quality and utility of water information*”
- Through the 5-y water information R&D alliance (WIRADA), CSIRO and the Bureau collaborate to develop water information infrastructure and services.
- Includes development of a water balance observation system to support water resources assessments and the National Water Account.



Australian Government  
Bureau of Meteorology



Water Information  
DATA > INFORMATION > INSIGHT

# A national water observation system



## Sample questions

- How much water has been generated?
- How much is used by whom, for what?
- How much have we got left?
- Does a trend or shift emerge?
- What can we expect from here on?
- What is the observed impact of extraction/land use/farm dams/bushfires on water security and environment?

## System specifications

- Continental coverage
- Local accuracy and relevance
- Considering all relevant observations to maximise confidence and acceptance
- Up to date and insightful information
- Robust and benchmarked methods that can evolve

# Model-data fusion – the best of three worlds

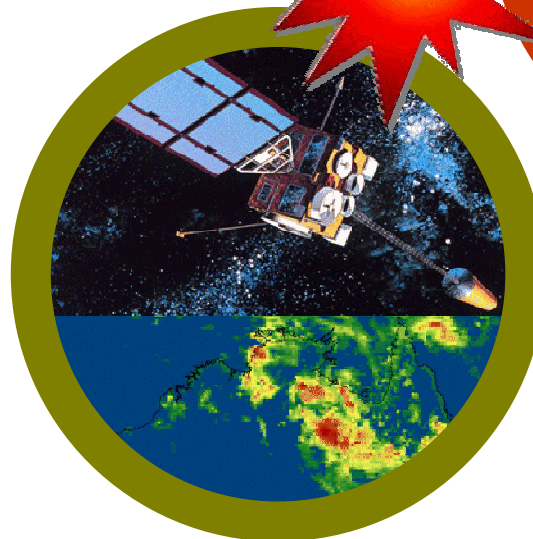
## On-ground observations

- **relatively direct**
- sparse and/or infrequent
- not predictive



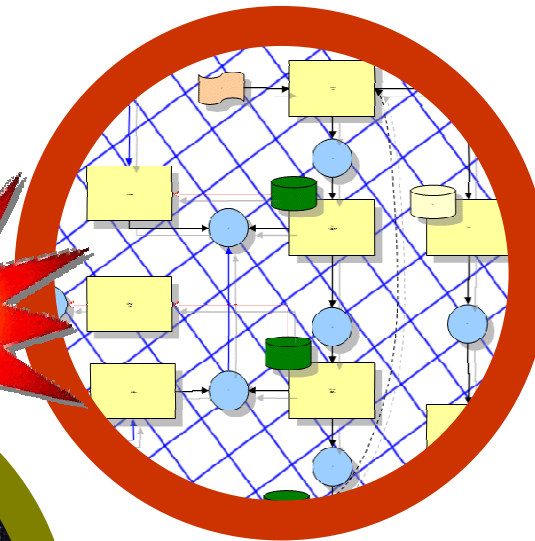
## Satellite observations

- **full and frequent coverage**
- relatively indirect
- not predictive

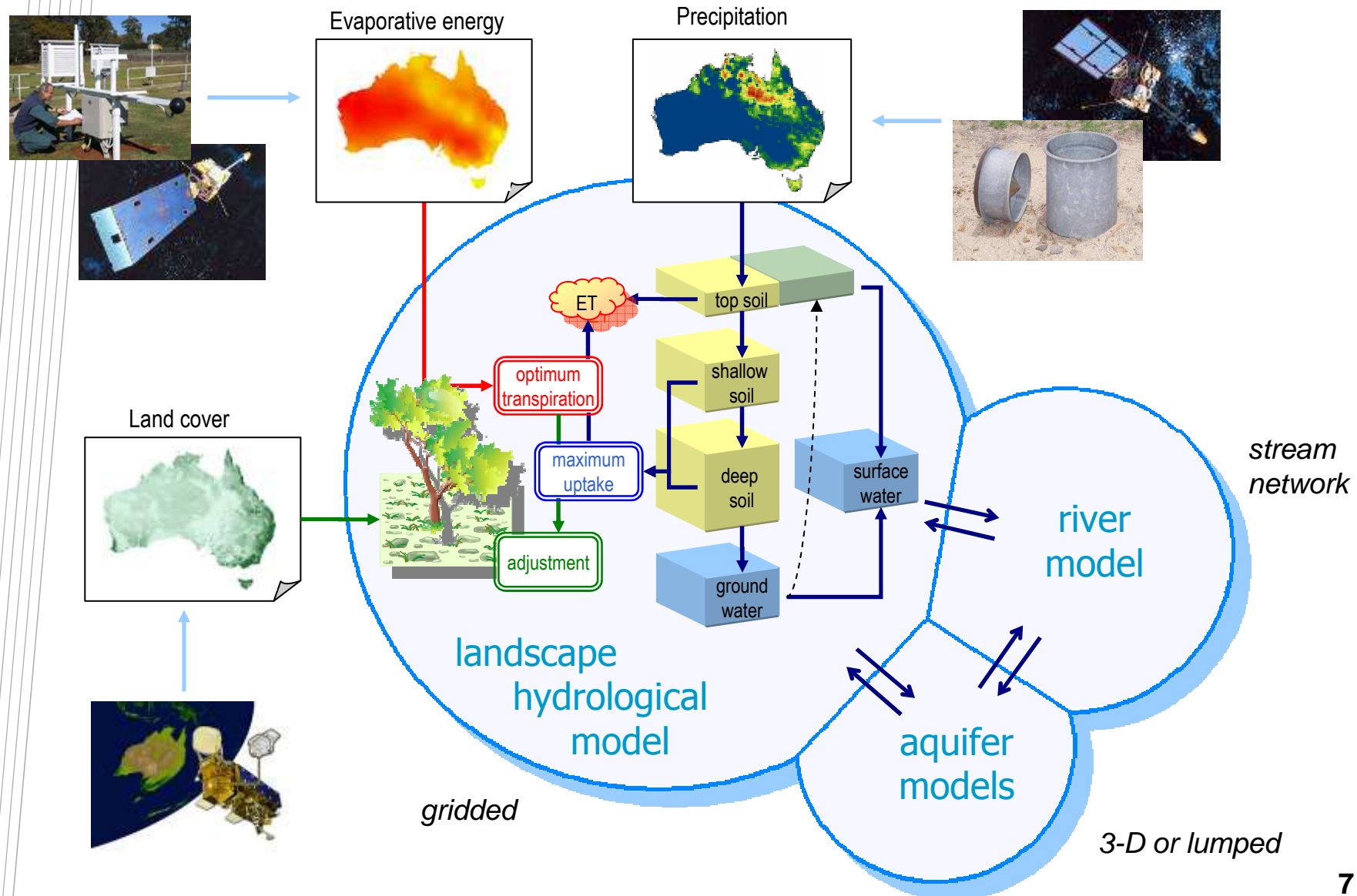


## Biophysical models

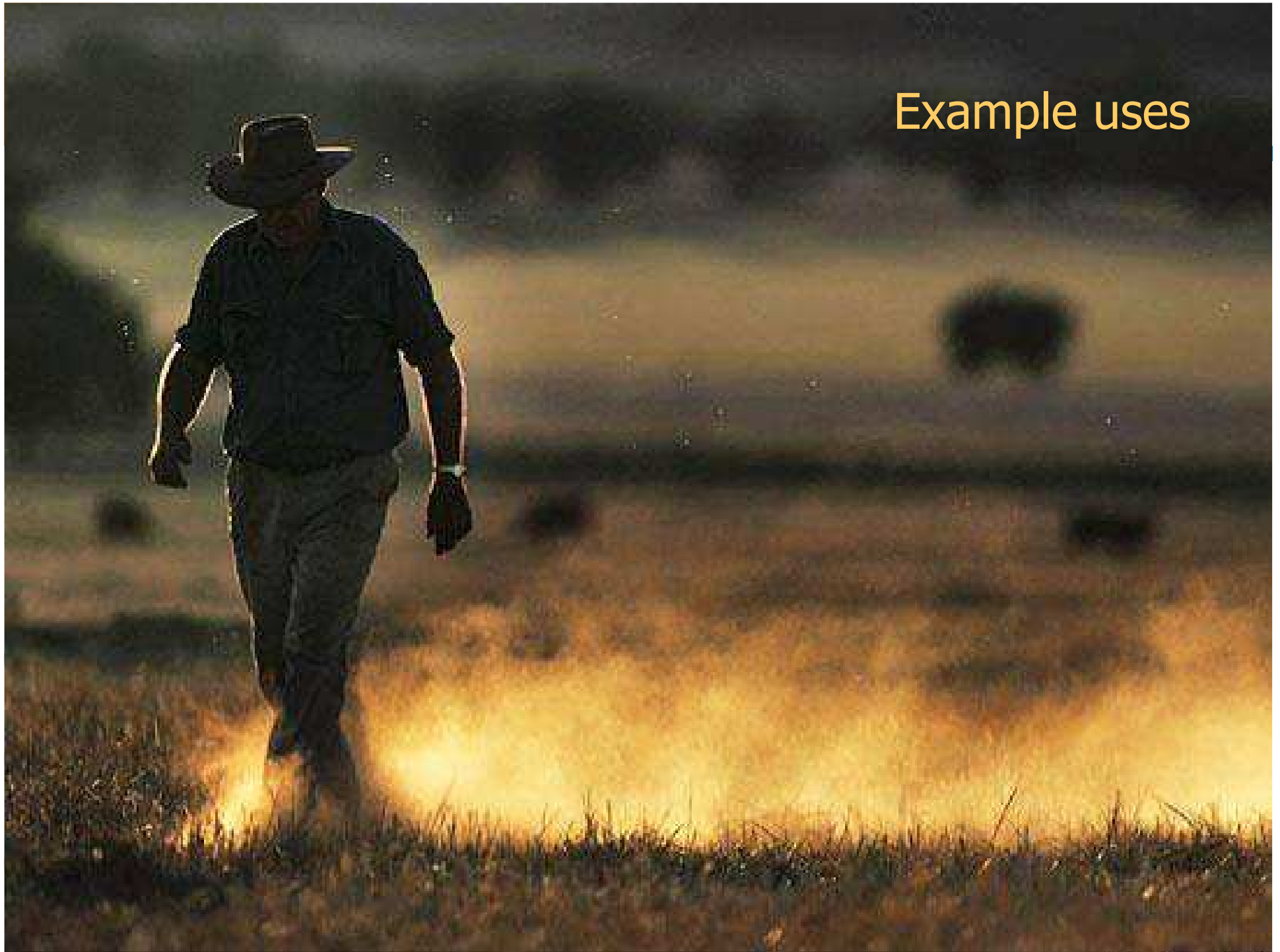
- **predictive**
- **directly interpretable**
- **full and continuous coverage**
- unhindered by reality



