

BRS SEMINAR SERIES PRESENTS:

Friday 1 July

“Water, water everywhere, nor any drop to drink...” — towards mapping water availability across Australia

Dave Barratt - BRS

Water issues are now considered among the most important drivers and limitations for natural resource management in Australia, ranging from biodiversity, primary production and environmental hazards like salinity and drought, through to urban and rural water supplies. A better understanding of water availability is needed across the entire continent and is relevant to the implementation of key government policies such as Exceptional Circumstances and the National Water Initiative.

This presentation outlines a new project on national water availability being coordinated by the Bureau of Rural Sciences, in collaboration with the CSIRO and the Bureau of Meteorology, funded by the National Heritage Trust. A new, integrated approach to monitoring and predicting seasonal and multi-year water balances, from national to paddock scales will be demonstrated. Project outputs will include maps and electronic information on past, present and future levels of the components of the water balance (including soil moisture) and will be relevant to a broad range of government and non-government programs.

This and other projects being undertaken by BRS, CSIRO, NLWRA, BoM, AGO, MDBC and other agencies are intended to help quantify and map the crucial linkages between climate and water availability and improve water management by government, industry sectors and individuals. For example, the Water 2010 project, another BRS undertaking, will help highlight risks and opportunities related to water availability in the landscape due to changes in landuse, populations and industry, government policies, and seasonal and annual climate variability and change.

BIO

- BSc from Sydney Uni
- 3 years research on elephant ecology in Southern Africa
- Master of Applied Ecology at Canberra Uni, and 10 years experience in coordinating and managing science for policy in forestry, fisheries and drought assessment areas within DEH and BRS.
- Currently working in the Climate Impact Sciences Program in BRS, managing research aimed at better understanding the relationships between water availability and drivers such as climate, land use, urban growth and government policies.

**11.00am - 12:00noon (morning tea at 10:45am)
Edmund Barton Conference Centre (in the courtyard)
Edmund Barton Building
Kings Avenue, Canberra**

Bookings not required.

Parking can be a problem, we suggest taking a taxi.

For further details, please call the BRS Seminar Coordinator on 6272 3440.

For further information on BRS Seminars or to obtain papers/presentations supplied by previous seminar presenters, please visit our website at: www.brs.gov.au/brsseminars



Australian Government
Bureau of Rural Sciences

Towards mapping water availability across Australia

SCIENCE FOR DECISION MAKERS

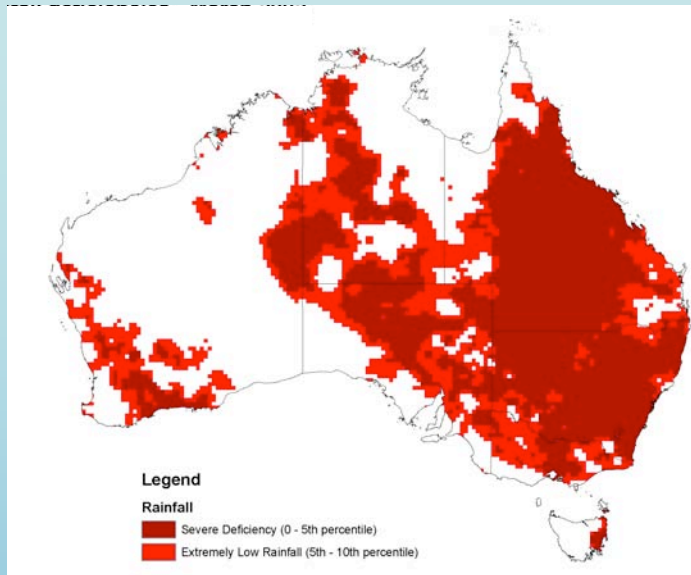
DEPARTMENT OF AGRICULTURE, FISHERIES AND FORESTRY

Outline

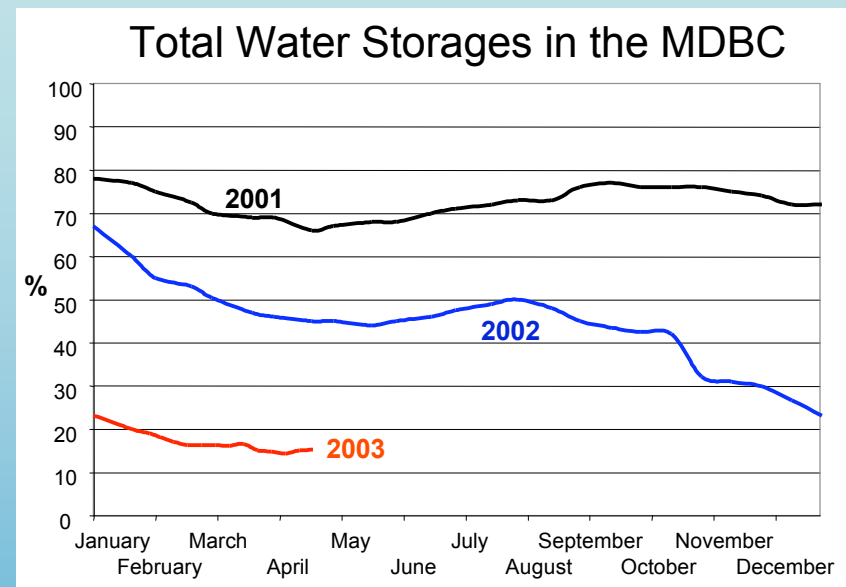
- National water and drought policy
- Australian Water Availability Project
- Water 2010

Water Use and Reform

- Irrigated agriculture = ~ 75% of total consumptive water use in Australia.
- From 1983 to 1996 extractions ↑ by 76%.
- Concern about effects on river health and ecosystems.
- In 1994, COAG agreed to a national water reform framework.



2002/03 drought



Renewed focus on water reform

August 2003 – COAG National Water Initiative

- Maximise the productivity and efficiency of water use
- Ensure the health of rivers and sustainable use of surface and groundwater

Drought Policy

- 1992 – National Drought Policy (ARMCANZ)
- 1999 – Drought encompassed under new generic Exceptional Circumstances (EC) criteria
- 2003/04 – Drought policy review
- October 2004 – IDC request working group to assess feasibility of a National Monitoring System (NMS)

The Australian Water Availability Project (AWAP)

- Two year project
- NHT funded through DAFF NRM Division
- Partnership between BRS, CSIRO & BoM

Goal

To develop an operational prototype of a new, integrated approach to monitoring and predicting soil moisture and other components of the water balance for Australia.

Australian Water Availability Project

Approach: Combine a model for all terms in the water balance with remotely sensed and *in-situ* climate data (historic and current) to provide estimates of:

- Plant transpiration
- Evaporation
- Runoff
- Soil moisture
- Deep drainage

Outputs: Retrospective analyses and current information (updated fortnightly).

Future: Forecasting?

