

# Land use change: tropical savannas, greenhouse gases, water, agriculture

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Last Updated: **October 20, 2011**

## Top End key for food bowl

Andrew Bolt | Herald Sun | September 21, 2011 12:00AM | 25 comments

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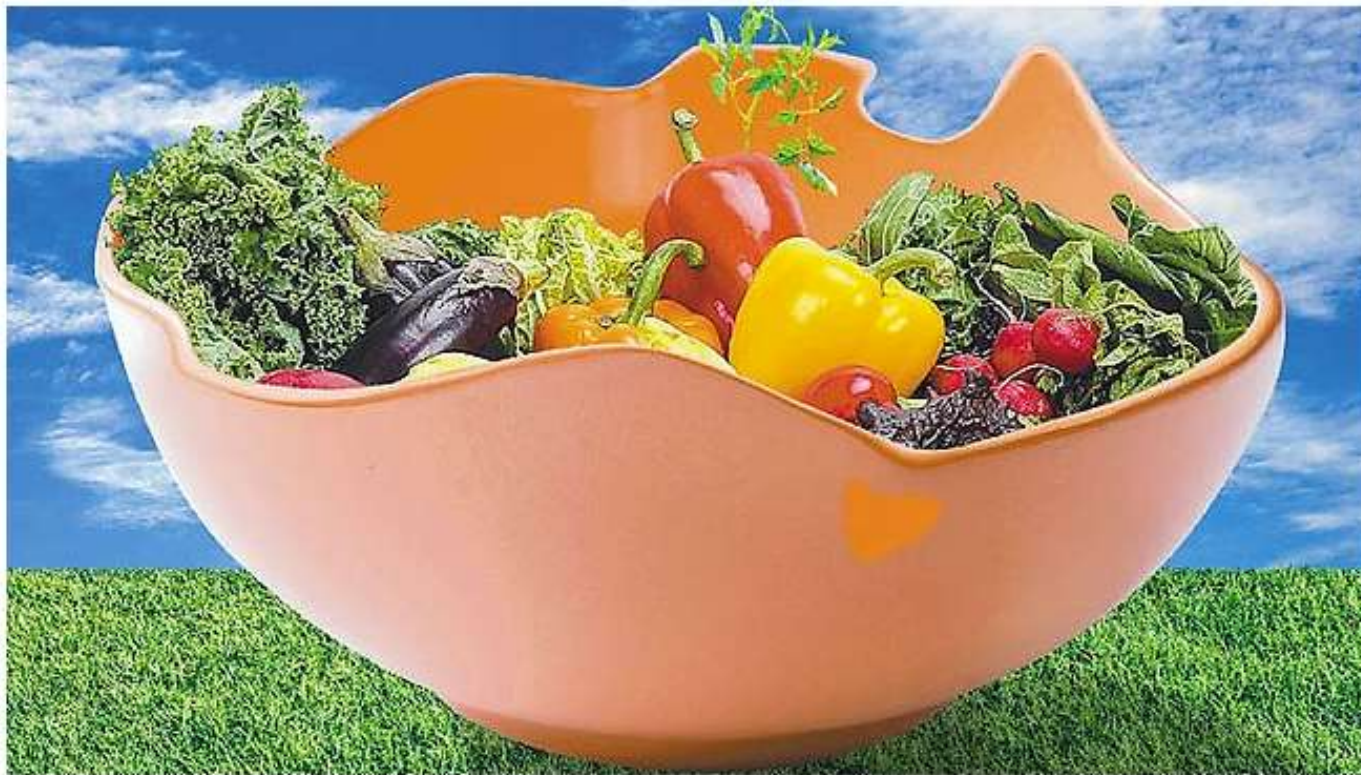
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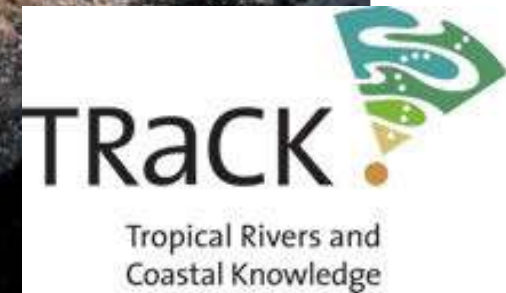
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Harness the wet. Use available land. Only then will we be able to double food production, says Andrew Bolt. Herald Sun