# Australian water resources assessment system (AWRA)

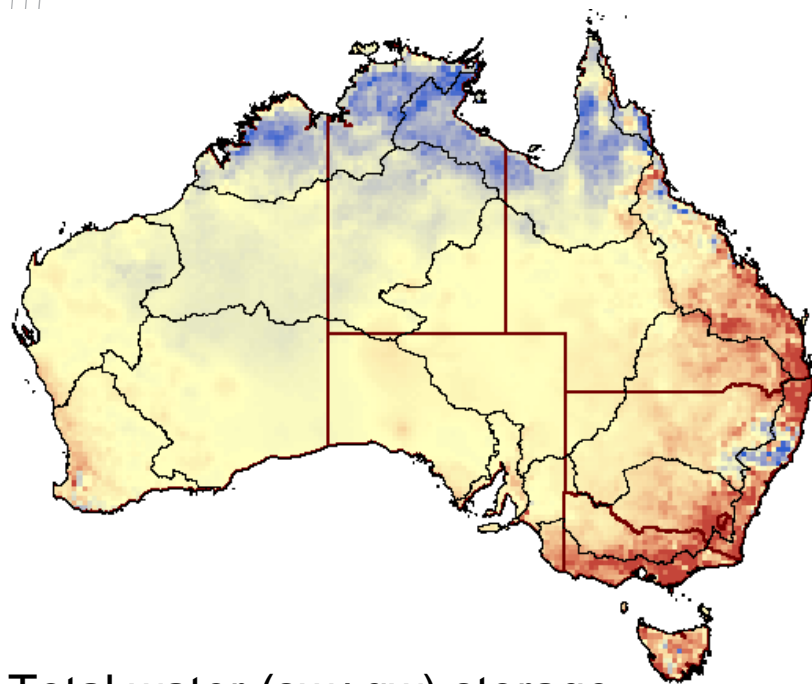


Example uses

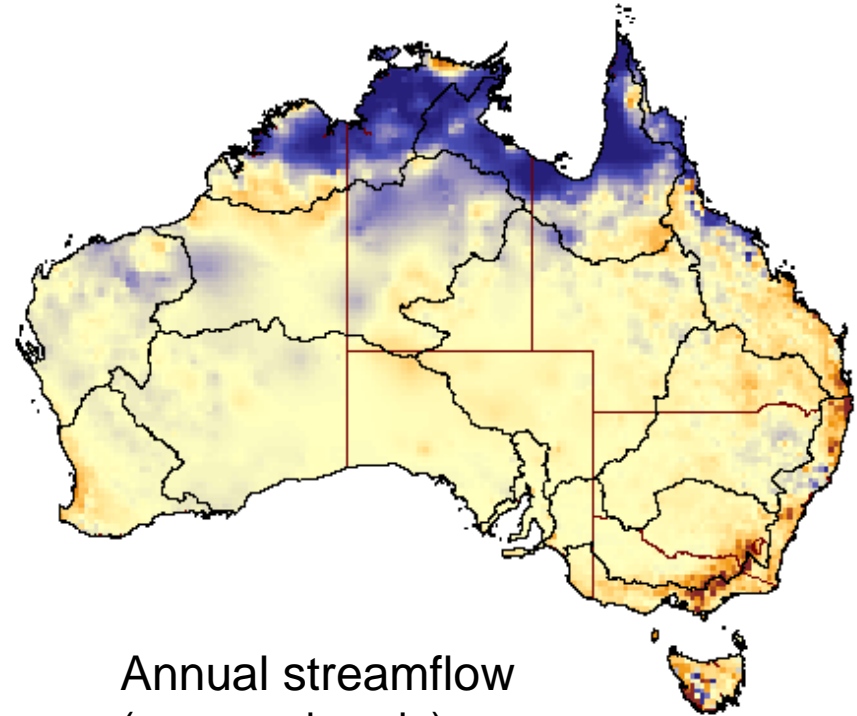
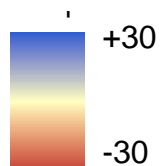


# Interpreting the past

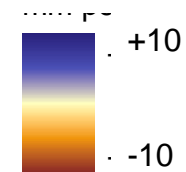
