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PROFITABLE PERENNIALS FOR AUSTRALIAN LANDSCAPES

OPTIMISING WATER USE AND MINIMISING DROUGHT RISKS IN BIOMASS PRODUCTION: AN AUSTRALIAN PERSPECTIVE.

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& Don White**

(FFI CRC, DAFWA, Murdoch University, CSIRO)



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Outline

- * Challenges for future biomass production
- * Environment of southern Australia
 - Climate and soil limitations (fertility, water, salinity)
- * Water availability limits productivity
 - Impact of seasonal & episodic droughts
 - Risk vs Productivity
- * Options for managing water limitations
 - Species selection
 - Site selection
 - Management of LAI
 - Arrangement of plantings in landscapes
- * ***Using data from a range of sources and environments***



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Challenges for biomass production

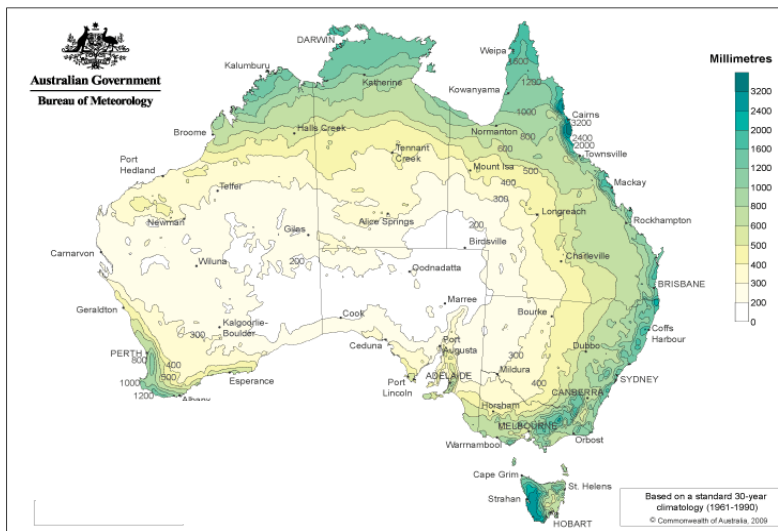
- * **Dry (Mediterranean) environment**
 - Seasonal rainfall distribution
 - Drought: Annual and Periodic
- * **Soils**
 - Infertile
 - Shallow soils & low water storage
- * **Changed conditions**
 - Climate change and variability
 - Altered hydrology (+ve & -ve)
 - Planting in drier areas
- * **Allocation of water**
 - Existing conditions
 - Emerging constraints on development



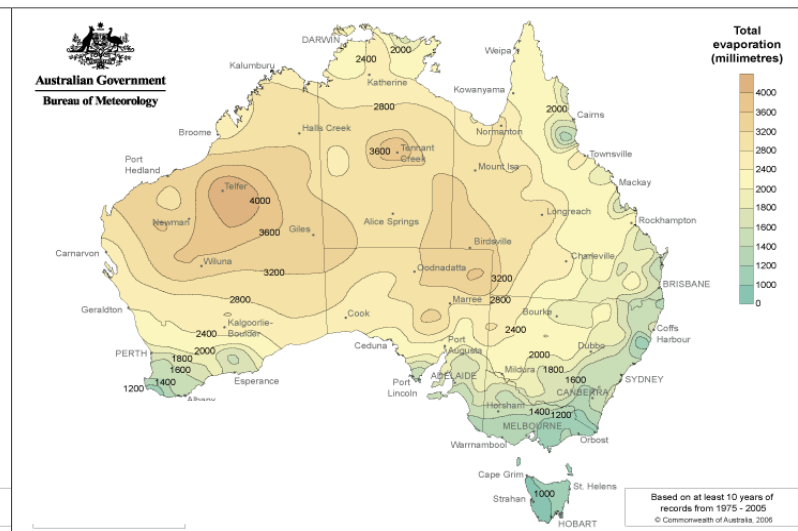
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Mean rainfall and evaporation - Australia is a dry continent

Rainfall



Evaporation



Over much of Australia Rain (P) < Evaporation (E)



