



Greenhouse  
Accounting  
CRC



## Carbon dynamics in Australian savannas



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# Climate change and carbon is now mainstream

## Follow the issues in the Media

- **Science:** Reports on key papers in Science, Nature and PNAS
  - <http://www.theaustralian.news.com.au/climate/>
- **Economics:** Follow-up to Stern and Garnaut Reports

### California dreaming

Glenn Milne, *Australian*, January 21, 2008

The great thing about visiting California is that it gives you a sense of where Australia is probably headed. In the context of the climate change debate, this assertion stands, only more so.

### Smart money goes on trees

Matthew Warren, *Australian*, February 23, 2008

ROSS Garnaut's push for incentives for business to capture and store greenhouse gases in forests will provide a windfall for Andrew Grant and his fledgling company CO2 Australia.

- **Politics:** Virtually daily

# Savannas and carbon – why?

## Global savannas:

- 12% land area ( $16 \times 10^6 \text{ km}^2$ )
- 13% global C stock (66Pg C)

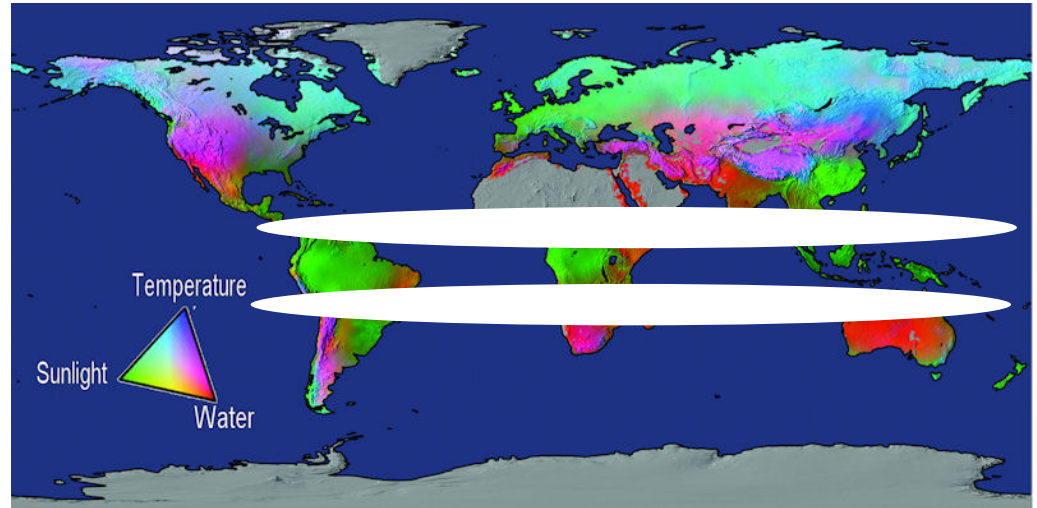
## Australian savannas:

- 26% land area ( $2 \times 10^6 \text{ km}^2$ )
- 33% continental C stock

## Oz Sav Emissions, 1991-2005

- Deforestation: 50-130 Mt CO<sub>2</sub>-e y<sup>-1</sup>
- Livestock: 60-66 Mt CO<sub>2</sub>-e y<sup>-1</sup>
- Fire: 5-15 Mt CO<sub>2</sub>-e y<sup>-1</sup>
- Strong influence: climate, land use

## Sequestration capacity



# We need knowledge about savanna carbon

## **Savannas will be increasingly important because:**

- GHG abatement is international news
- Savannas a large part of the national and international emissions and sequestration story
- Meeting targets will become big business
  - individuals, corporations and governments
- We need to know where we stand as savannas will be part of the deal

# Savanna ecology 101

Wet season



Dry season



Strongly seasonal phenology of growth and disturbance  
Extensive, 'intact' landscapes  
Multiple values

# Carbon dynamics in Australian savannas

## Three foci of carbon project

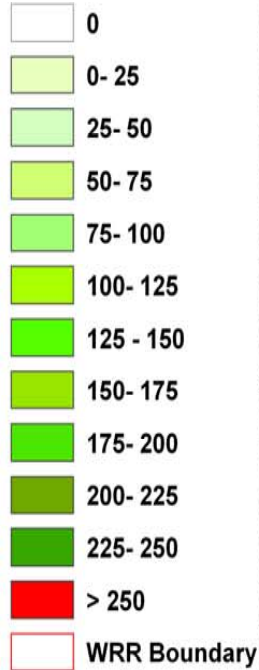
- Stocks – chopchop, digdig and weighweigh, allometry, RADAR
- Emerging knowledge of strength of sink/source in relation to land use
  - **Net Ecosystem Productivity (NPP – autotrophic respiration)**
    - **Net Biome Productivity (NEP minus disturbance)**
      - **FACE experiment**
- Markets and the long-term business prospects