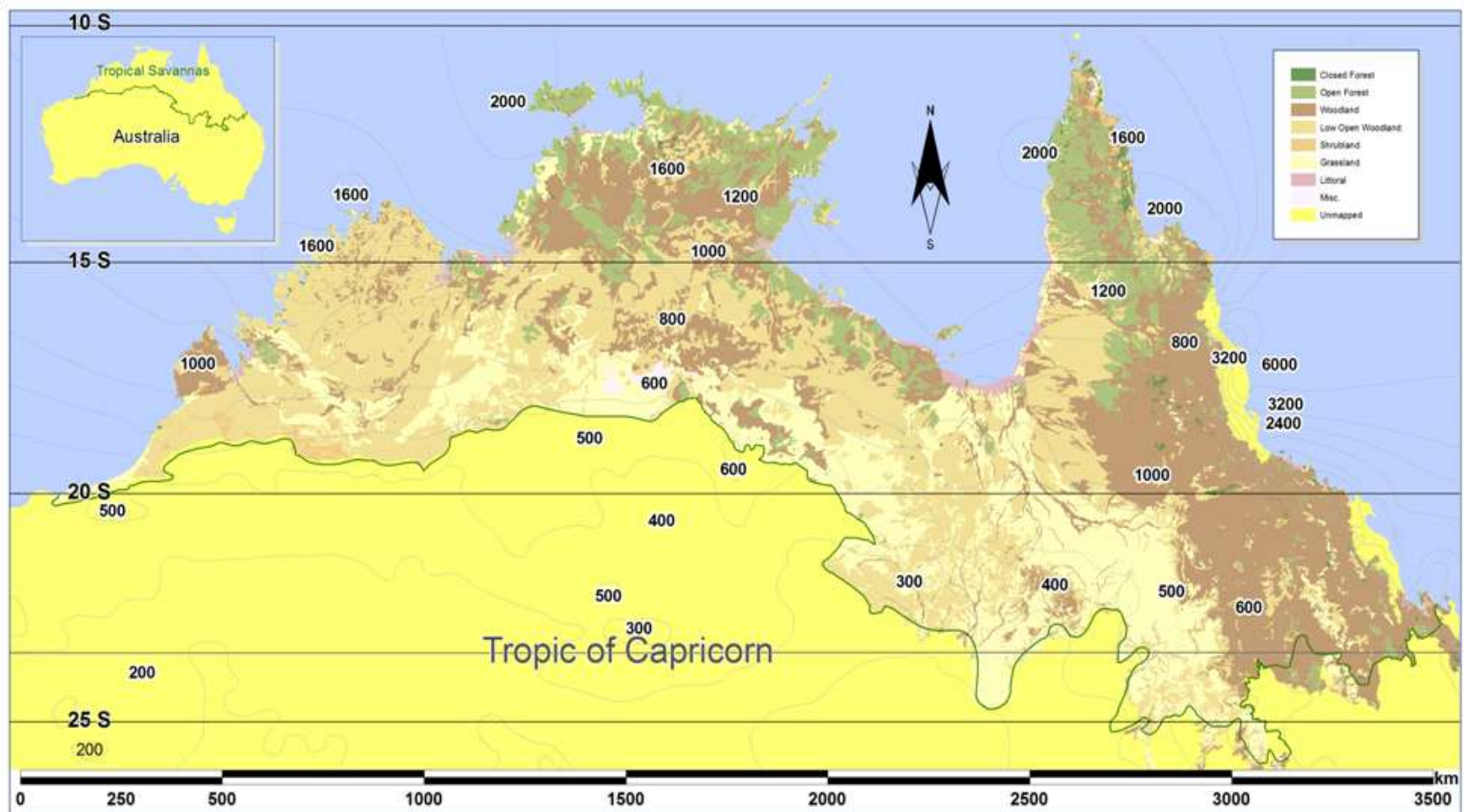


# North Australian water resources



# Landscapes of north Australia

- Tropical savanna woodland and open-forests dominate the north







# Project aims



**Evaluate the impacts of LUC on ecosystem GHG exchange**



**Evaluate the impacts of LUC on soil C and N stocks and processes at long time scales**



**Evaluate the impacts of plantation afforestation on water resources**

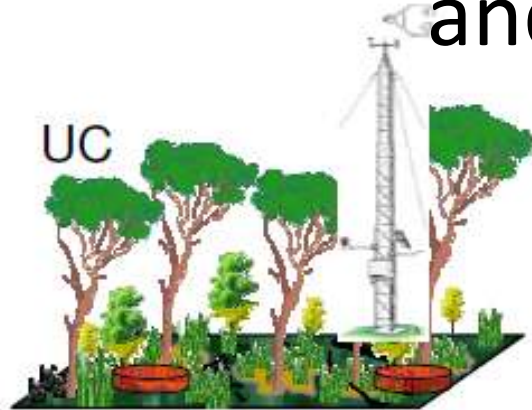