Agency contributions

Bureau of Meteorology

*David Jones, Neil Plummer, Xiang-Dong Wang,
Ian Grant and Anthony Rea*

- **Provide enhanced baseline meteorological data sets (incl. solar radiation, humidity, and wind data).**
- **Implement procedures for delivering data sets in near-real-time.**

CSIRO Land & Water

Tim McVicar, Tom Van Niel

- **Direct interpretation of remotely sensed data to infer soil moisture availability.**

CSIRO Earth Observation Centre

Michael Raupach, Peter Briggs

- **Develop a prototype data assimilation system, suitable for near-real-time estimation and prediction of soil moisture and water-balance fluxes (transpiration, soil evaporation, runoff and drainage).**

Bureau of Rural Sciences

John Sims, David Barratt, Greg Laughlin, Eloise Nation

- **Project management and administration.**
- **Host map and data products on-line (updated fortnightly).**

AWAP Approach

Mapping soil moisture across large regions

1. Measurement

- NDVI
- NDTI

2. Modelling

1. Measuring water inflows
2. Modelling outflows
3. Water balance equation:

Change in soil water = inflows – outflows
= rainfall + irrigation – transpiration –
soil evaporation – runoff – drainage

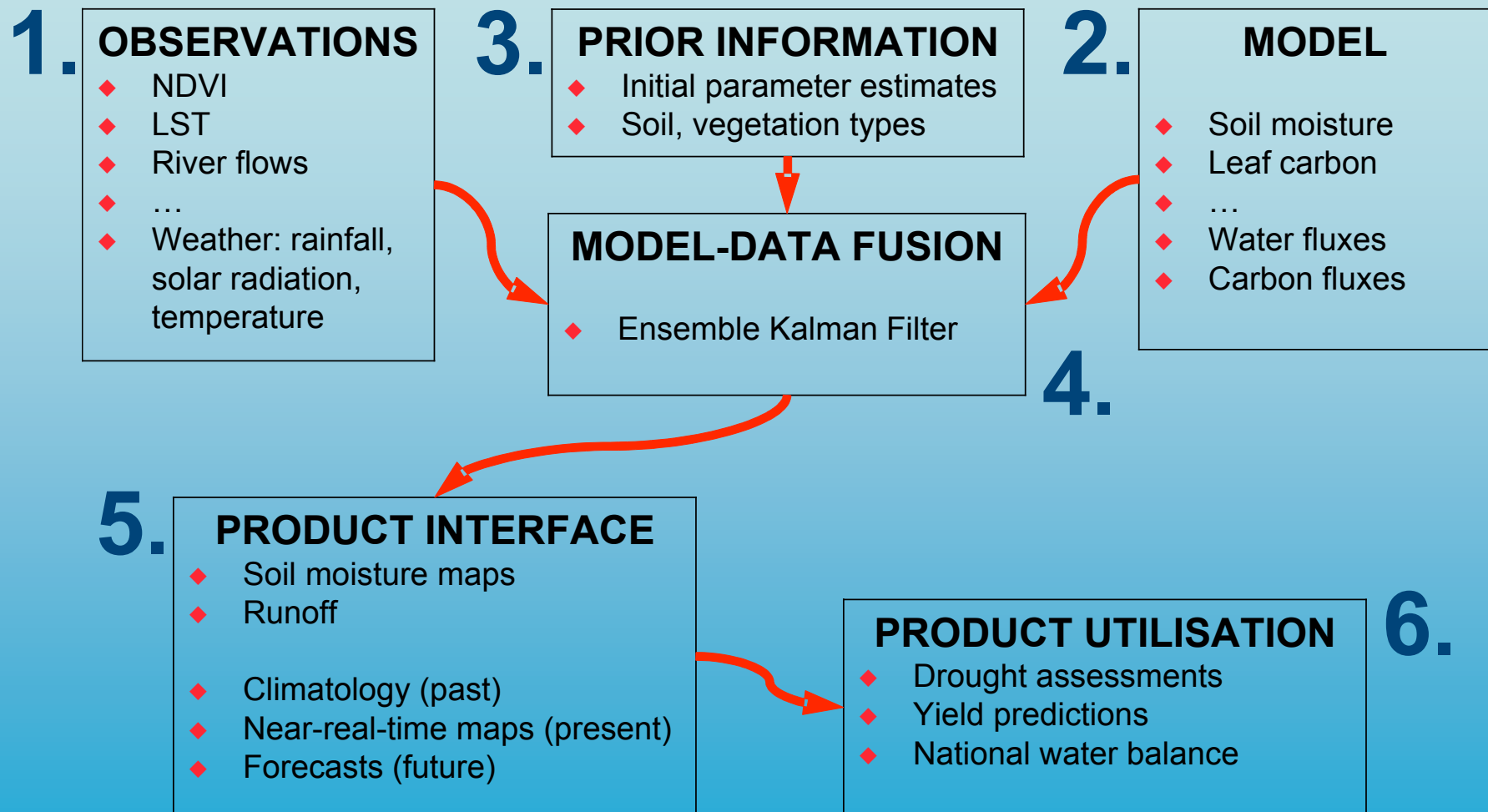
AWAP VISION

Map and predict soil moisture and related quantities by using *model-data fusion* methods to combine both measurements and modelling

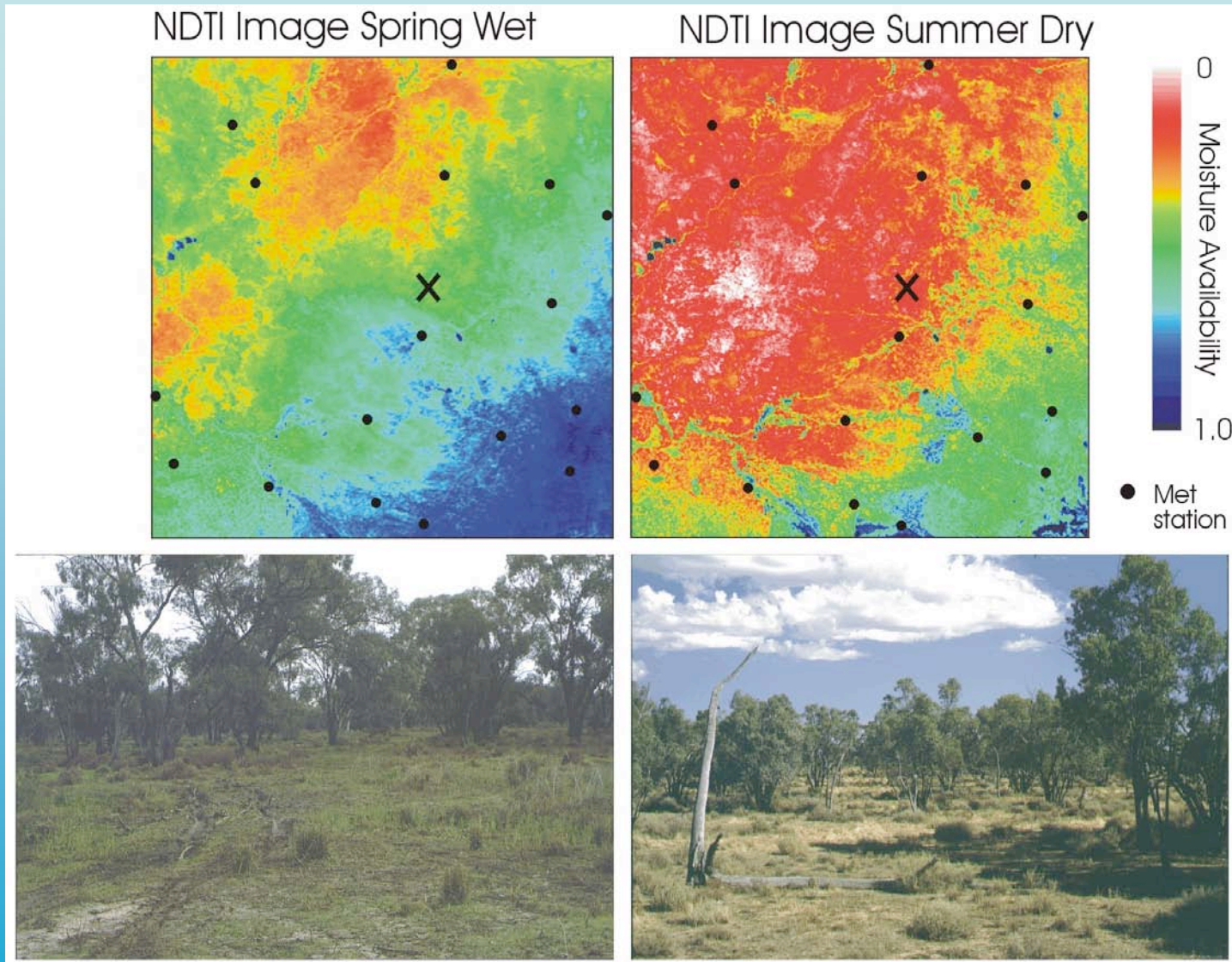
- (1) overcomes the individual weaknesses of measurement and modelling approaches on their own, and,**
- (2) provides information not only about soil moisture but also about other important quantities, eg, transpiration, evaporation, runoff and drainage**