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Climate variability

Seasonally variability

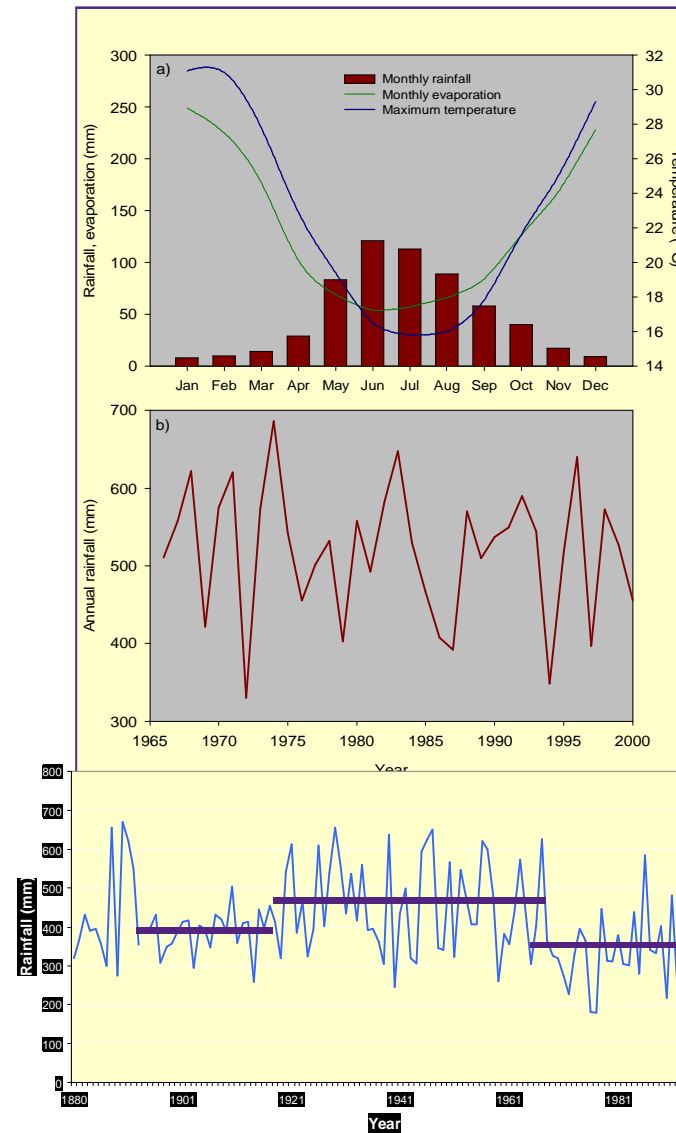
- 85% rain in 5 months
- Dry, hot summers

Annual variability

- Droughts are common

Inter-decade variation

- Extended periods of high and low rainfall



Data from BoM, IOCI

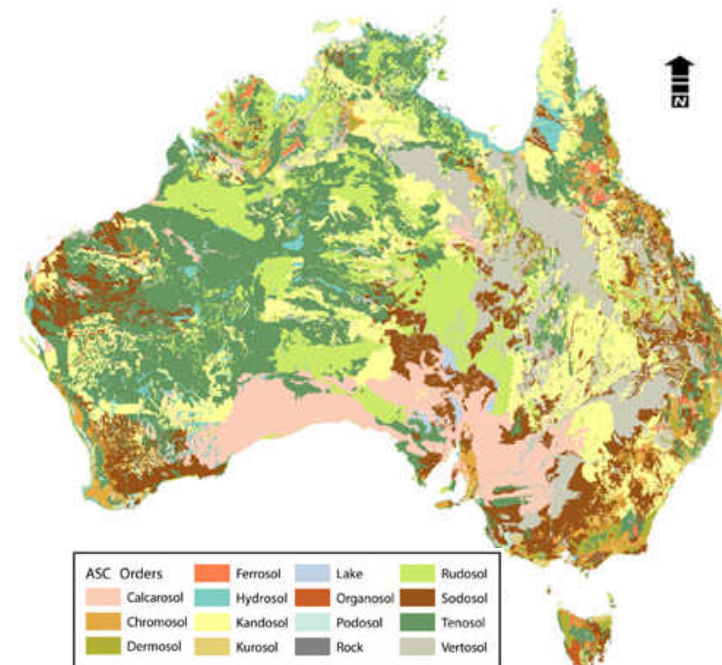


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Soils of Australia



- * Old leached
- * Some have low water holding capacity
- * Low fertility (modified by agriculture)
- * Salinity
- * Acidity
- * Erosion





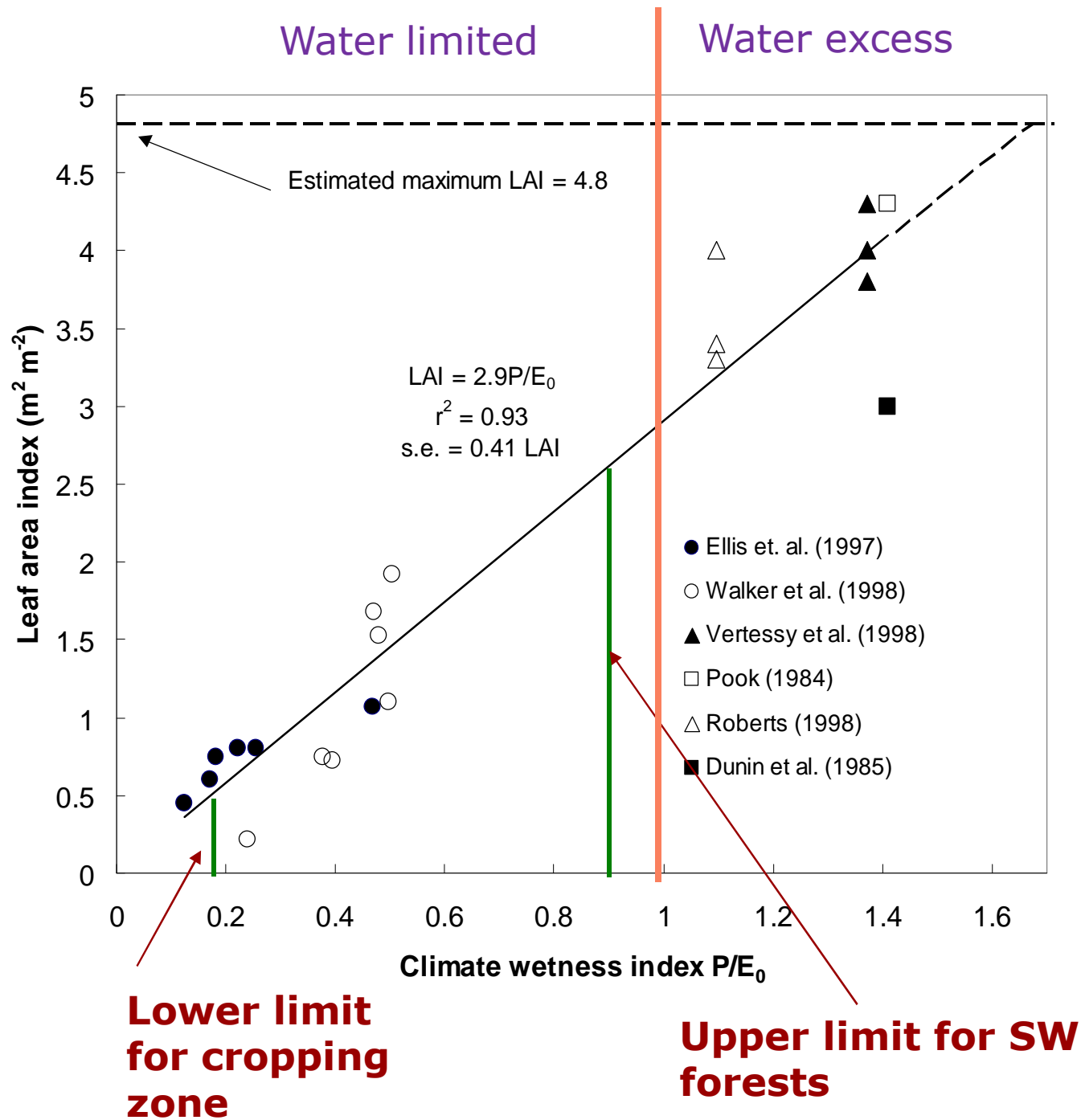
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Water Use determines biomass production (in a water limited environment)