# Estimation of biomass carbon stocks by RADAR

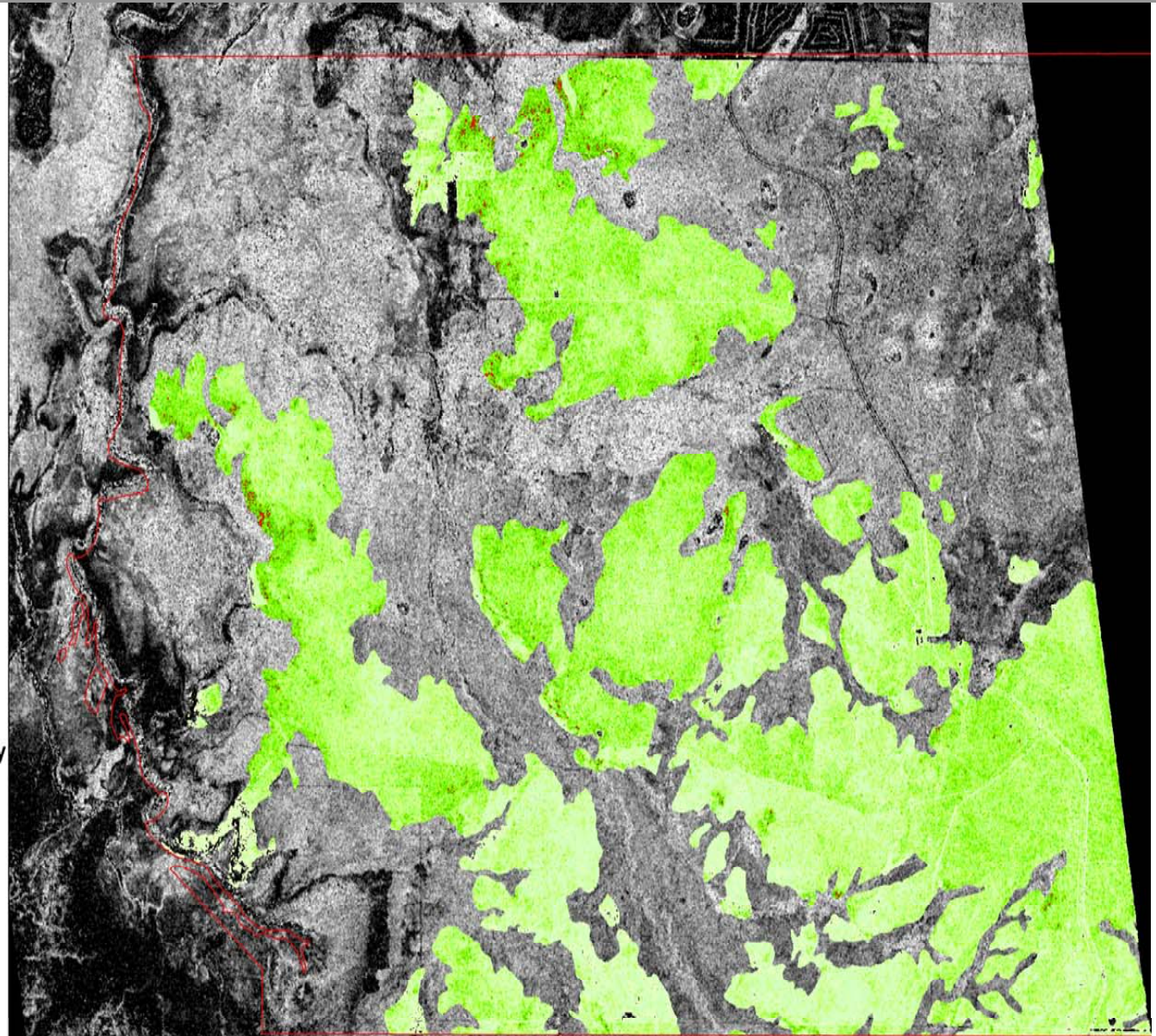
Mary River Catchment *Collins et al. in press*

## Total C storage

t C ha<sup>-1</sup>



0 1.5 3  
Kilometers



# Savanna carbon sequestration potential

## Necessary component of full carbon accounting

### Substantial international efforts

Five published approaches to estimating Net Ecosystem Productivity (NEP) and Net Biome Productivity (NBP) in Australian mesic savannas

1. By Mass-balance and allometry (*Chen et al. 2003*)
2. Apply point source NEP, to landscape-scale area burnt (*Williams et al. 2004*)
3. Eddy covariance before and after fires (*Beringer et al. 2007*)
4. Inventory modelling (*Cook et al. 2005*)
5. VAST coupled carbon-water model (*Barrett et al. 2008*)