## Estimated trends in water resources (1980-2008)



Total water (sw+gw) storage  
(mm per decade)



Annual streamflow  
(mm per decade)

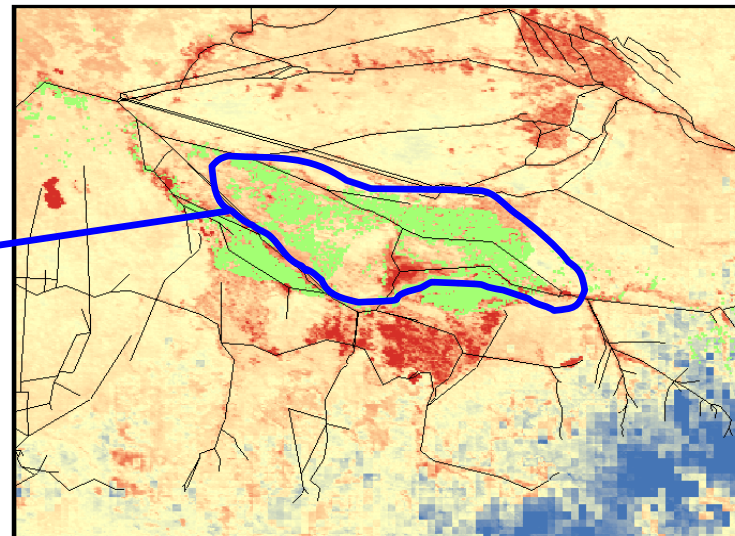
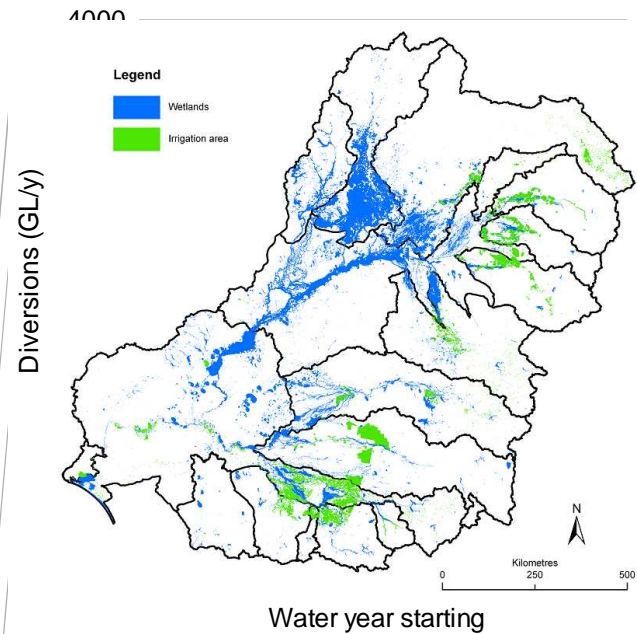
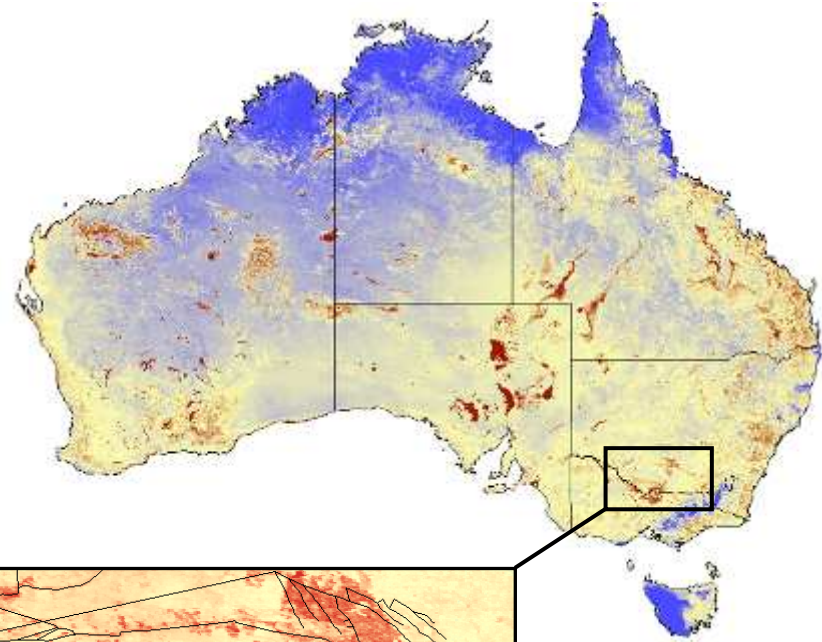