Yield = Water Used x WUE x ~~Harvest Index~~

kg = (mm) x (kg/mm) x (kg/kg)

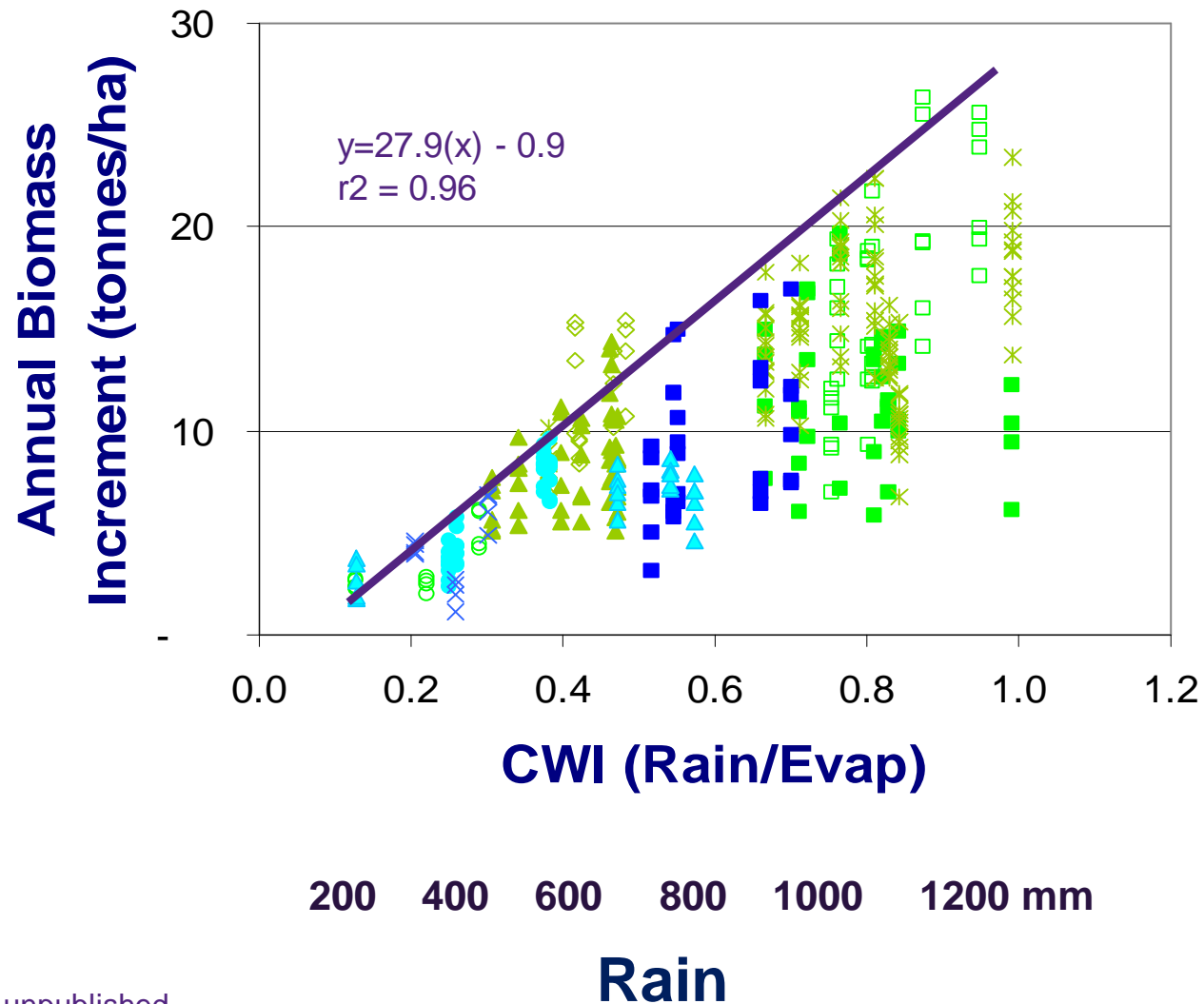
(adapted from Passioura (1977) – J. Aust. Inst. Ag. Res)