# Chainsaw Chen et al.

Allometry, respiration chambers, and mass balance – site based

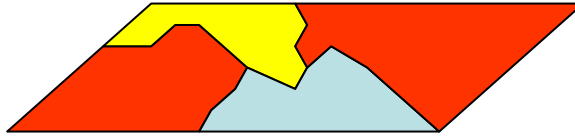


$$\text{NBP} = -1 \text{ t C ha}^{-1} \text{ y}^{-1}$$

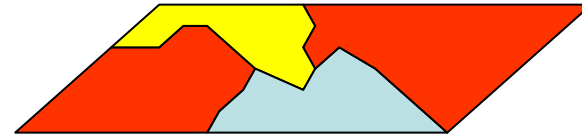
# Williams et al. 2004

NBP at landscape scale – NEP minus regional emissions in Arnhemland

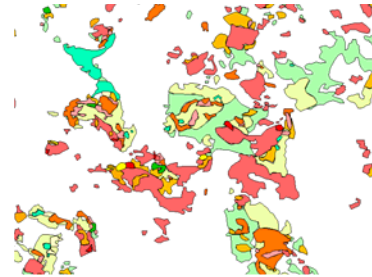
NEP  
estimate



Fuel type  
map

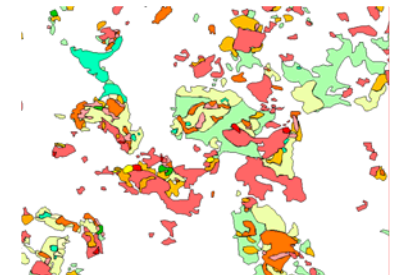


Area burnt



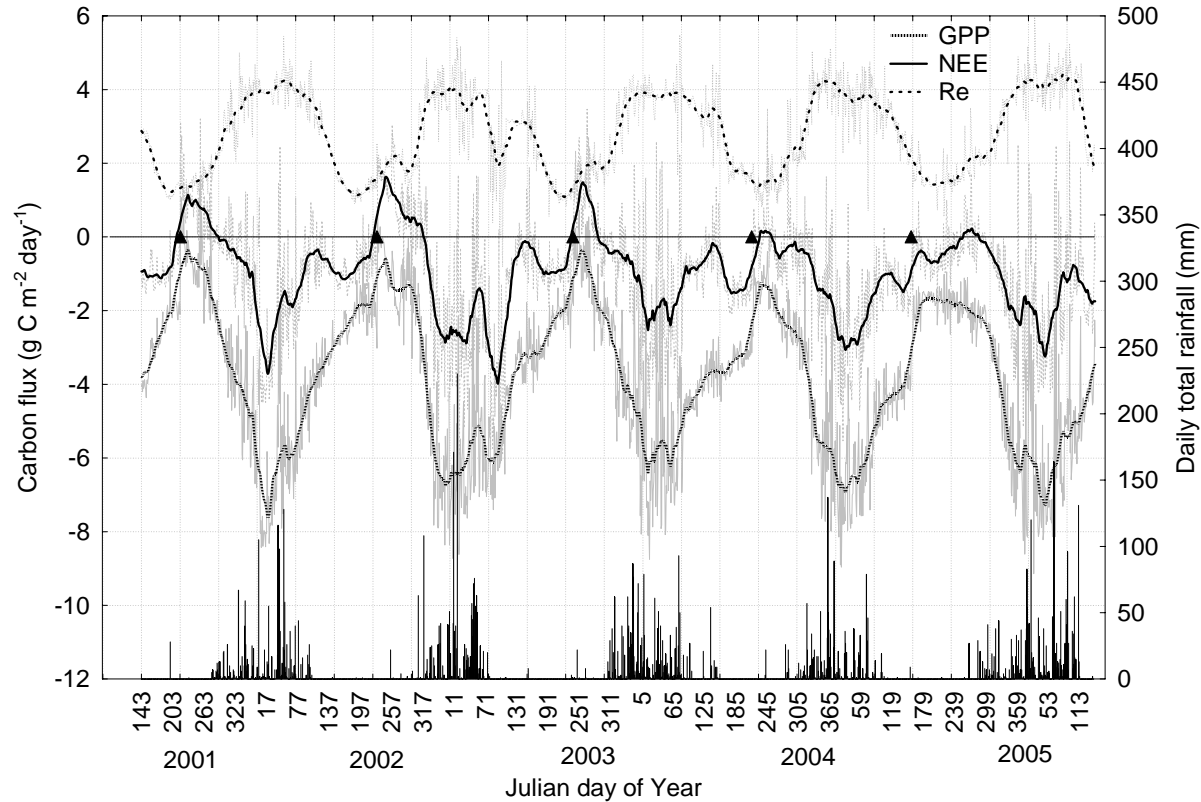
$$\text{NBP} = -1.1 \text{ t C ha}^{-1} \text{ y}^{-1}$$

Burning  
efficiencies



# Burnum Beringer et al. (2007)

Eddy covariance – Darwin site based; 5 years' data



$$\text{NBP} = -2 \text{ t C ha}^{-1} \text{ y}^{-1}$$

# Cook et al. (2005)

Tree NBP at multiple sites, decadal, mesoscale plots at Kapalga Research Station

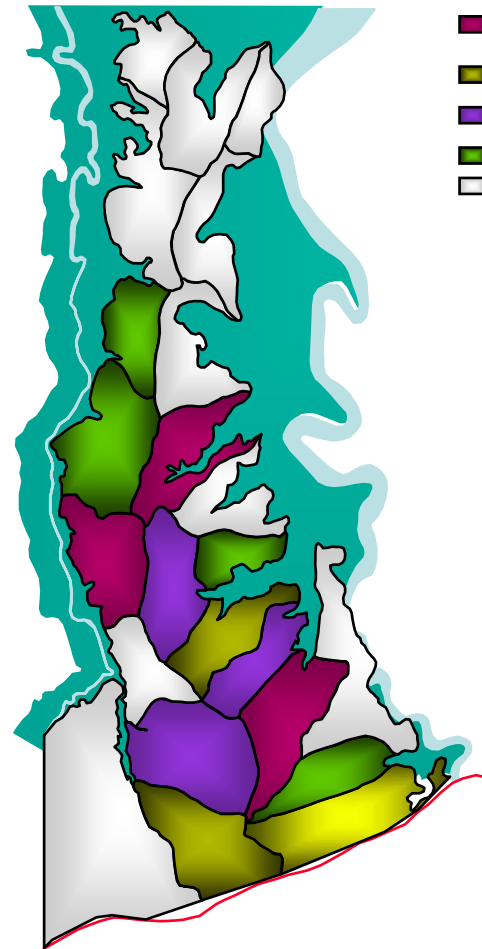
30 Long term 0.1 ha plots at Kapalga, NT

Stand allometry – thousands of DBHs

Varying fire regimes over 15 years at replicated landscape scale

– benign to severe

**NBP (trees)**  
**= - 0.5 t C ha<sup>-1</sup> y<sup>-1</sup> (benign)**  
**+ 4 t C ha<sup>-1</sup> y<sup>-1</sup> (severe)**

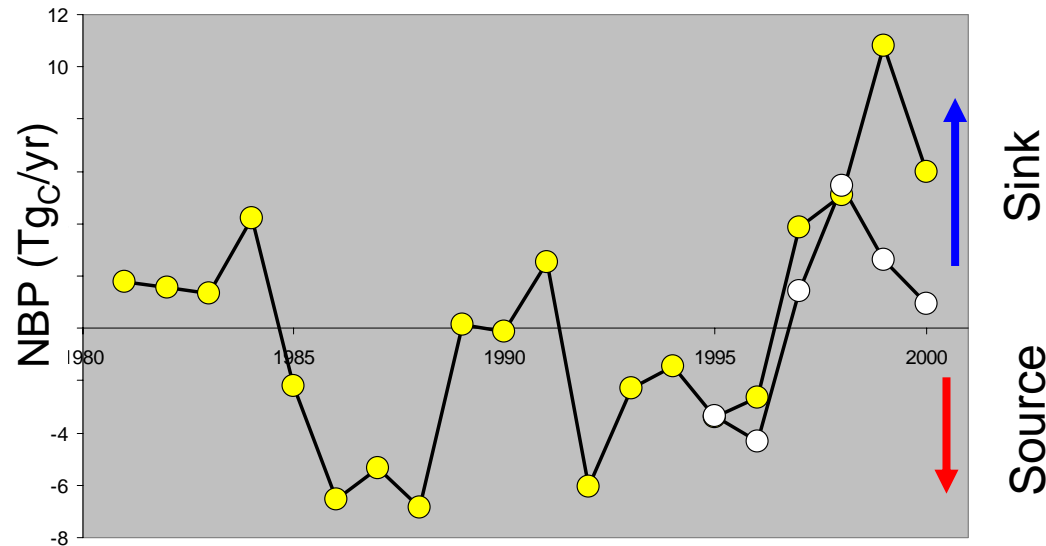


■ Ann. Early  
■ Ann. Progressive  
■ Ann. Late  
□ Unburnt  
Not used

0 10  
Kilometers

# VAST coupled carbon-water model

Barrett *et al.* 2007



## Coupled fire into model:

- 15 years: mean fire frequency
- 5 years: AVHRR/ATSR forcing
- Captured feedback: climate → NPP → fuel → emissions