Hydrological and Terrestrial Biosphere Data Assimilation System (HTBDAS)

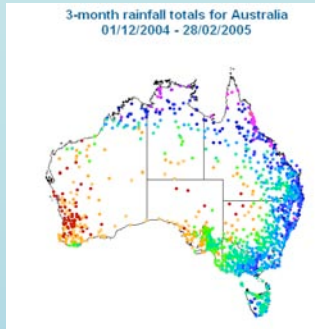
(from Raupach et. al. 2005)



Example of two dates of NDTI (from McVicar et. al. 2005)

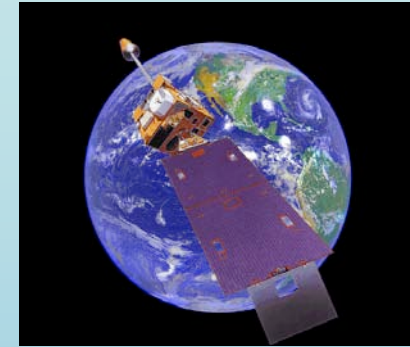


BoM Components



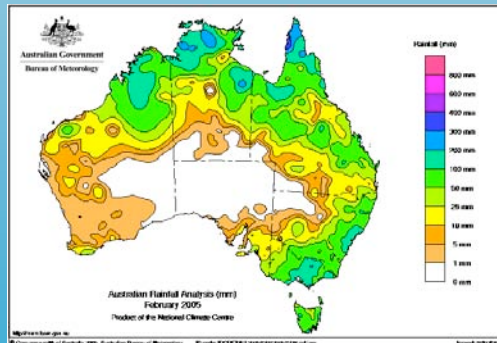
In-situ observations
from the Bureau's
network

Raw visible
geostationary
imagery

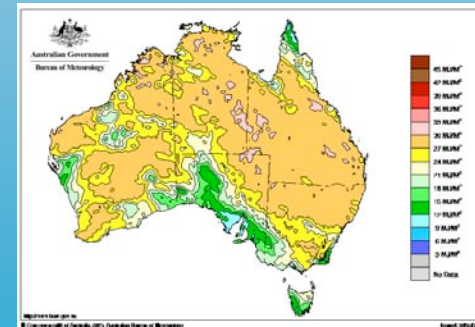


Topography-resolving spatial analysis
techniques

Radiative transfer
model



Rainfall, maximum & minimum temperatures,
humidity and wind



Solar Radiation

Rainfall & Temperature

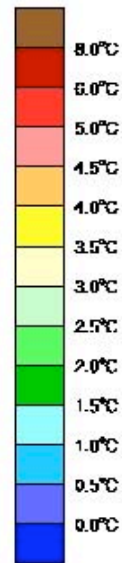
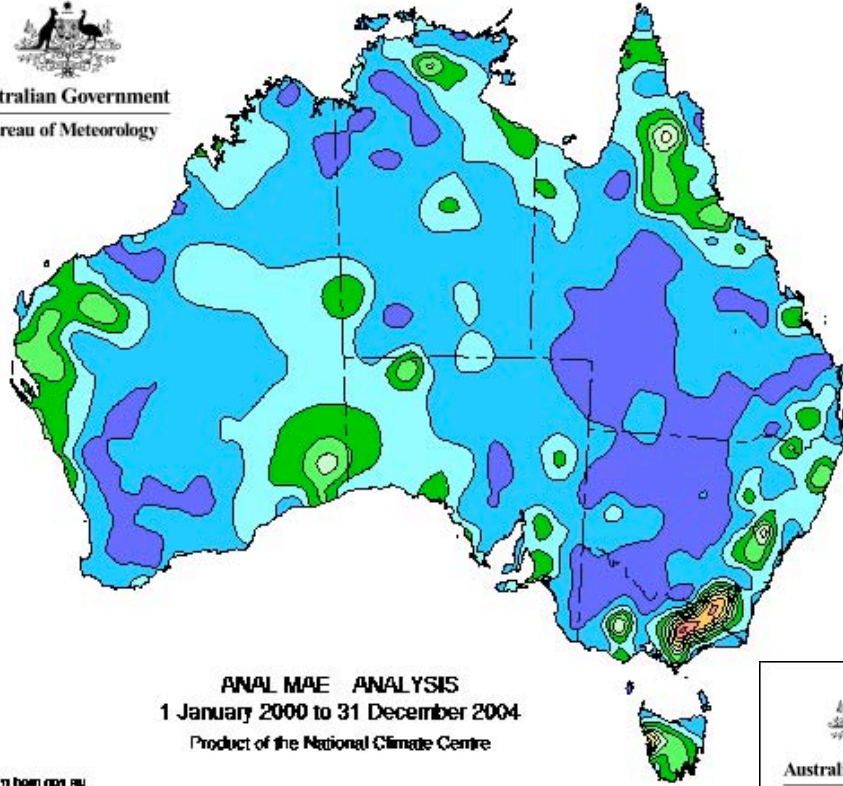
Construct high-quality, high-resolution (5km) daily and monthly data sets (grids) initially dating back to 1980.

Required of the technique:

- Consistency between daily/monthly analyses and climatology.
- Applicable to high and low station densities (e.g., pre 1957).
- Computationally achievable.
- Robust enough to run automatically in real-time.