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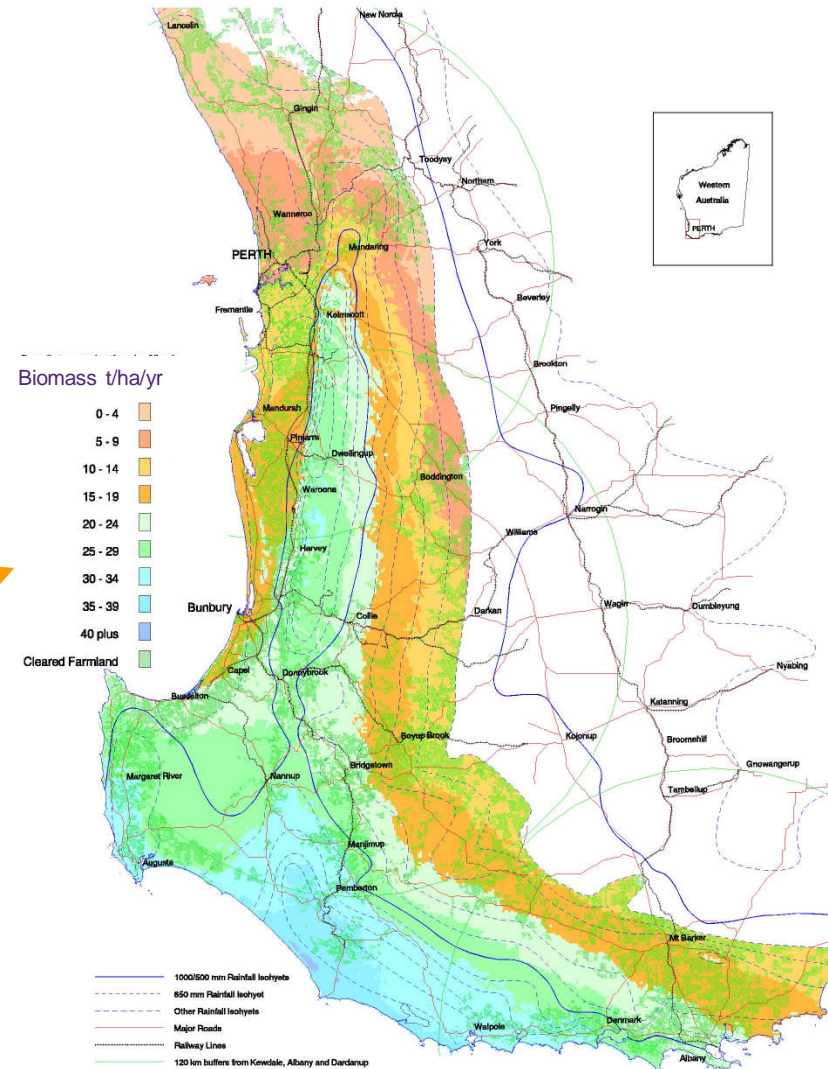
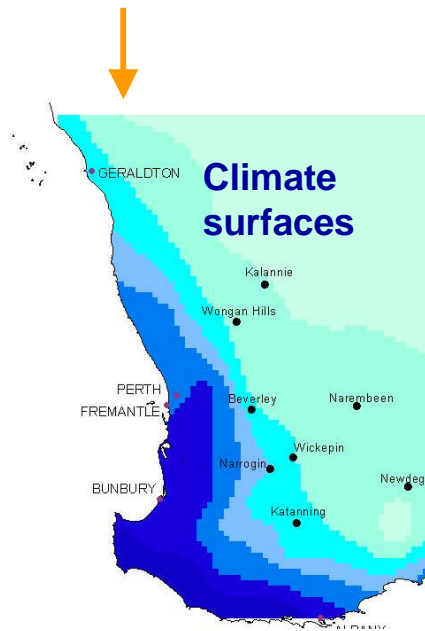
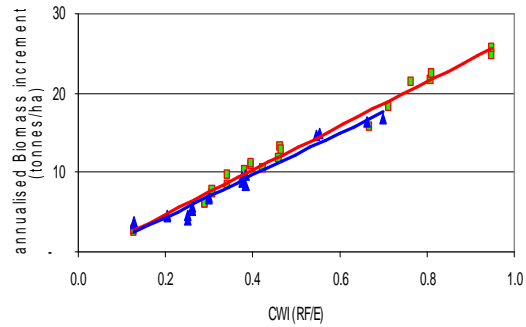
Water availability limits biomass production