**Source or sink on decadal scale**

**Strong climate feedback on NBP**

# Savannas a sink....consistent signal, multiple methods

**NBP: Range -1-2 t ha<sup>-1</sup> yr<sup>-1</sup>**

- In line with most of the world's forests – sinks

Amazon, Siberia, Europe; ca. -1 to -5 t C ha<sup>-1</sup> yr<sup>-1</sup> (Schulze; 2005 Biogeosciences Discussions; Magnani Nature. 2007)

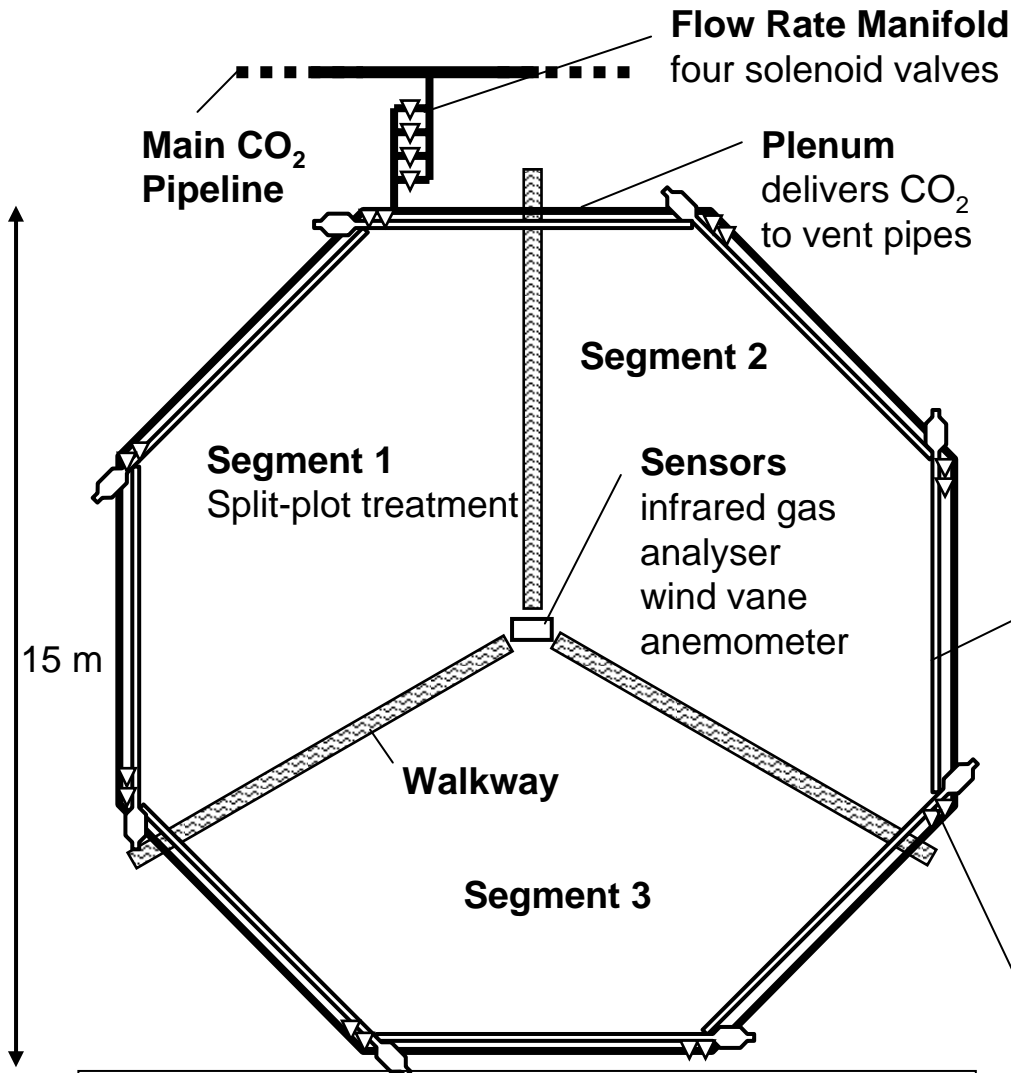
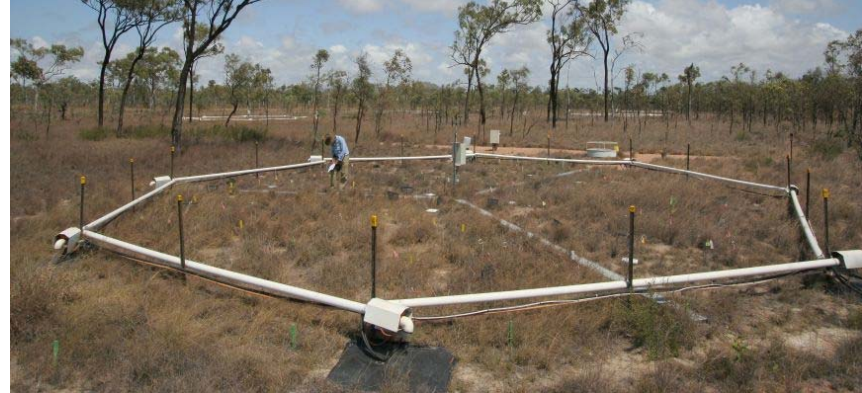
Global savanna sink: - 0.15 t C ha<sup>-1</sup> yr<sup>-1</sup> (Grace; *GCB* 2006)

- Oz savannas a sink even when burnt (25 - 50% of landscape)