Australian Government
Bureau of Meteorology



ANAL MAE ANALYSIS
1 January 2000 to 31 December 2004
Product of the National Climate Centre

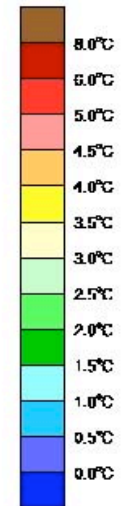
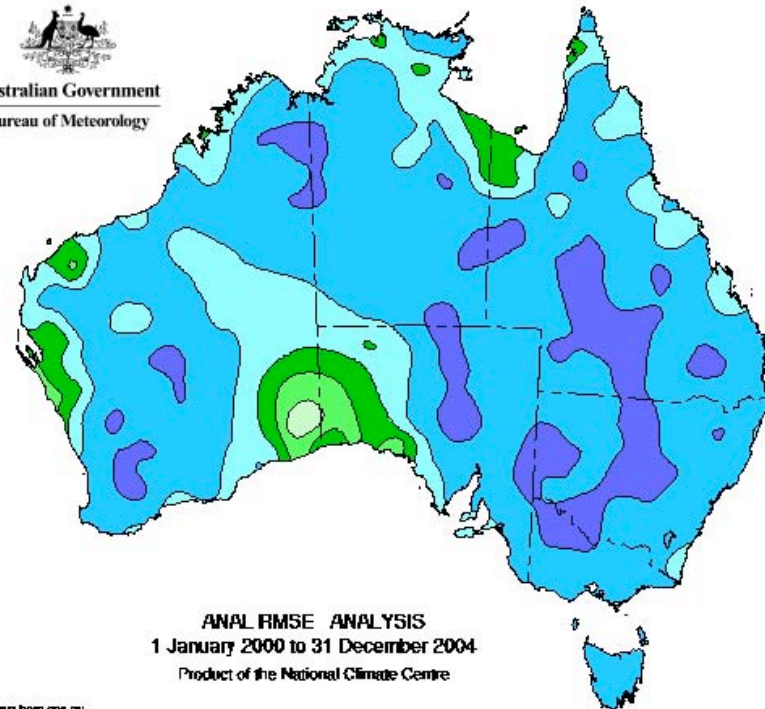
<http://www.bom.gov.au>

© Commonwealth of Australia, 2005, Australian Bureau of Meteorology

Operational Tmax Errors



Australian Government
Bureau of Meteorology



ANAL RMSE ANALYSIS
1 January 2000 to 31 December 2004
Product of the National Climate Centre

<http://www.bom.gov.au>

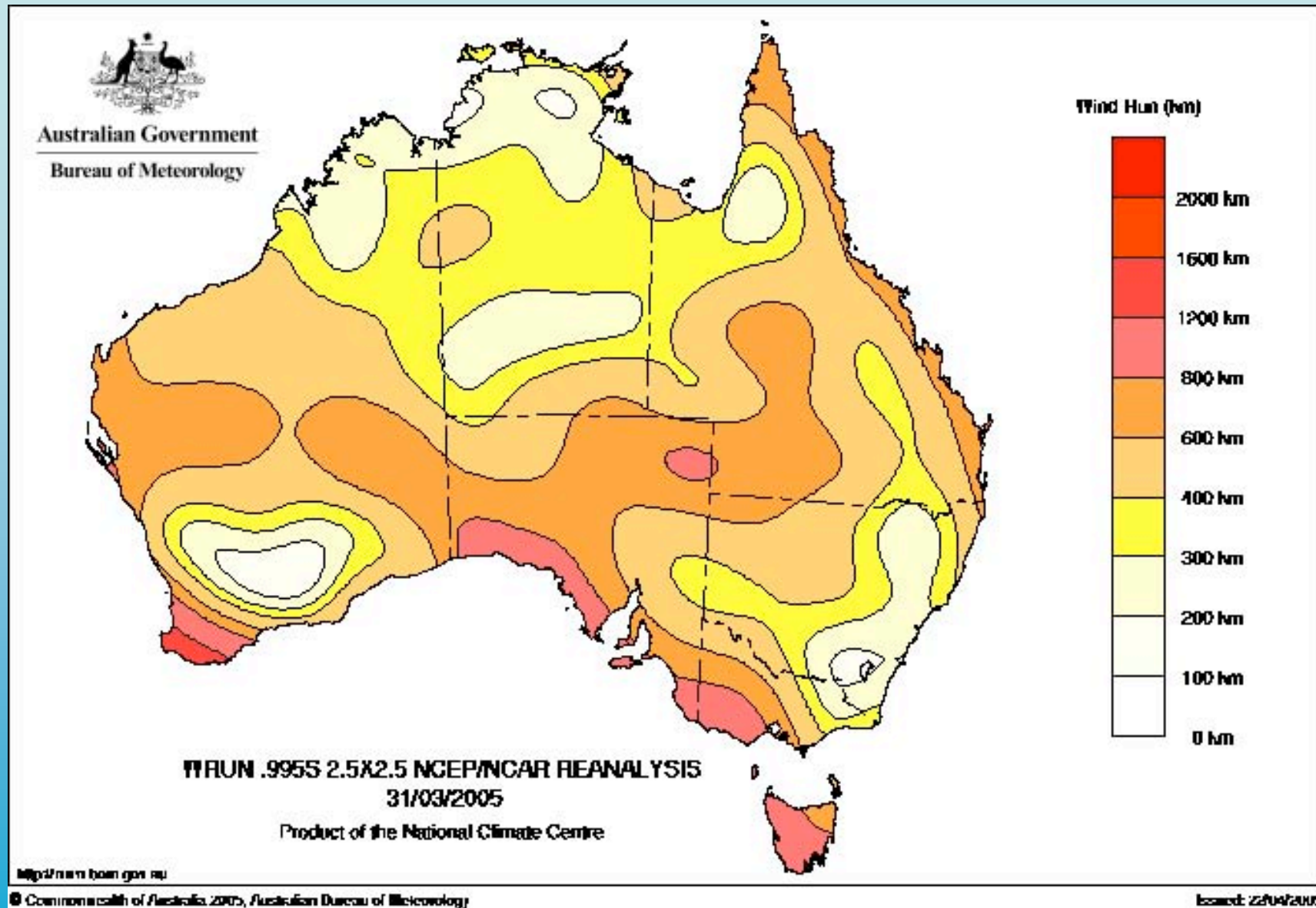
© Commonwealth of Australia, 2005, Australian Bureau of Meteorology