**Assess different LUC scenarios and implications for ecosystem service provision**

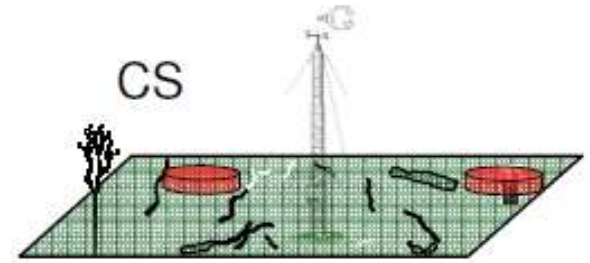


# Land use change – water use, GHG fluxes and carbon storage

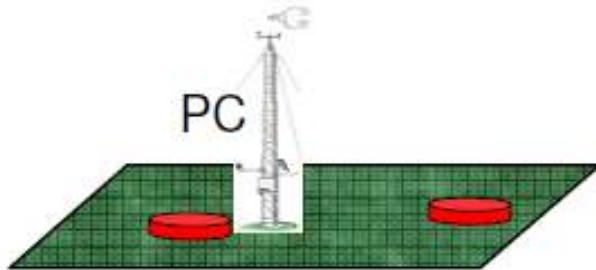
Aim 1,2



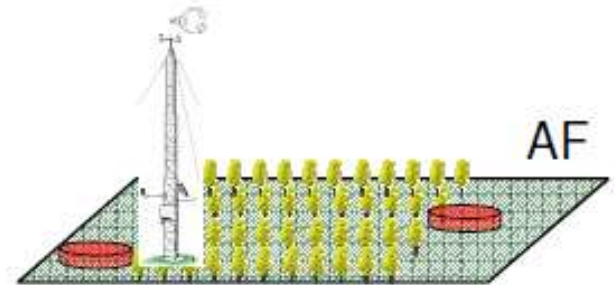
Deforestation



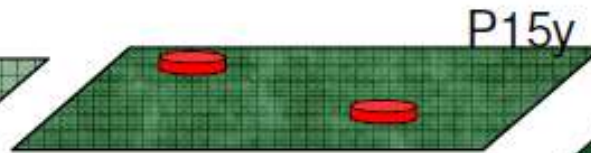
Aim 1,2



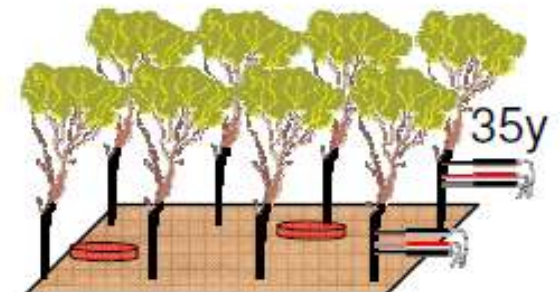
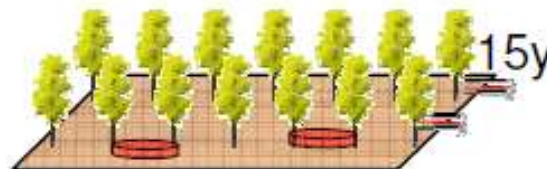
Afforestation