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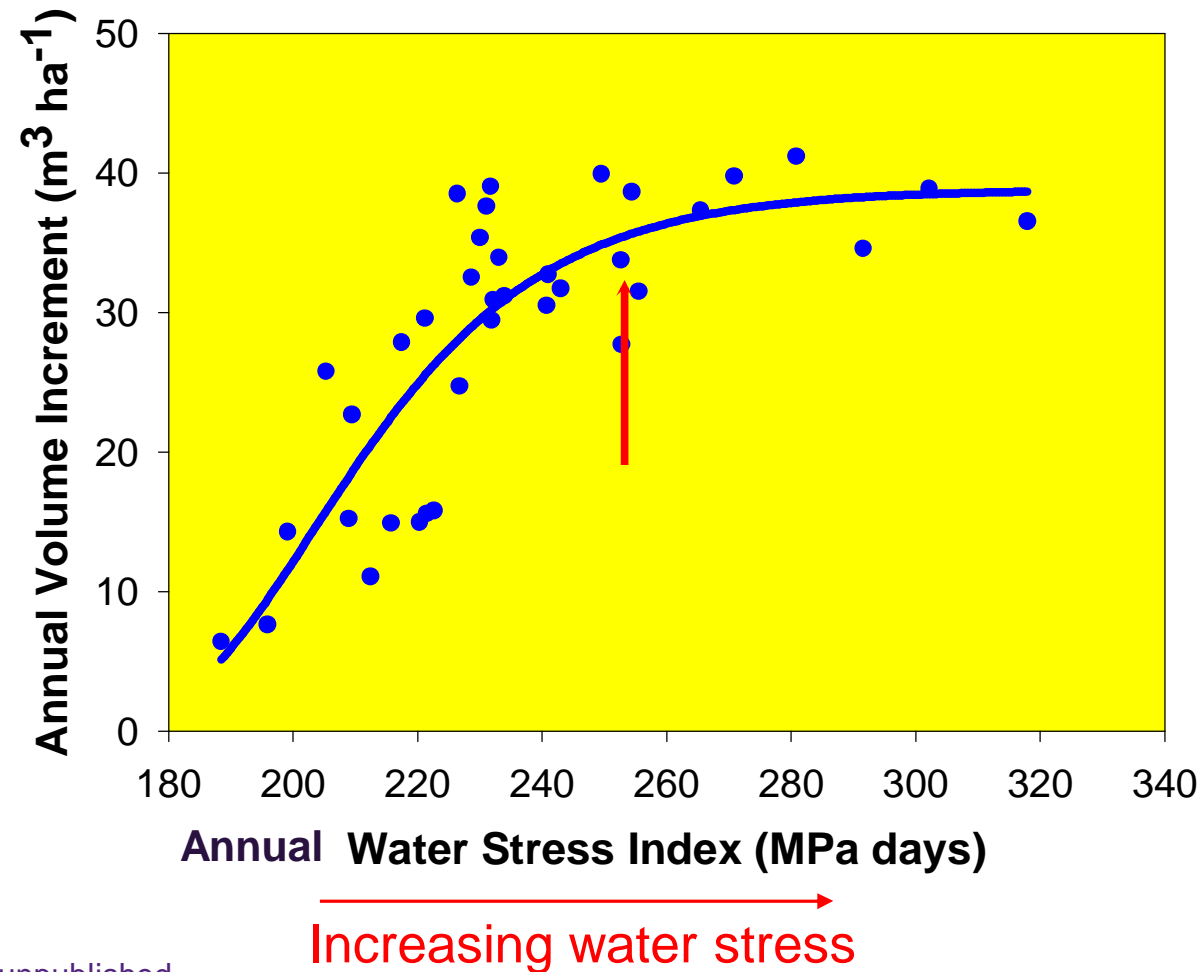
Predicted biomass production based on water availability





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Relationship between biomass production & water stress (**Productivity vs Risk**)





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Maximise or optimise water use?

- * Managing stands for maximum water use and water use efficiency will
 - a) maximize productivity and
 - b) minimise the water cost (at least at larger scales)
- * ... but there is an inescapable nexus between productivity and risk
- * Maximising water use for average or optimum conditions increases drought risk in dry years
- * Use climate statistics to evaluate the risks (intensity & frequency of drought)





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Options to manage water use

- * Species selection
- * Site selection
- * Management of water use
(density/LAI, arrangement, nutrient status)



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Species selection

- * Tolerance and avoidance of water stress is based on a number of morphological and physiological factors
 - root/shoot ratio (investment in root architecture)
 - control of water loss (stomatal control, leaf structure)
 - conservative leaf growth (low LAI)
 - prevention of xylem failure (cavitation)

- * Match species with environment (functional mimicry)