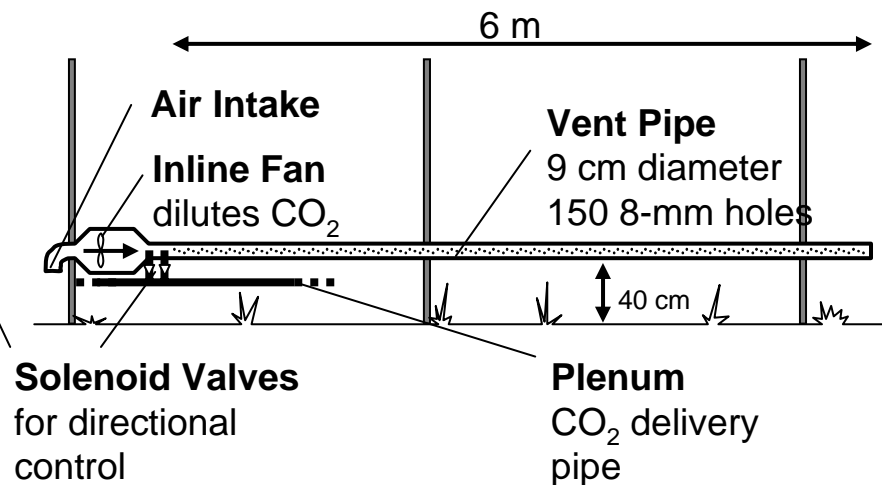
- NBP sensitive to fire regime

Profound implications for international carbon accounting

# OzFACE Townsville; Stokes et al



## Single Vent Pipe (Horizontal view)



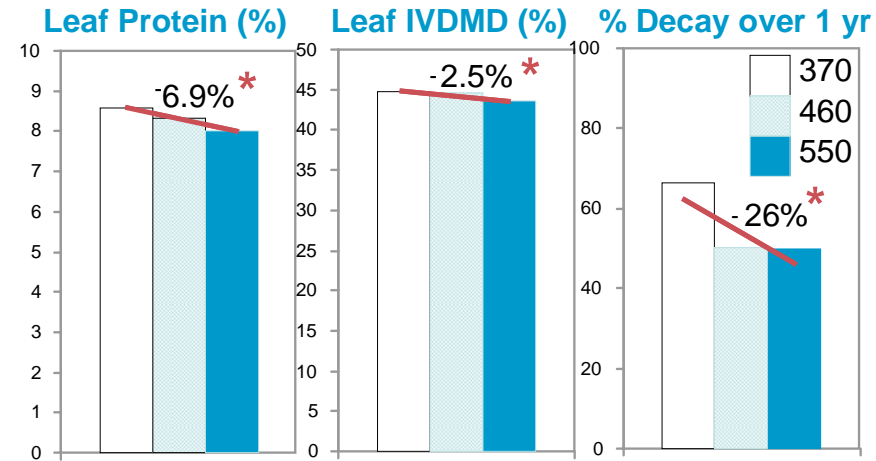
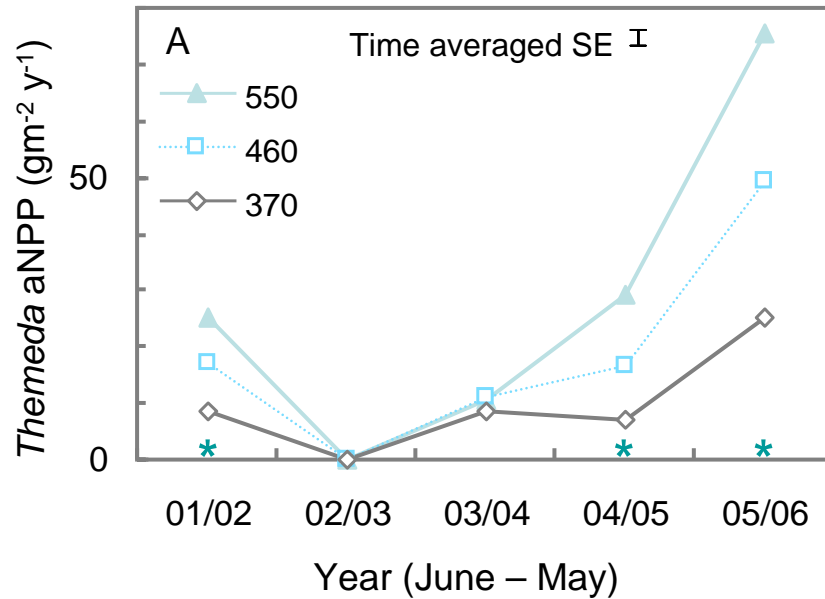
**3 levels CO<sub>2</sub> fertilization:**  
370 ppm (current ambient); 460 & 550 ppm

# FACE - results

- Tree seedlings (eucalypts and acacias) show evidence of enhanced growth under elevated CO<sub>2</sub>
- Grass growth enhanced under elevated CO<sub>2</sub> **BUT** accompanied by decline in crude protein and bulk digestibility
- Rising soil moisture levels under elevated CO<sub>2</sub>, which might be due to increased water use efficiency of vegetation



# *Themeda triandra* (Kangaroo grass) eCO<sub>2</sub> responses



## *Themeda* – dominates aNPP response

- Overall 5 yr aNPP response +38%
- Themeda*: +183%\* (~triple)
- Other perennial: (+3.3%)
- Annual grass aNPP: (-2.9%)