# Understanding water resource systems

*Net water balance 2000-2006 (rainfall minus water use)*



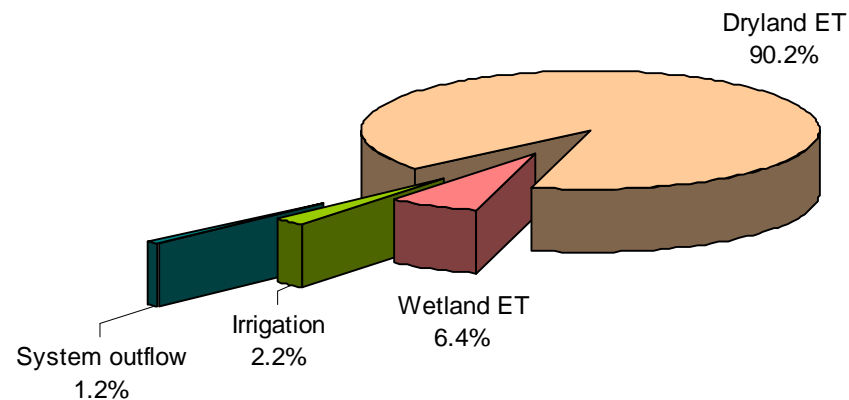
Identifying areas of water resource generation and use, and estimating regional irrigation water use.