Aim 2



Aim 2,3



# Aim 1... Red Dirt Melons farm: savanna to melons



**Evaluate the impacts of LUC on  
ecosystem GHG exchange**





Adelaide River



Howard Springs



# RED DIRT MELONS



Daly River

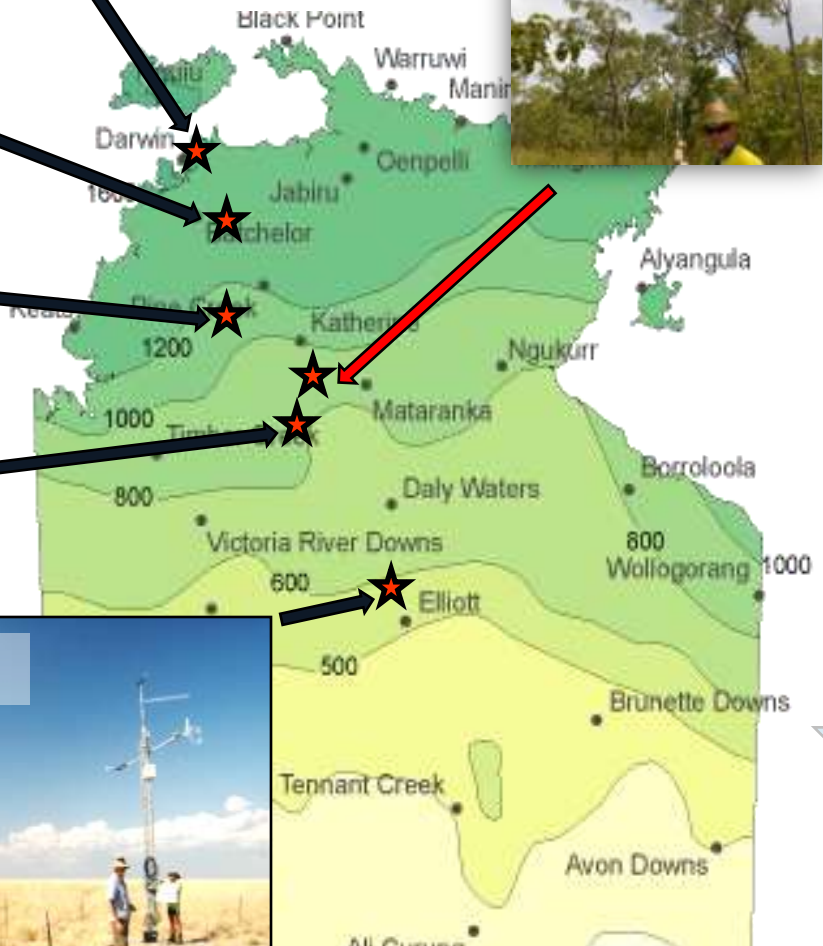


*EC Towers*

Dry River



Sturt Plains



Rainfall gradient

# Red Dirt Melons: savanna LUC site



- eddy covariance tower:
  - Aug 2011 - current
- soil gas exchange FGGA ( $\text{CO}_2$ ,  $\text{CH}_4$ ) and manual ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ), + soil nutrient and moisture monitoring:
  - Oct 2011 – current (3 pre-clearing + 7 post clearing; seasonal)

*supported with measures of:*

- Veg surveys (C stocks), litter & grasses, CWD, seasonal LAI (hemispherical photos)



# Aims 1 & 2: Soil fluxes CO<sub>2</sub> and non-CO<sub>2</sub> and drivers, and stocks C & N



**Evaluate the impacts of LUC on soil C and N stocks and processes at long time scales**



- Temporal and spatial sampling
- Replicated cleared and uncleared plots
- NO<sub>3</sub>, NH<sub>4</sub> pool size and net nitrification (resin bags)
- Soil gas diffusivity