AWA Tmax Errors

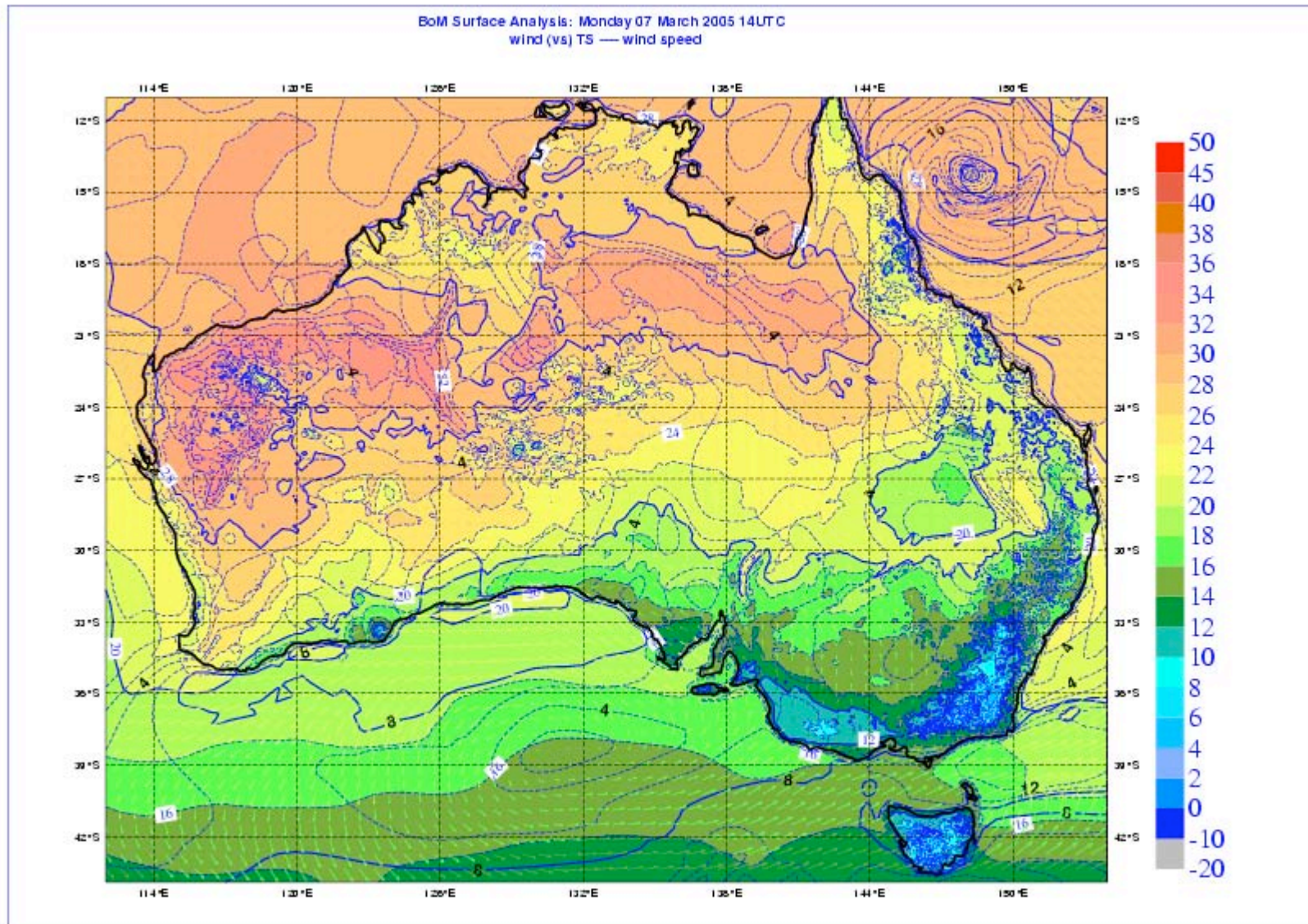
SCIENCE FO

Issued: 31/03/2005

Near Surface Wind



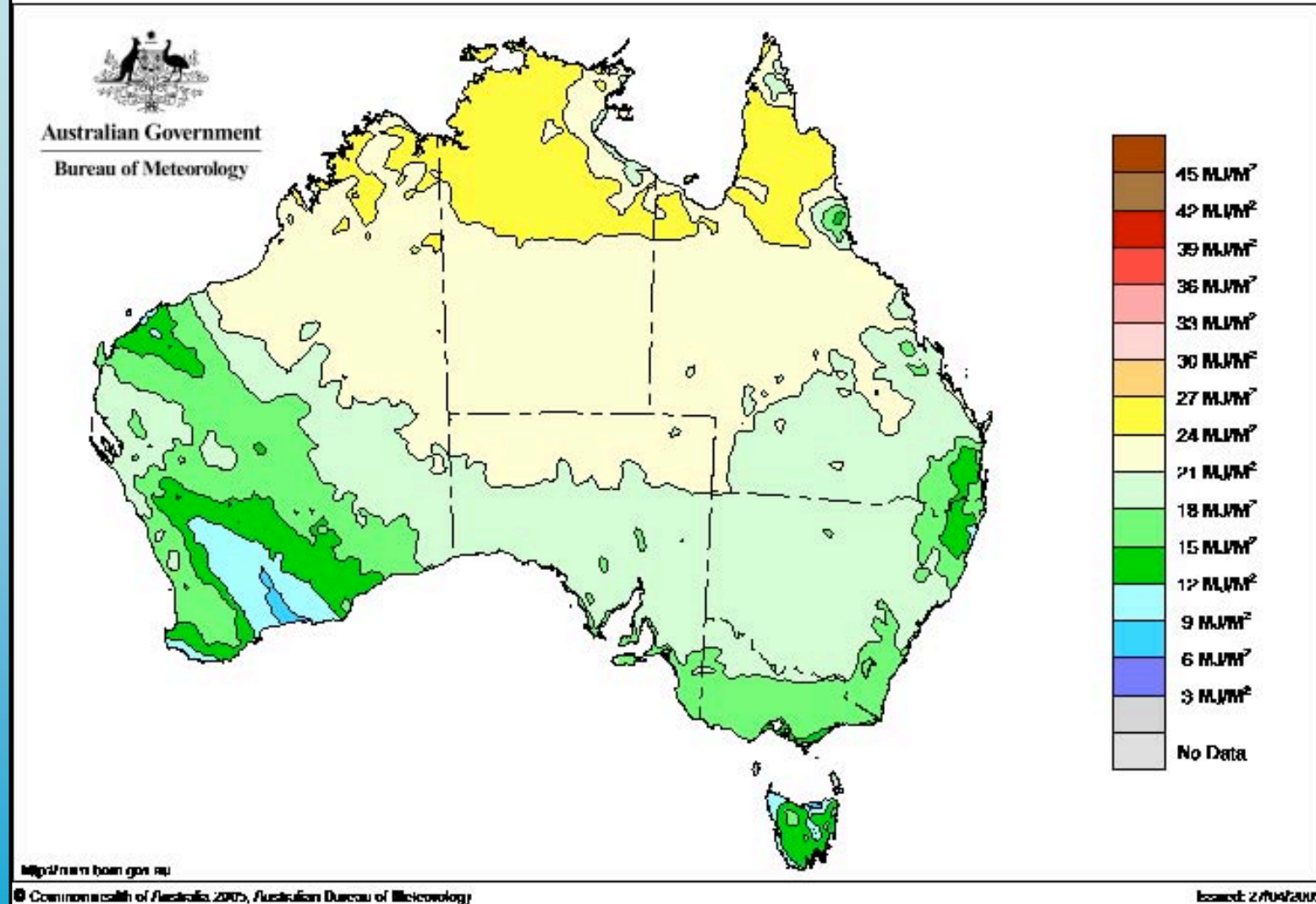
Near Surface Wind



Solar Radiation

GSOLRAD 0.25X0.25 OPERL SATELLITE EST MJ/M² 20050427

Product of the National Climate Centre



Progress to June

Max & Min Temp: Daily ✓ Monthly ✓

Rainfall: Daily ✓ Monthly ✓

Surface Winds: 6-hourly ✓

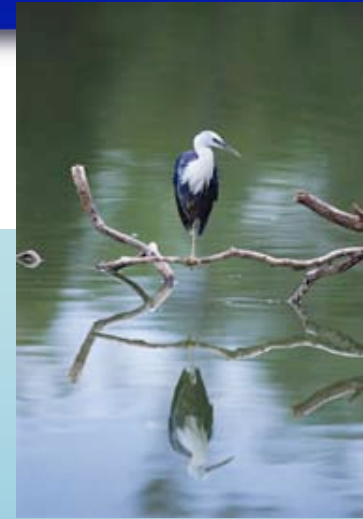
Solar Radiation: ✓ (regeneration of archive underway)

Humidity: under investigation

- Substantial increase in analysis accuracies
- Website with data updated automatically



Water 2010



- Capture information on water balance at the best resolution possible (incl. groundwater);

- Investigate water consequences of likely or desired changes in land use, population, climate, policy/practices;



- Examine potential impacts on communities, industries and regions, to underpin policy development.



National Water Initiative

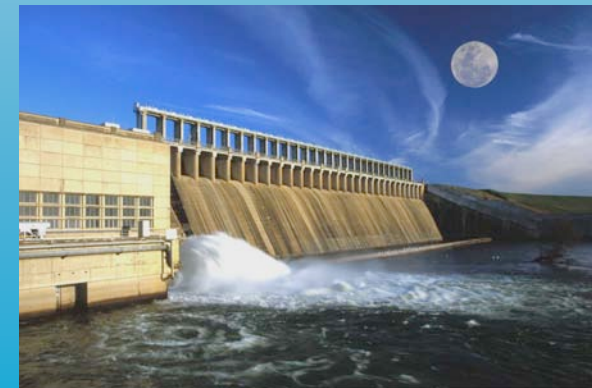
Water access entitlements and planning

- Water planning – Sections 36-40
- Addressing over allocated and/or overused systems – Sections 41-45
- Assigning risks for changes in allocation – Sections 46-51
- Interception – Sections 55-57