## Reduced *Themeda* forage quality

- lower leaf protein
- lower digestibility
- reduced litter decay

# OzSavanna carbon story

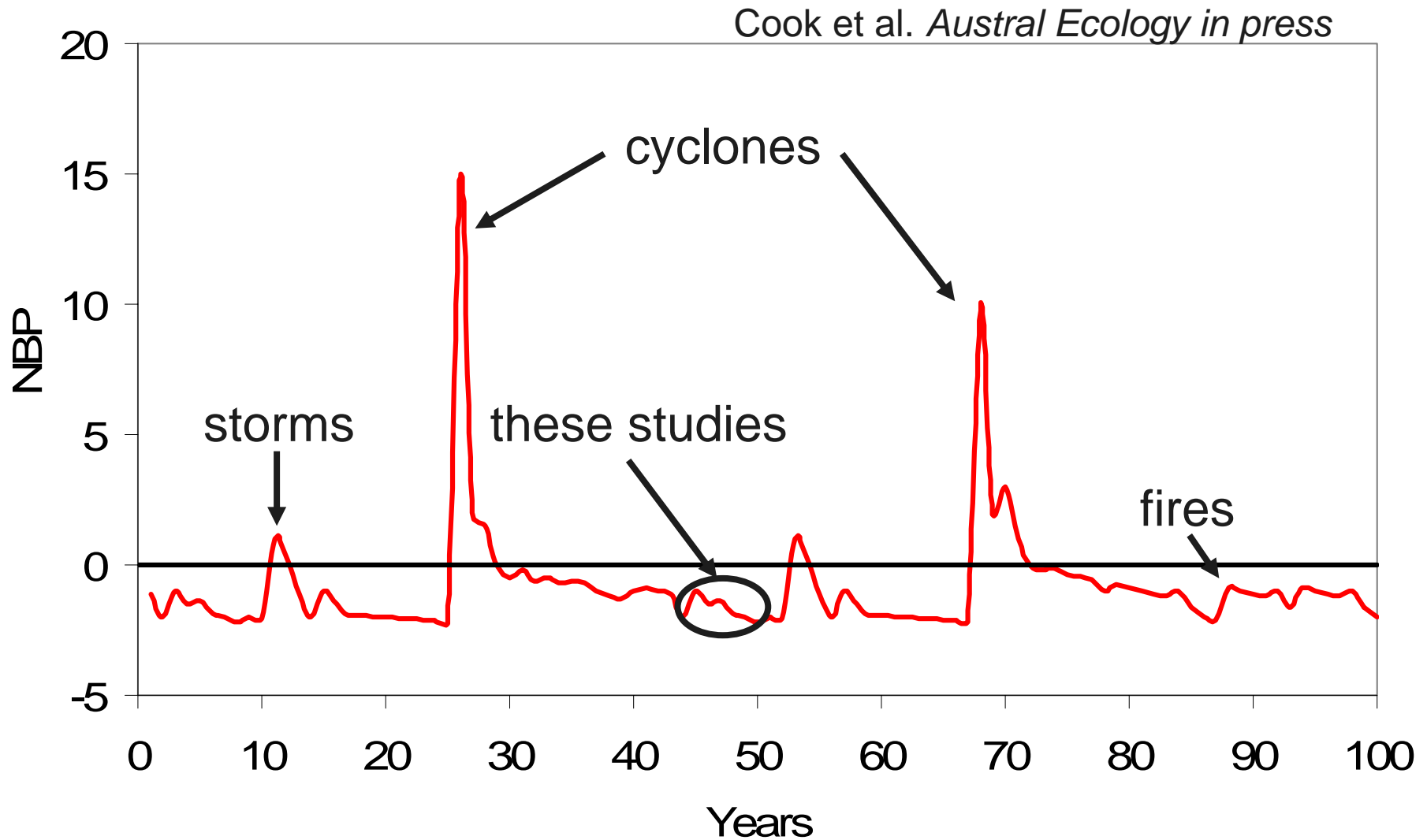
## The future

### **Disturbance regimes and climate interactions**

- Long-term variation in NBP – fire x cyclones
- Grazing and soil carbon

# Sink dynamics

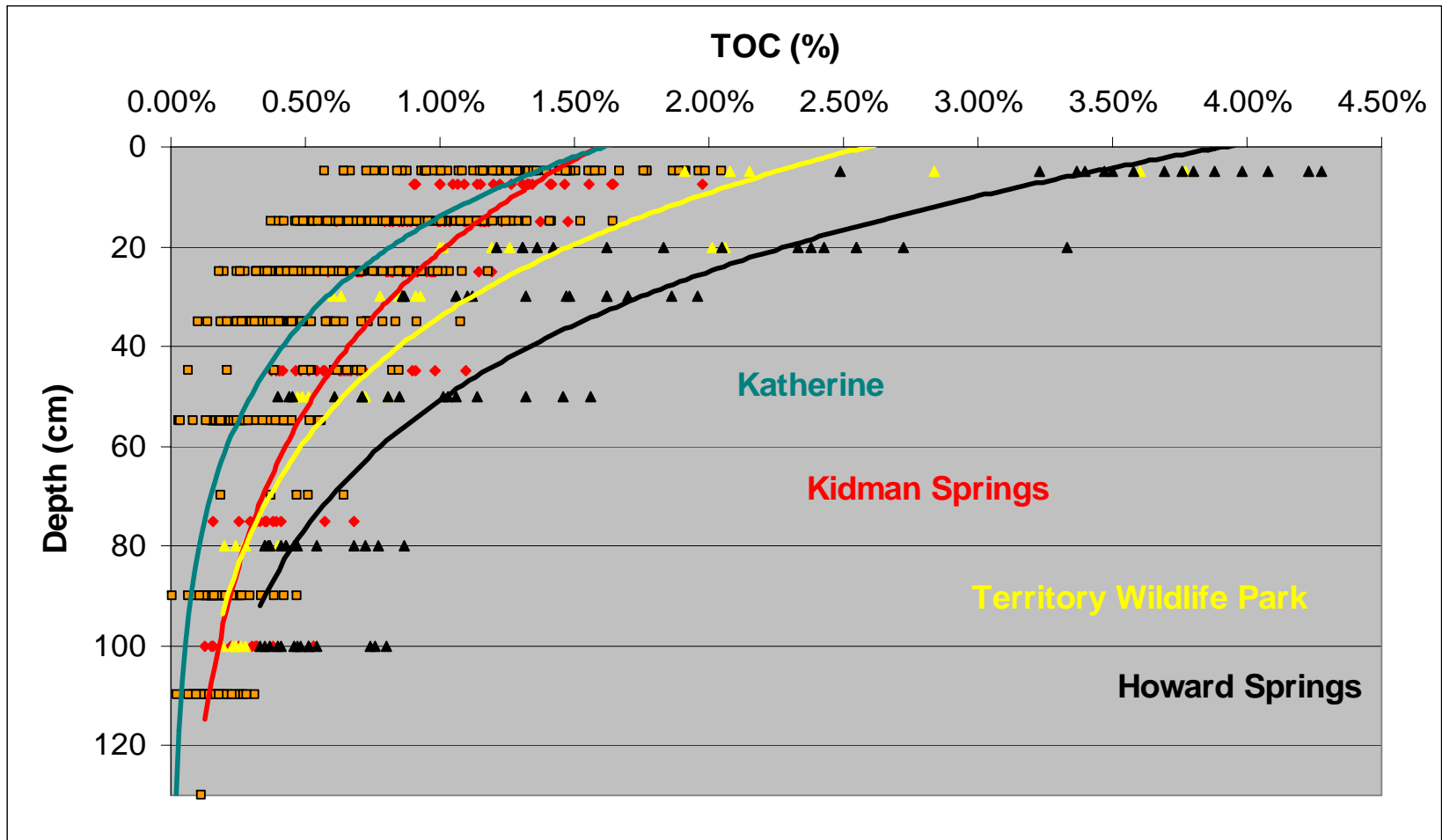
Constant disturbance cycle



# Soil Organic Carbon -

where most of the carbon lies; where the action will be

## SOC in mesic and semi arid savanna sites



# OzSavanna carbon story - The future

## **Disturbance regimes and climate interactions**

- Long-term variation in NBP – fire x cyclones
- Grazing and soil carbon

## **Greenhouse Accounting**

- Emissions from smoke