# Aim 2: Soil C & N



**Evaluate the impacts of LUC on soil C and N stocks and processes at long time scales**



- Soil C & N
- Soil moisture
- Soil physical changes

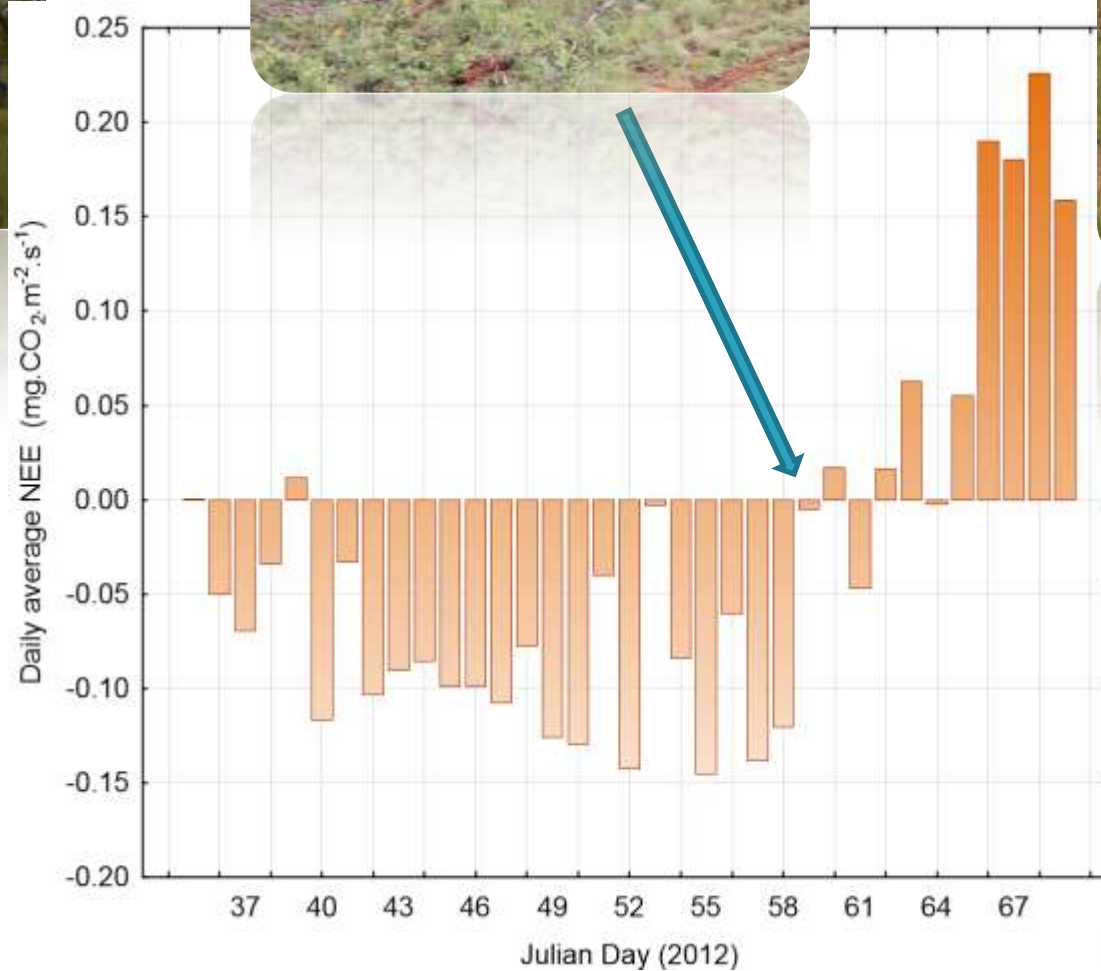


# Video





**Before**



**After**

# Aim 3: afforestation...



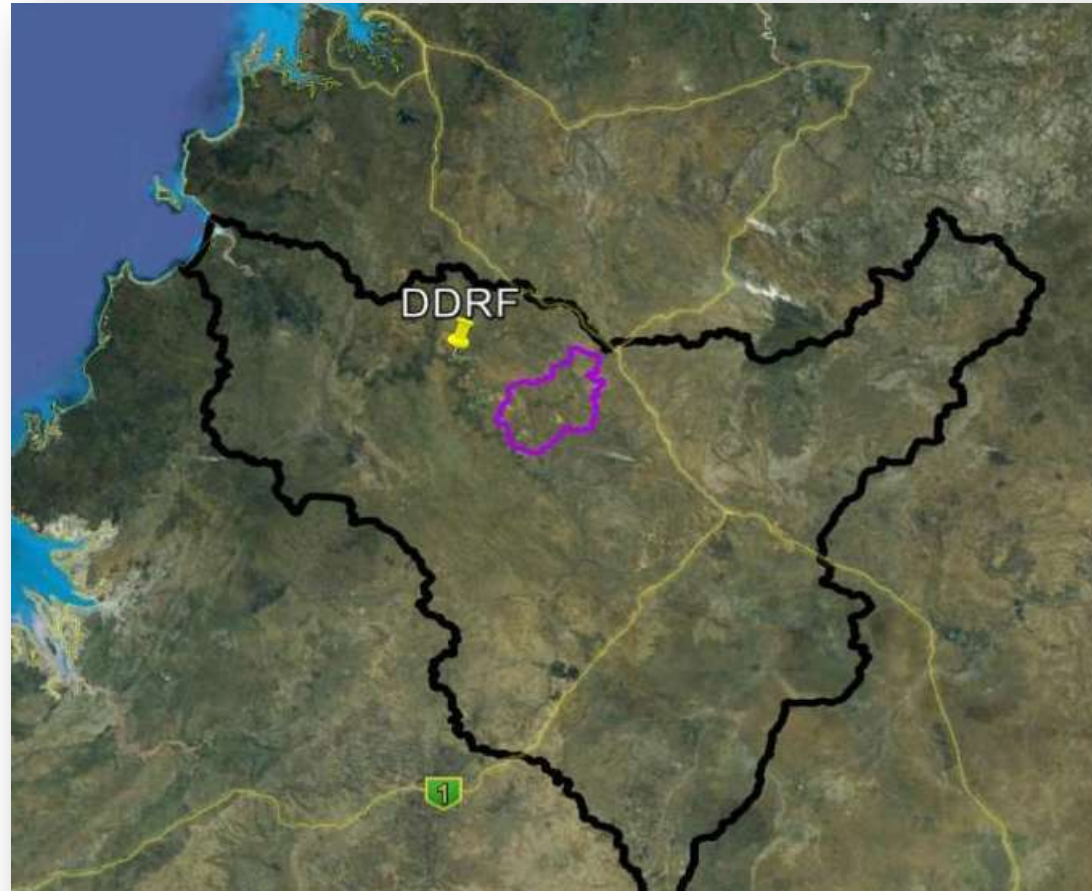
**Evaluate the impacts of  
plantation afforestation on water  
resources**





# Afforestation study Area

- Douglas-Daly study area ~ 200 km south of Darwin
- 4-8% of catchment suitable for agriculture
- Khaya (mahogany) plantations <1% total catchment area
- ~ 13,000ha, potentially increasing to 50,000ha



Douglas-Daly marked in black with research sites established at the DDRF and within the Stray Creek sub-catchment, marked in pink.

# Aim 3: afforestation ....

- Accessing ground water?
- Water use compared with other land uses
- Contrasting mahogany with savanna and with pasture they are replacing