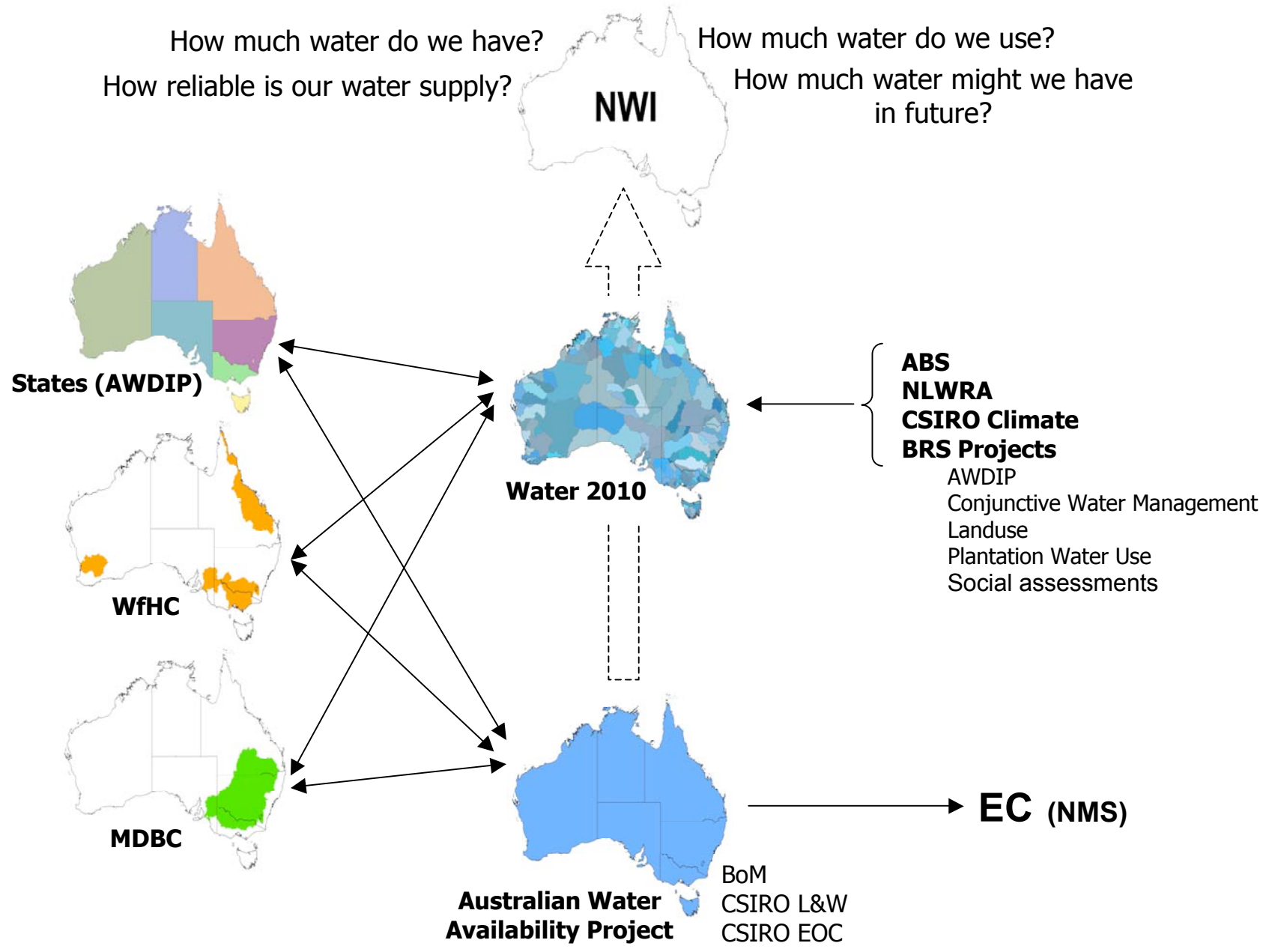
Water resource accounting

- Consolidated water accounts – Sections 82-83
- Information – Section 86



Knowledge and capacity building

- Identifying key knowledge and capacity building priorities – Section 101





Water Balance

Budyko model

- Estimates the long-term, large scale water balance

$$PE=+ \quad \text{Runoff}$$

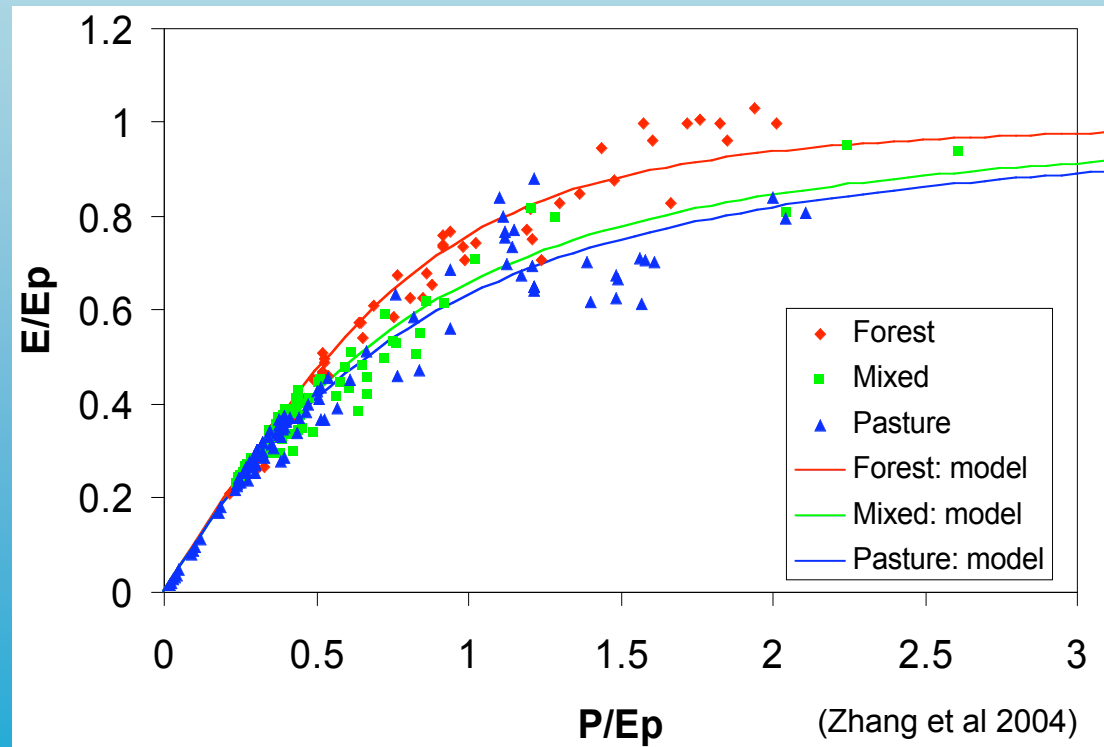
$$E/E_p = \frac{1 + (P/E_p)^a}{(P/E_p)^a}^{1/a}$$

P = precipitation

E = total evaporation

E_p = Priestley-Taylor evaporation

a = 1.5 (grass) to 2.5 (forest)



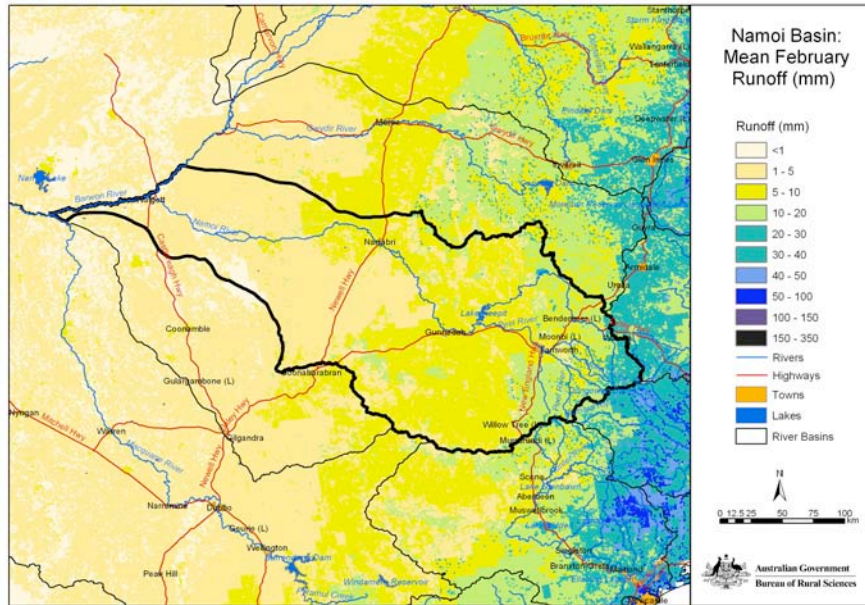