# Water resource accounting

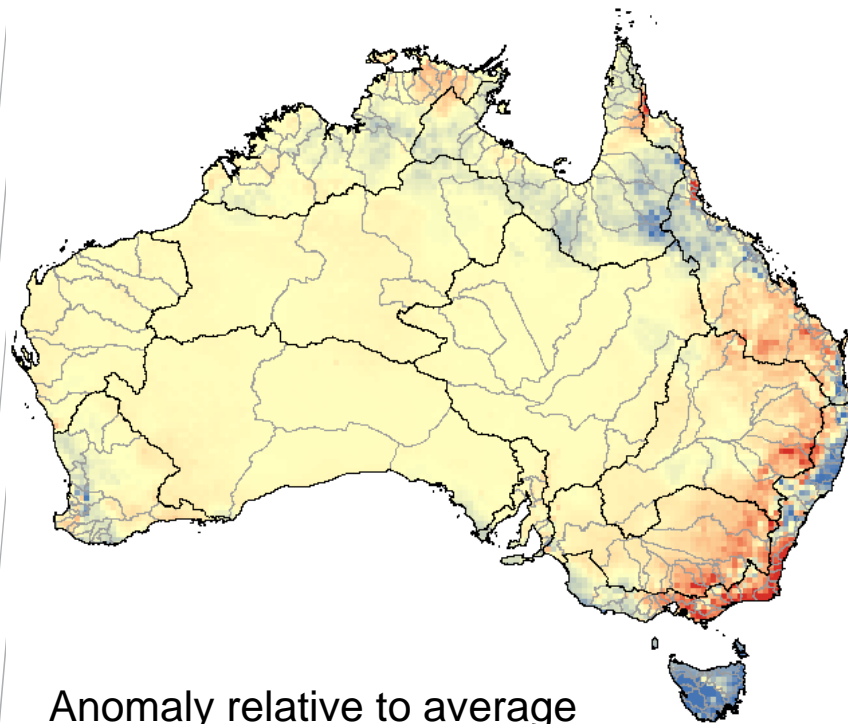
Murray-Darling Basin water accounts (1990-2006)

Soil water account	mm/year	GL/year	River network water account	mm/year	GL/year
Rainfall	428	452,730	River inflows	41	43,041
Evapotranspiration	421	445,765	Riparian and floodplain losses	27	28,521
Runoff	26	28,035	Net extraction	10	10,697
Deep drainage	14	15,005	Net open water evaporation	3	3,102
Net storage change	-34	-36,075	End of system outflow	6	6,156
			Net storage change	5	5,435

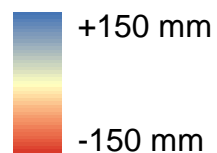


# Current awareness

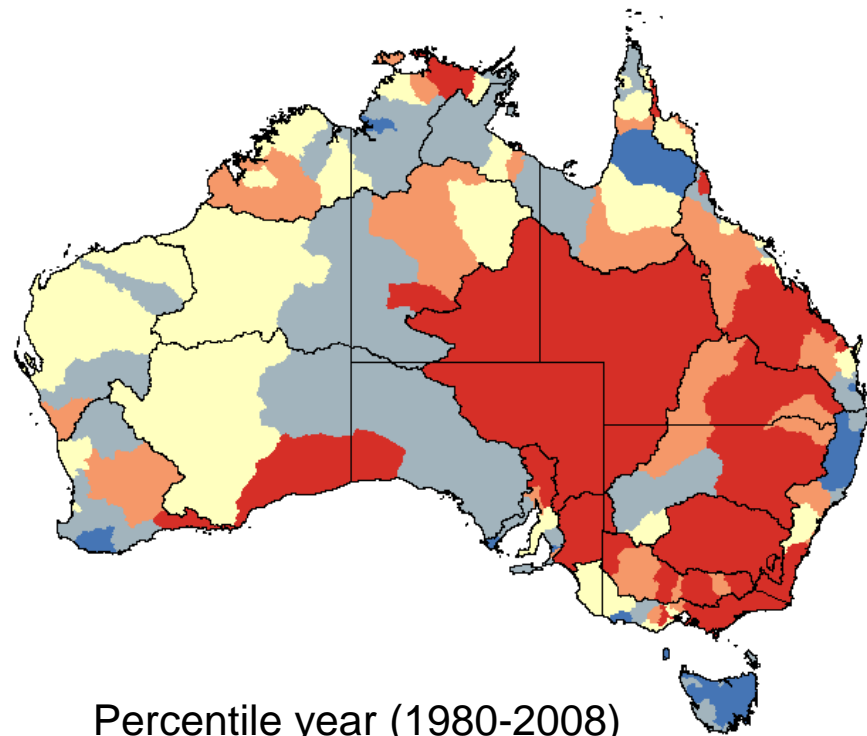
Estimated combined soil and ground water storage on September 8, 2009



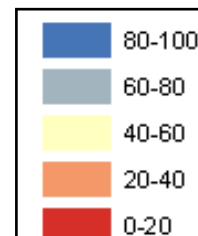
Anomaly relative to average total storage (1980-2008)



Estimated cumulative streamflow for the 3 months preceding September 8, 2009



Percentile year (1980-2008)