# Tree ecophysiology... to model

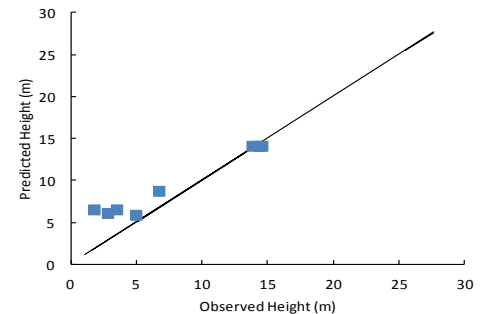
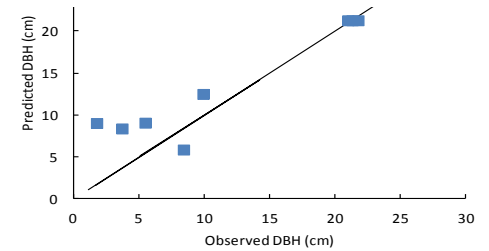
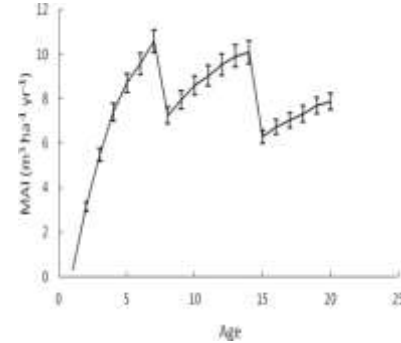
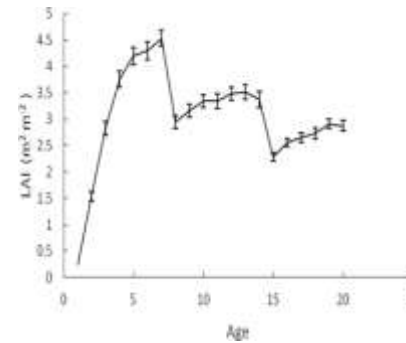
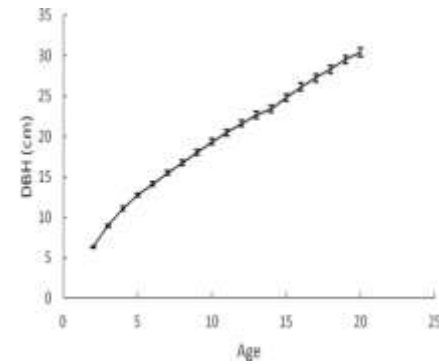
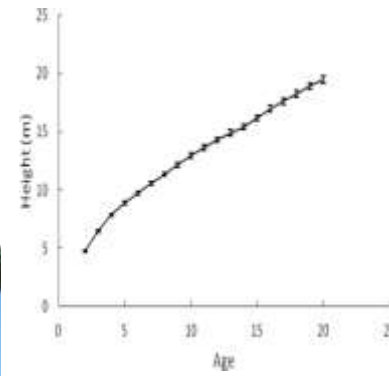


# Methods: 3PG

- Growth is modified by species dependent variables: temperature, VPD, fertility, stand age, frost and soil water.
- no parameterisations of 3PG for mahogany
- no comprehensive surveys of the growth and physiological response to these environmental variables
- conducted via a combination of literature review and expert knowledge... *first pass*



# Results: growth



$$I_R = \begin{cases} R_e & R_e \leq L\delta_{wx} / (1 - e_0 / r) \\ L\delta_{wx} + e_0 R_e / r & R_e > L\delta_{wx} / (1 - e_0 / r) \end{cases}$$