  - Non-CO<sub>2</sub> story (methane, nitrous oxide)
- Carbon sequestration capacity and land use
  - The CO<sub>2</sub> story
  - NCAS – 9/10 carbon Accountants recommend NCAS!
  - Coupled and calibrated ecosystems models (CABLE, ACCESS)

## **Risk management**

**Research** - ARC Linkage on non-CO<sub>2</sub> fluxes and land use; ARC Discovery on spatial modelling of CO<sub>2</sub> fluxes

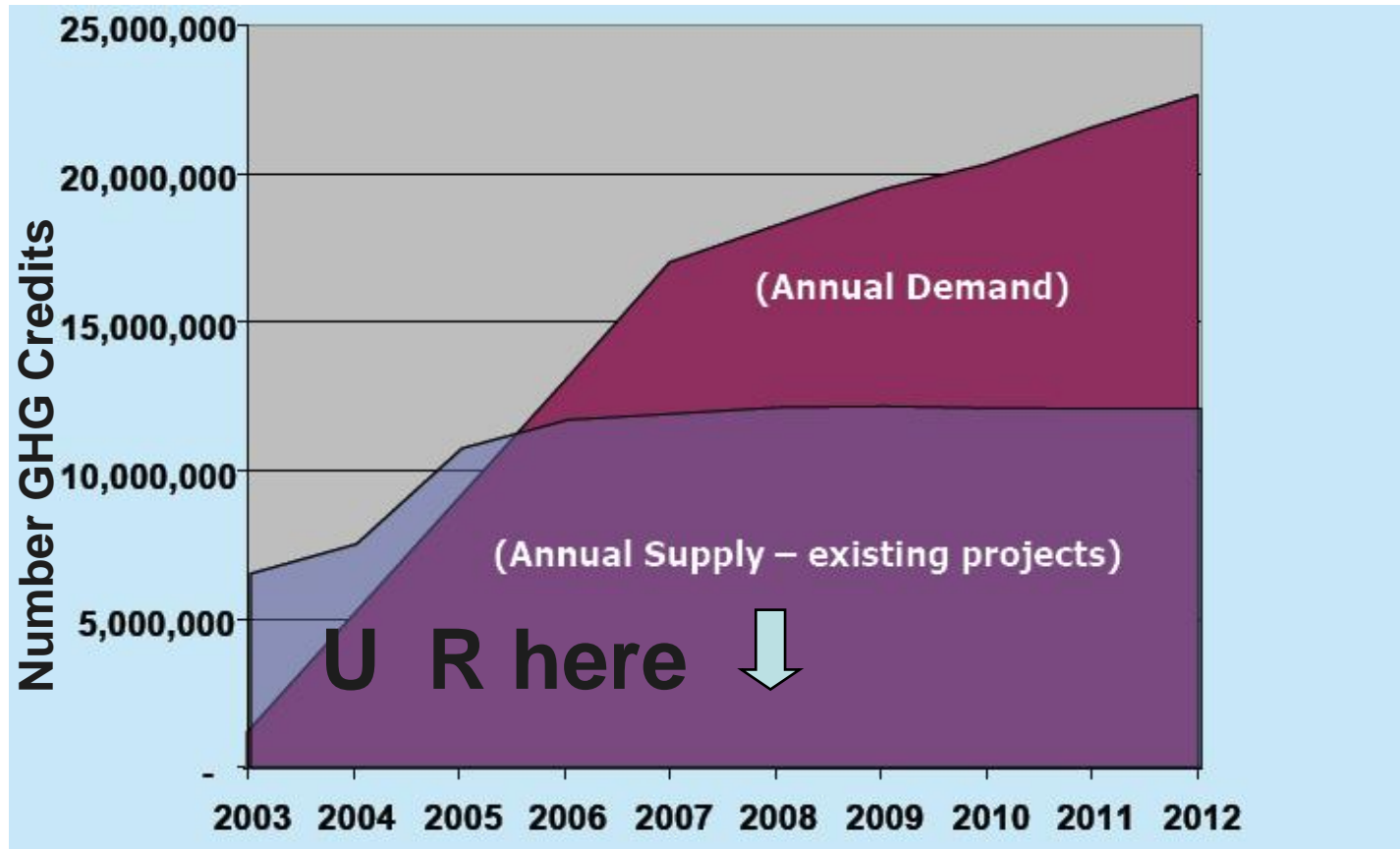
# Carbon markets

- **Global carbon markets traded more than 800 million t CO<sub>2</sub>e worth \$13 billion in 2005**
- **Spot price ca. US\$5-50 tonne**
- **Voluntary and regulated markets**
- **Extensive and boutique markets; willingness to pay**
- **Carbon product quality (bond market?)**