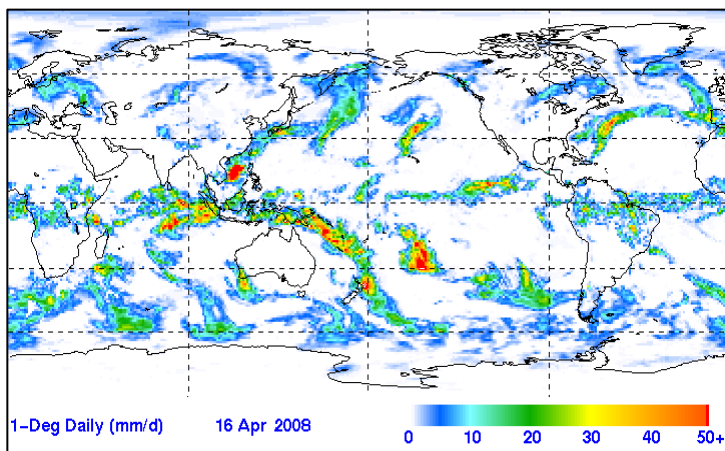


Application beyond Australia?

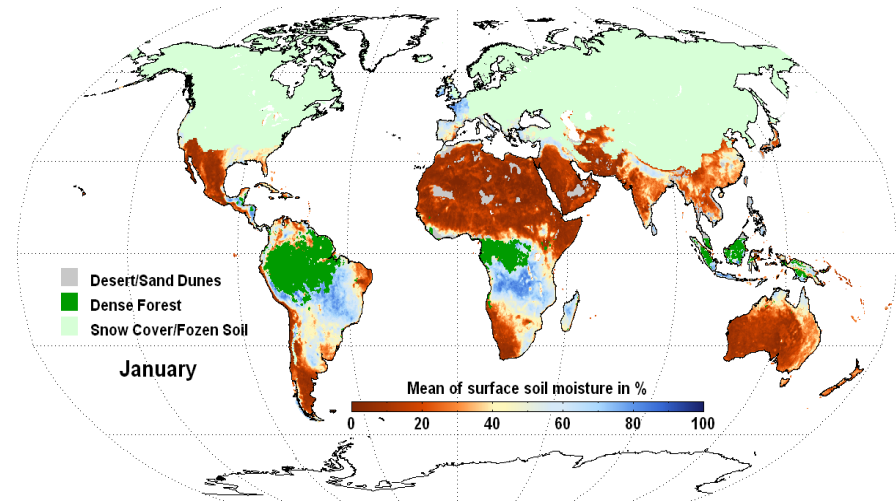


# Global data sets provide excellent information

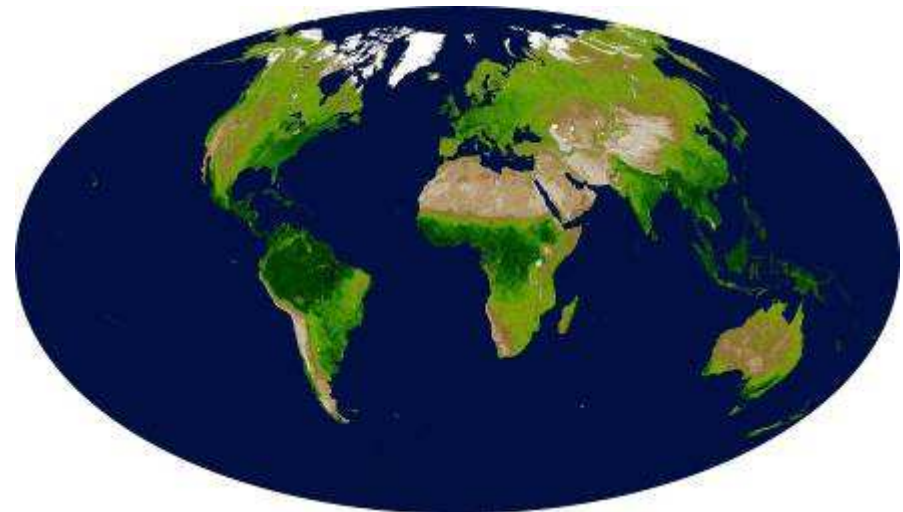
- remotely sensed rainfall (3 hourly)
- inundation (optical, radar)
- soil moisture (passive microwave, radar)
- vegetation (leaf area, water content)
- total water storage (GRACE)
- weather interpolation/NWP reanalysis and forecasts