Site selection

Better definition of climate and species matching

Better definition of sites to depths of several metres

Maximizing soil water storage; avoid “shallow” sites



An Australian Government Initiative



Site Selection for Farm Forestry in Australia

by RJ Harper, TH Booth, PJ Ryan, RJ Gilkes, NJ McKenzie and MF Lewis

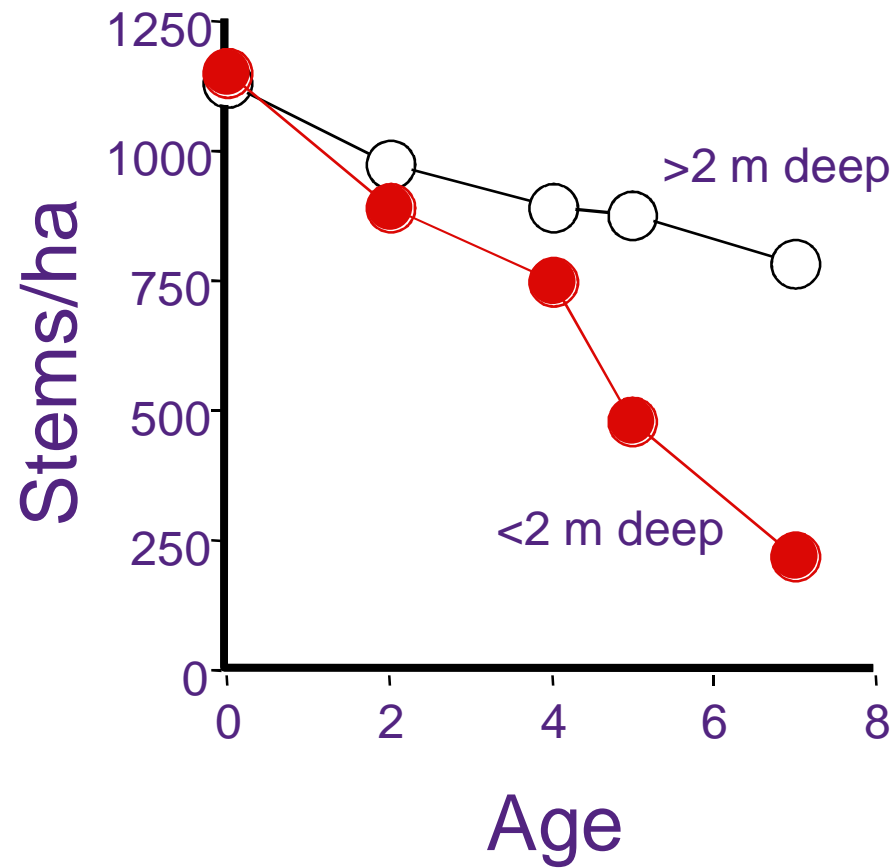
October 2008

RIRDC Publication No 08/152
RIRDC Project No CAL-4A

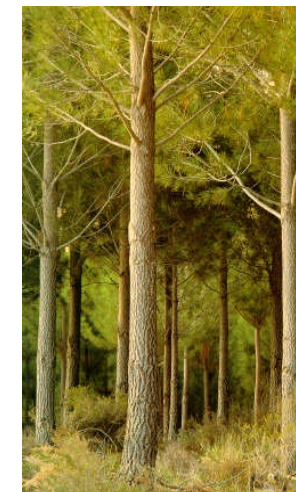
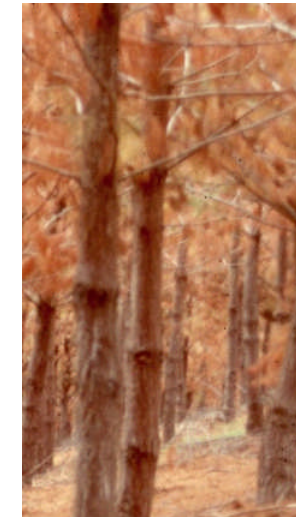
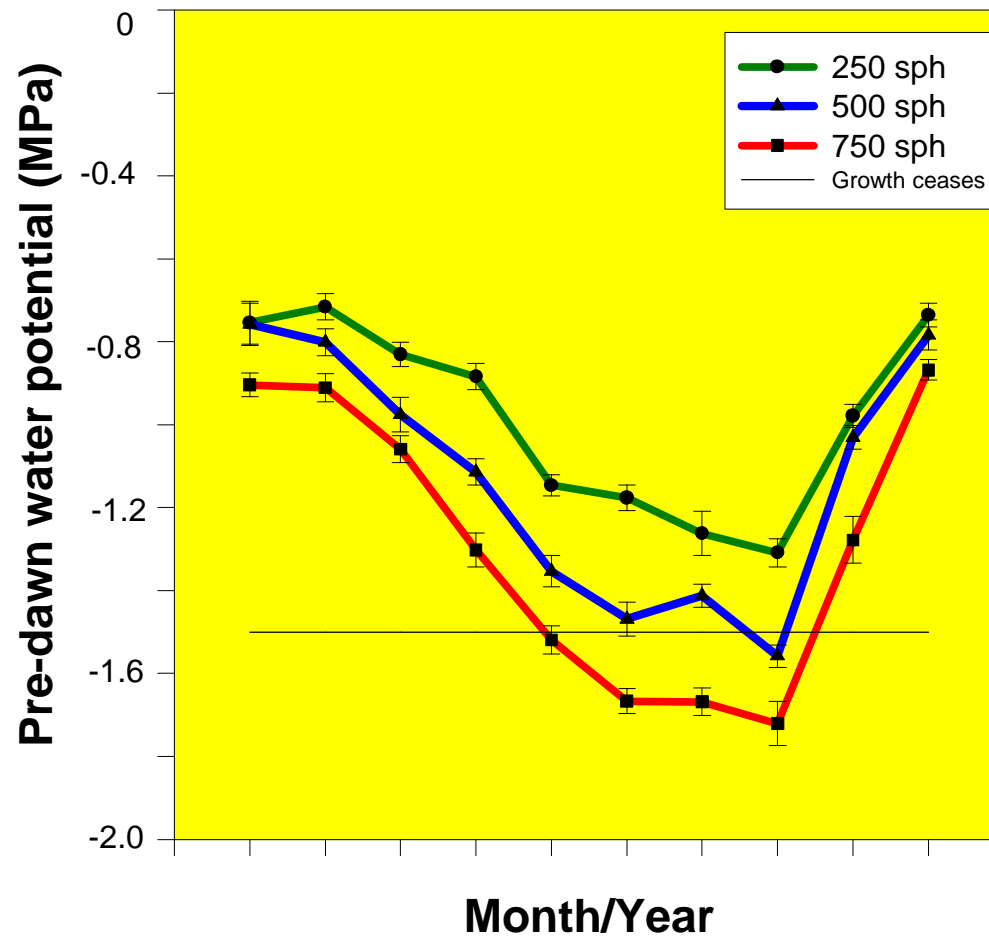