Modelling process

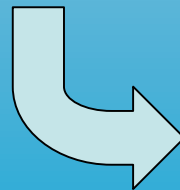
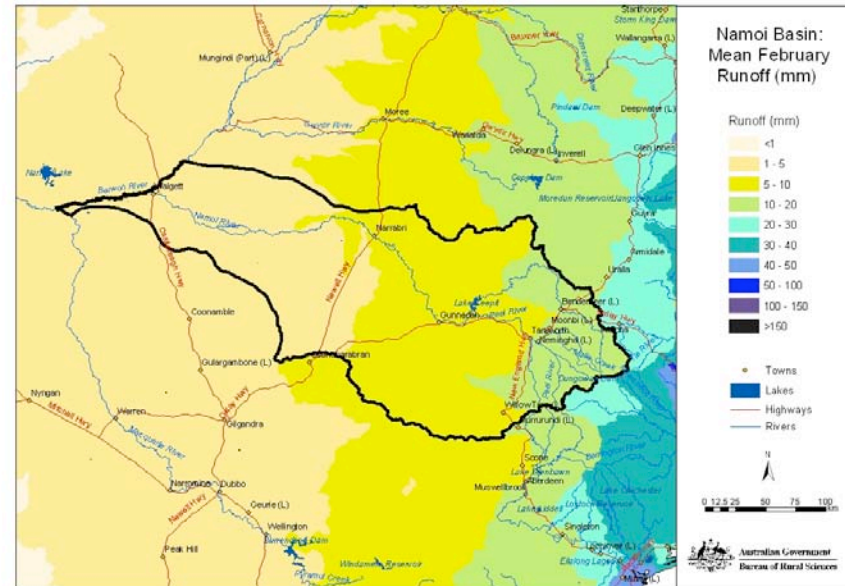
1. Developed new 'best available' land use layer (CLUM, NFI, Modis, NLUM, MDBC)
2. Assigned water use coefficients to land use classes
3. Modelled monthly and annual outputs using BoM precipitation and CSIRO EOC potential evaporation grids
4. Separated 'runoff' component into surface runoff and deep drainage (Runoff = rainfall – ET – deep drainage)
 - Deep drainage is proportional to rainfall and is affected by soil texture and cultivation (Raupach et. al. 2001).
5. On cells that are irrigated, irrigation = $E_p - ET$.