TRMM 3-hourly rainfall product



Mean ERS scatterometer surface soil moisture (1991-2007), TU Wien

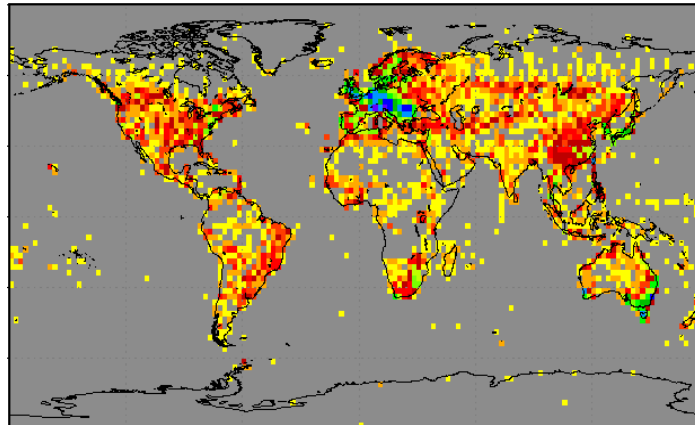


Mean vegetation greenness

# But accuracy requires on-ground data

- The quality of model estimates will always be better where on-ground hydrometric data are available (rainfall, streamflow, groundwater).
- National agencies usually have access to larger and more up-to-date on-ground networks.
- CSIRO would be interested to discuss any opportunities to jointly develop similar systems in other countries!

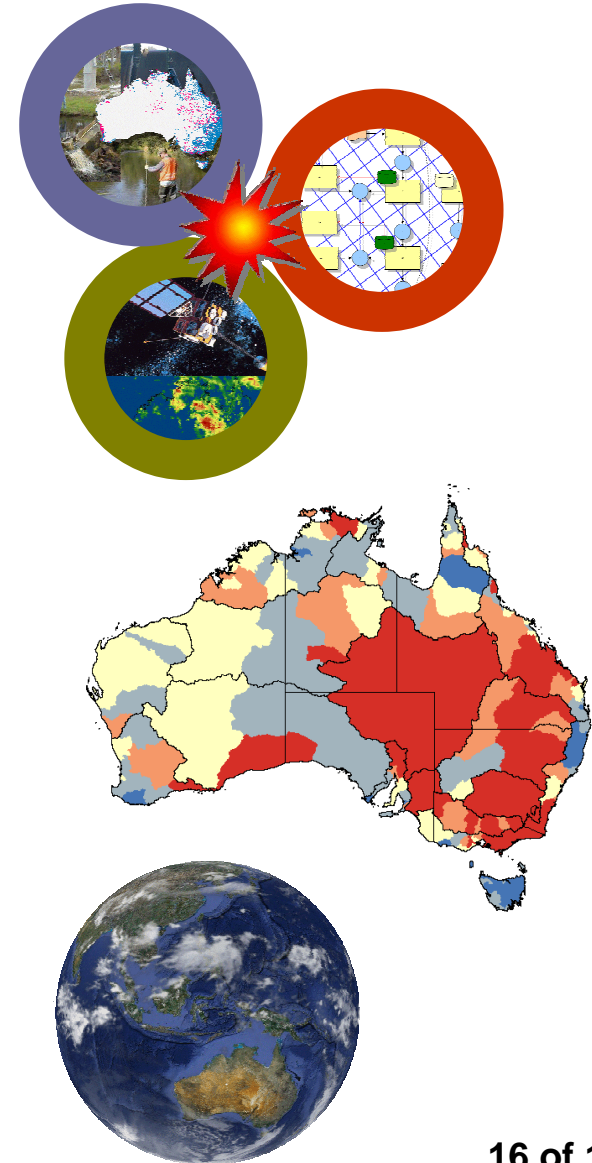
Published global rain gauge data (GPCC)



Published global runoff data (GRDC)

# Key points

- More comprehensive and up to date water information will benefit water management.
- A water observation system has been developed for Australia.
- The system follows a model-data fusion approach; combining on-ground and satellite observations with models.
- Results can be used for water accounting, understanding change, reporting present state and forecasting.
- CSIRO is looking for collaborators to jointly develop similar systems in other countries.



# Thank you



Albert van Dijk  
CSIRO Land and Water  
Phone: +61 2 6246 5780  
Email: [Albert.Vandijk@csiro.au](mailto:Albert.Vandijk@csiro.au)