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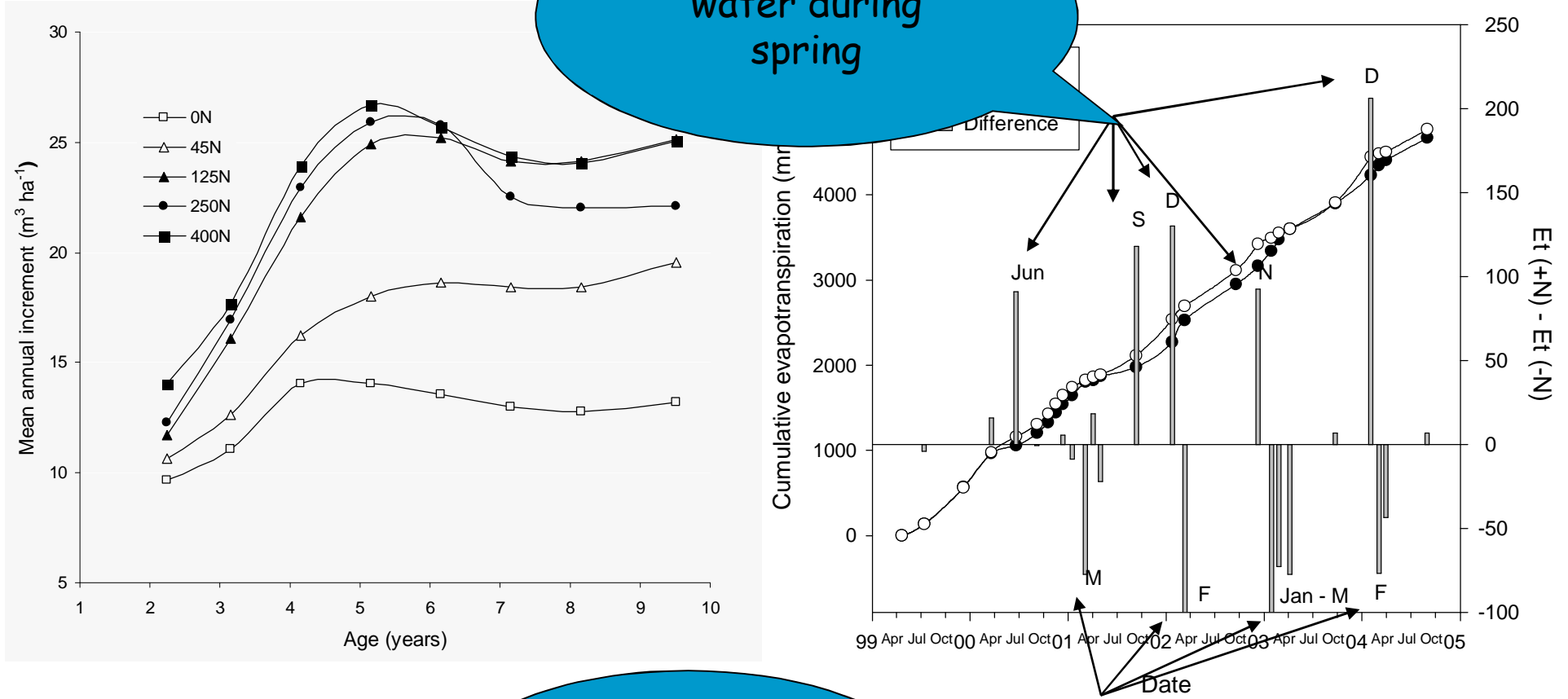
Soil depth influences survival



Plantation density influences tree water stress



Fertiliser, growth and water use – *E. globulus*



+N: uses more water during spring

- N: uses more water later in the year



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Planting design will influence water availability and water use

Plantation



Agroforestry belts



- New plantings are likely to occur in drier environments where integrated plantings offer significant advantages

Integrated mallee belts



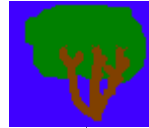
Biodiversity plantings



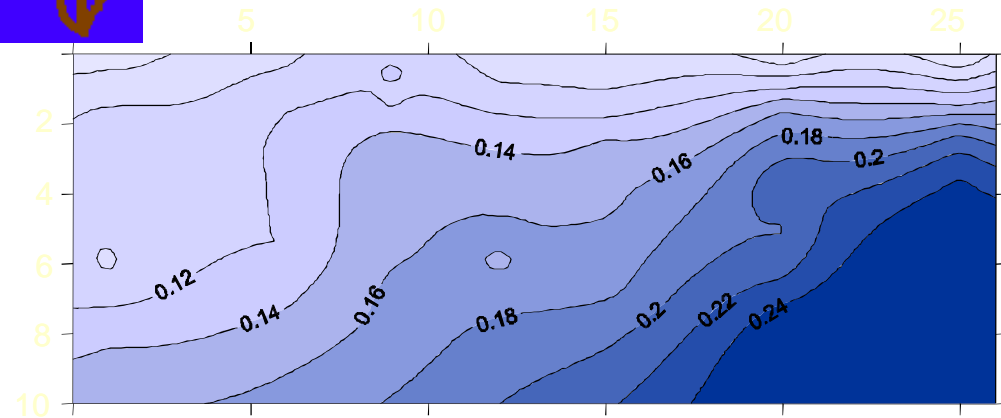


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Water use adjacent to mallee belts