Model Outputs



Grids



Sub-catchments



Water Use / Demand

Irrigation

- CSIRO / BRS: Irrigation = $E_p - ET$ (on irrigated land use cells)
- FAO: Irrigation = Crop ET (ie, $K_c * Ref\ ET$) – ET
- NLWRA / ABS / CSIRO: Irrigation = Mean Appl. Rate * crop ha

Urban / domestic

- BRS: Use = Ave. water consumption * ABS population data (stratified by state and urban vs rural)
- NLWRA



Groundwater Recharge

- Estimating groundwater recharge for regional recharge zones
- Based on chloride mass-balance

$$\text{Recharge (mm/yr)} = P * c_p / c_g$$

P is the mean annual precipitation (mm/yr)

c_p is the chloride concentration in precipitation (mg/L)

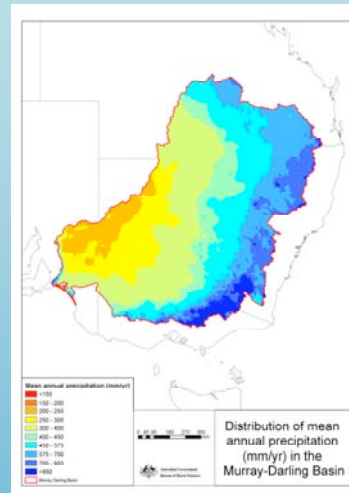
c_g is the chloride concentration in groundwater (mg/L)

- Initially calculated for Murray-Darling Basin

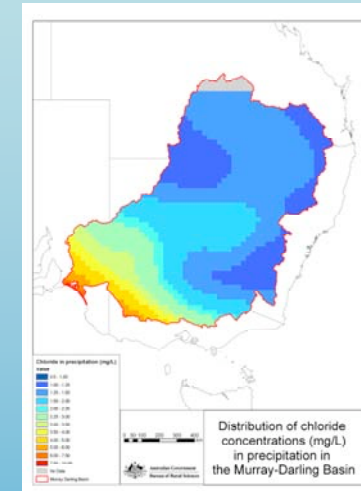


Groundwater Recharge

Mean Annual Precipitation (BoM)

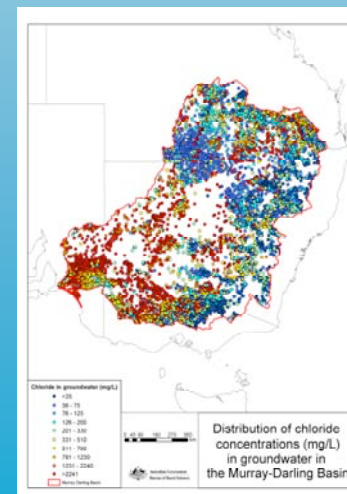


Chloride in Precipitation (Blackburn & McLeod 1983)



Chloride in Groundwater (States and Territories)

- Format and quality control





*WATER*2010

Water balance information for policy & planning

Website

SCIENCE FOR DECISION MAKERS



Issues

1. More sophisticated hydrology modelling required.
 - Influence of factors such as rainfall intensity, position in catchment, topography, soil type, vegetation species, fire frequency, etc, on runoff.
 - Transmission losses
2. Much more work required on relationships between runoff, deep drainage and groundwater.



2005 - 06

Groundwater

National recharge mapping
Connectivity framework

Validation and sensitivity analyses

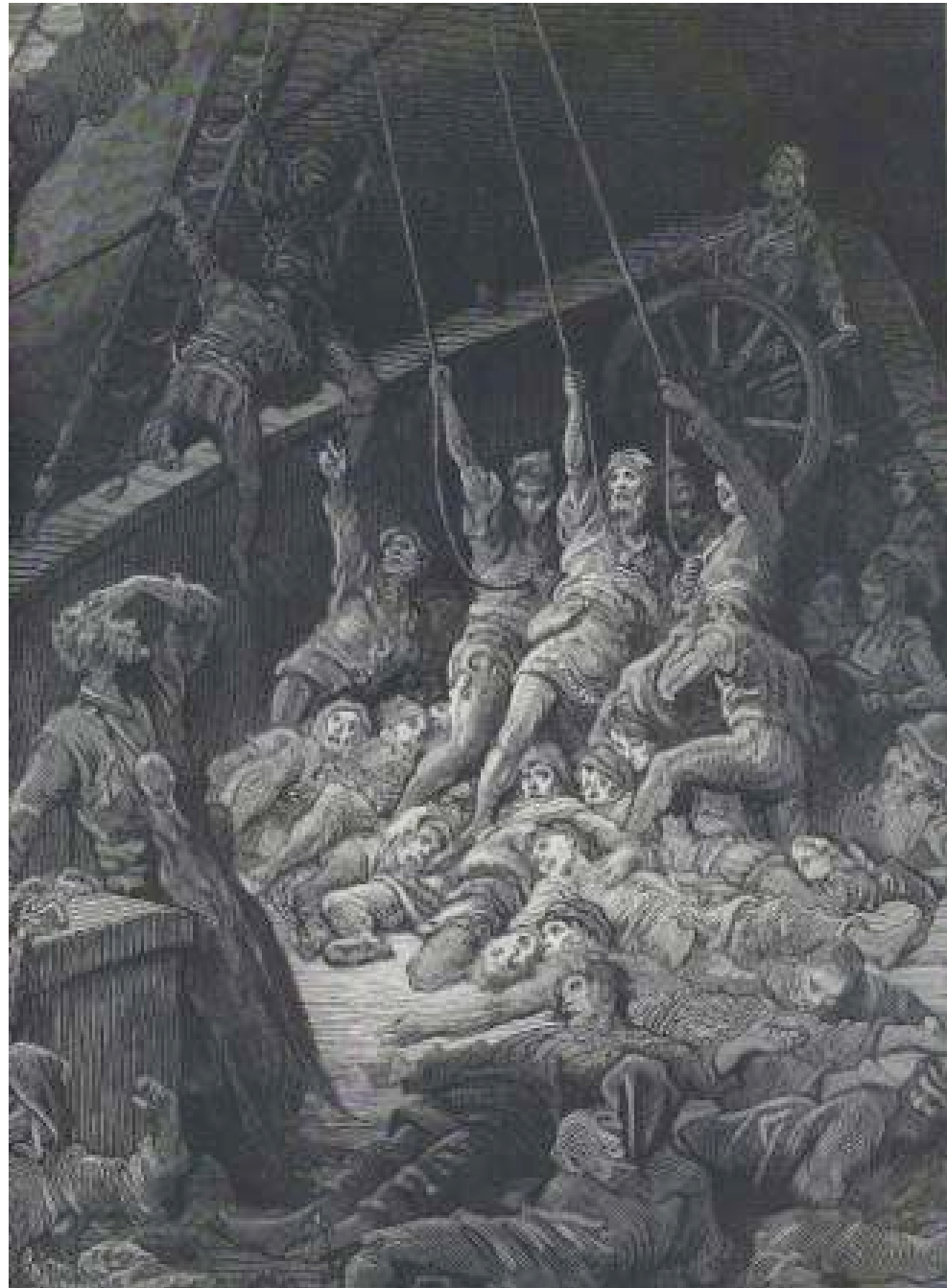
Checking & improving numbers.
Relative impact of changes in climate, land use, population etc

GIS tools for scenario testing

Reliability and change in reliability of inflows
Water consequences of increasing urban / irrigation demand?

Social assessment

Dependence on water (e.g. irrigation)
Community resilience to change
Potential to adopt improved practices.



SCIENCE FOR DECISION MAKERS