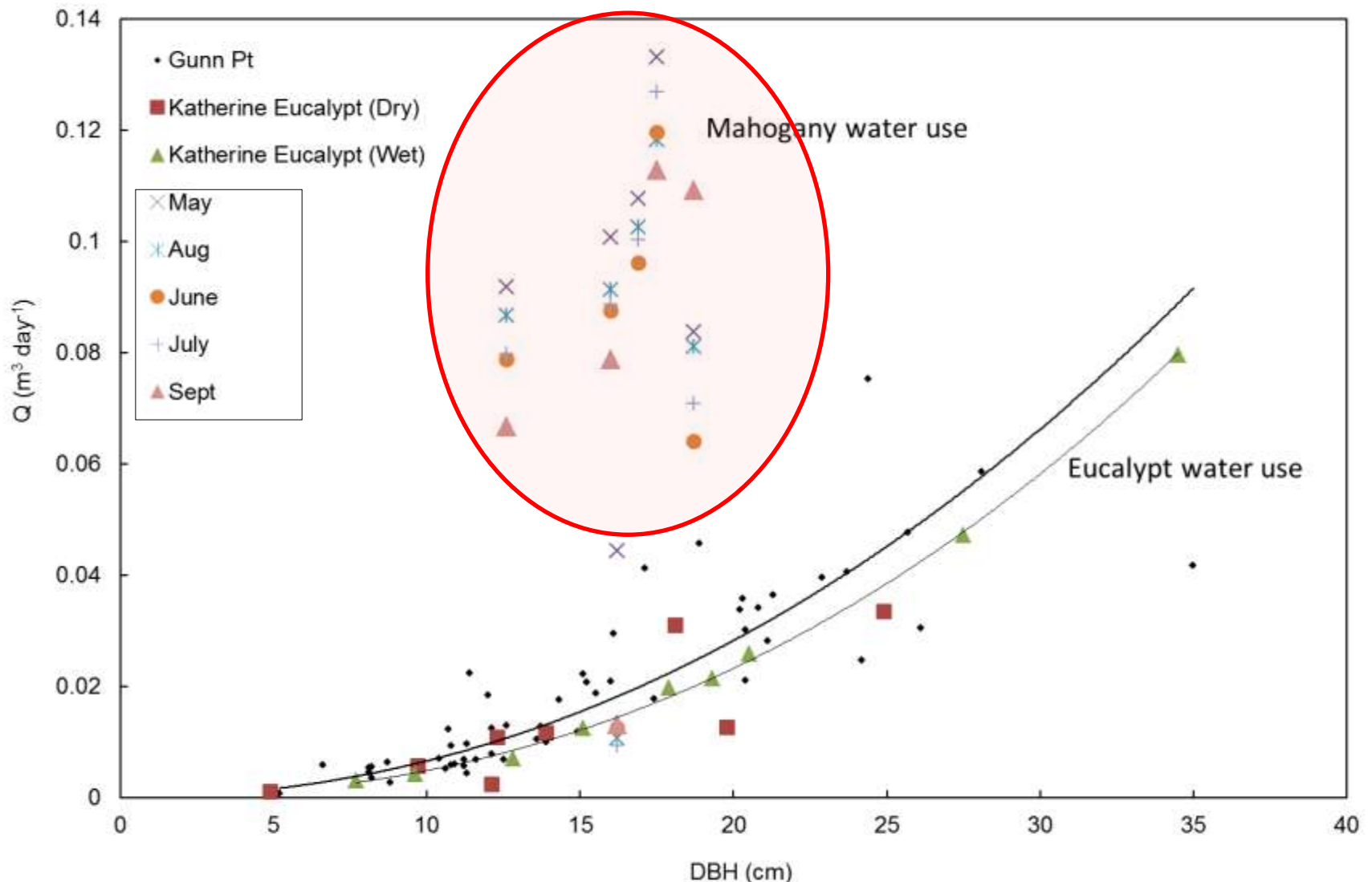
$$E_s(t) = \begin{cases} e_0 t & t \leq t_{S1} \\ E_{S1} + E_{S2} \left( \sqrt{1 + 2(e_0 / E_{S2})(t - t_{S1})} - 1 \right) & t > t_{S1} \end{cases}$$

$$D(L) = D_0 e^{-(\ln 2)L / L_{D0}}$$

$$L_F = \Delta LAI_{(t1-t2)} \times LMA$$

$$\Delta_D(t) = (\Theta_0 - V_{Soil} \theta_{fc})(1 - e^{-k_{Drain} t})$$

# Results: measured tree water use





Water balance components (all units are mm y <sup>-1</sup> )	African mahogany plantation	Tropical savanna	Improved pasture
Rainfall	1286	1260	1260
Canopy Transpiration	637	270	898
Understory transpiration	n/a	392	n/a
Interception	90	64	56
Soil Evaporation	180	184	191
<b>Total evapotranspiration</b>	<b>907</b>	<b>910</b>	<b>1157</b>
Runoff/drainage	403	379	74
ΔSoil	24	30	-28

# Aim 3: prelim results afforestation



## Evaluate the impacts of plantation afforestation on water resources

- tree water use was higher in mahogany trees compared with native savanna vegetation
- annual water use (evapotranspiration) was similar to savanna, less than pasture it replaces
- ***First pass...* impacts of mahogany plantations on water resources is deemed to be low**



From this.... to this....



To this...





# Over next year..



- Ongoing ecosystem scale CO<sub>2</sub> flux measurements
- Fire, cultivation, conversion to melons
- Ongoing monitoring of soil flux, and physical and chemical changes
- Leaf, tree and stand scale measures in mahogany trees to improve afforestation modelling

# Thanks... Questions??

Like to thank our research partners for allowing us access to their farms & plantations: Red Dirt Melon Farm, African Mahogany Australia, and Northern Tropical Timbers



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