Water Content
(g g⁻¹)



Robinson et al.(2006).. Plant and Soil. 286:141-151

Mallee belts
Wickepin WA





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Scales of decision making

- * Stand management –compartment (stand), estate
- * Licence to plant – stand, hill slope, property
- * Water allocation – catchment, region, state

Science and data need to reflect the different scales

A disconnect between the objectives of groups operating at different scales has the potential to create perverse outcomes



Summary

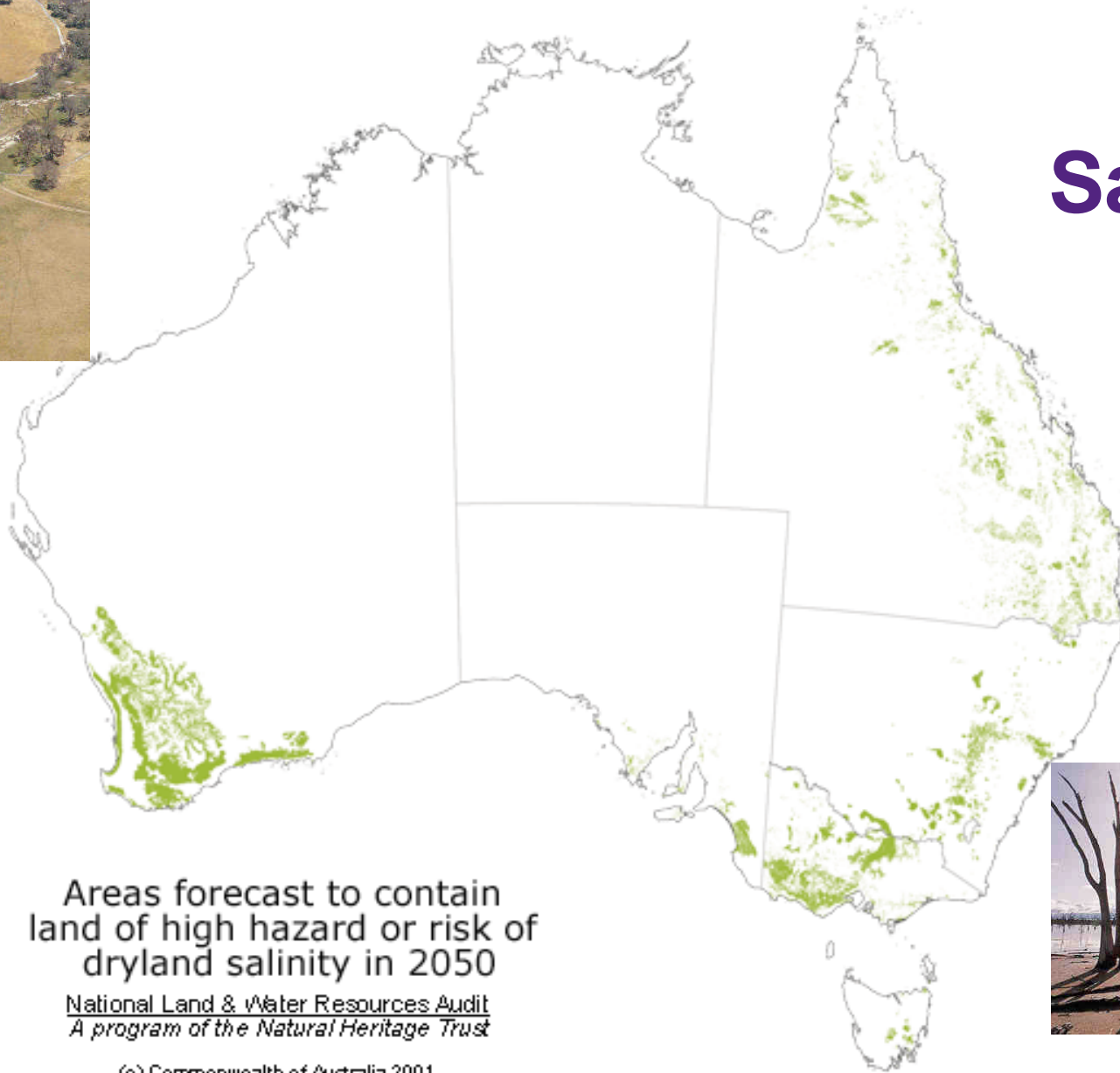
- ✦ Biomass production determined by water availability (Rain & Evaporation)
- ✦ There is a trade off between production and drought risk
- ✦ Risk assessment based on climate parameters
- ✦ Risk can be managed by
 - species selection
 - site assessment prior to establishment
 - manipulating water demand through planting density, thinning & nutrient management, planting design
- ✦ Management of water use has implications at local and regional scales



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Thank you

Salinity



Areas forecast to contain
land of high hazard or risk of
dryland salinity in 2050

National Land & Water Resources Audit
A program of the Natural Heritage Trust

(c) Commonwealth of Australia 2001