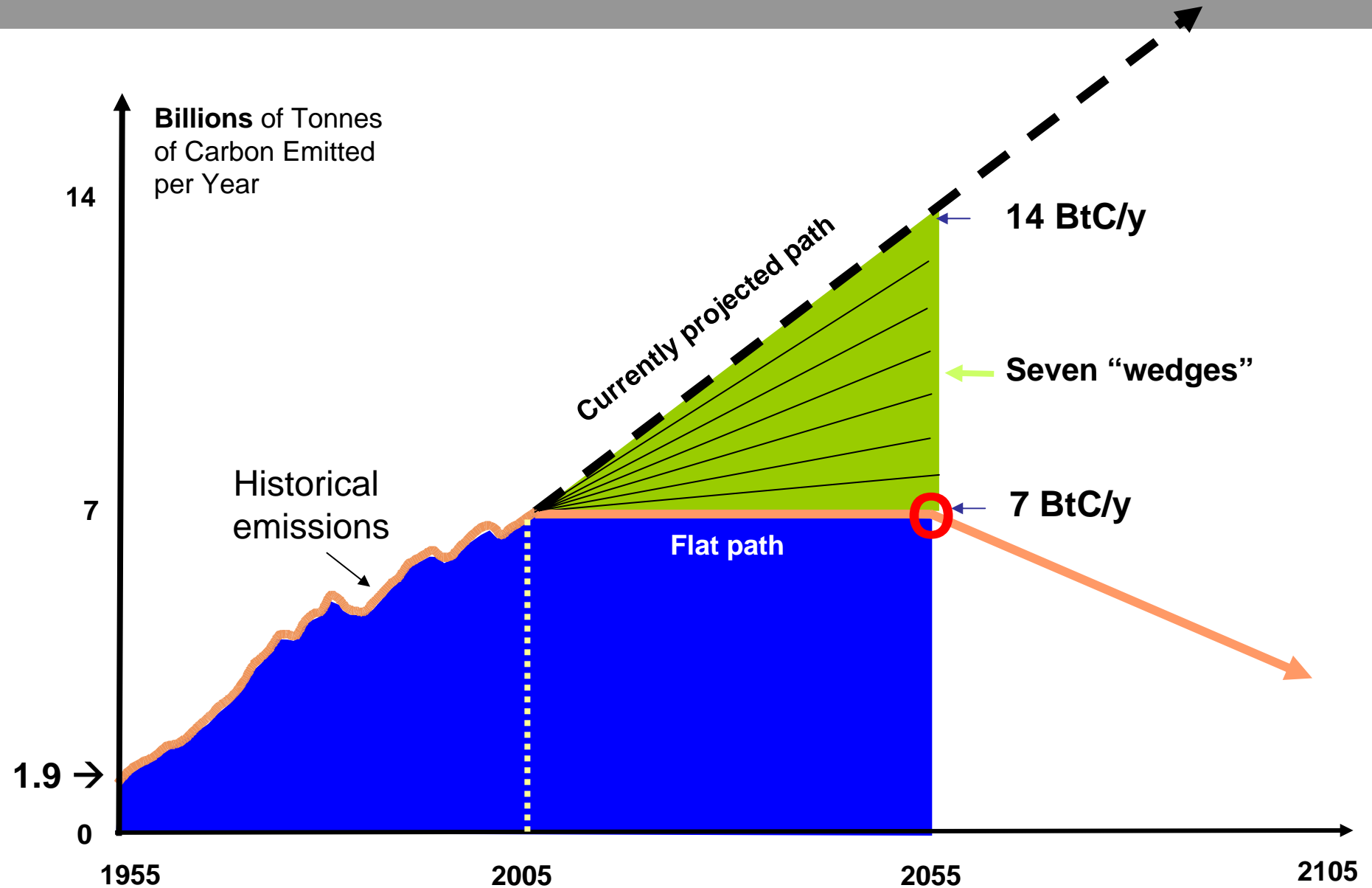
# Demand on our front door step

Demand for NSW GGAS Credits to 2012

Demand already outstripping supply



# Wedges – a way of looking at GHG abatement



# Carbon trade looks to land

MEET Queensland's first carbon farmer. Peter Allen, a third-generation farmer, has signed a \$1 million deal for doing nothing at all. JOEL DULLROY reports.

**I**N AN historic transaction, mining company Rio Tinto has purchased the rights to carbon dioxide stored in 3500ha of Peter Allen's bushy property, about 575km northwest of Brisbane.

Instead of clearing the land to run cattle, Mr Allen will preserve the trees for 120 years to ensure they soak up carbon dioxide.

When you hear talk of carbon offsets, this is where the money goes.

Many farmers stand to reap multimillion-dollar incomes from selling carbon rights to large corporations or individuals wishing to become carbon neutral.

"It's not like I have won the lotto or I'm a tree-hugger," Mr Allen said.

"It was a purely financial decision," he said.

"We looked at the return on developing that land for

grazing, compared to the return from the carbon rights.

"We had to think hard before we decided to lock that land up for the next 120 years. If it had been any less money, we wouldn't have done it."

This time last year, Mr Allen had eight bulldozers ready to knock down a swathe of trees on an investment property just outside Charleville.

Under the Queensland Government's moratorium on land clearing, farmers were given until December 2006 to enact one final clearing permit.

Rio Tinto stepped in, offering Mr Allen and five other farmers money in exchange for their inaction.

A total of 12,060ha was spared,

the carbon rights secured under a legally binding contract.

It is believed to be Australia's biggest carbon-trading deal.

The carbon industry is expected to boom after the Prime Minister's Task Group on Emissions Trading hands down its blueprint next Thursday.

But, as the carbon industry gears up, questions have been raised about the lack of regulation over the voluntary offset market — the system through which airline passengers, rock festival patrons and guilty drivers can pay for their pollution.

Green watchdogs say the voluntary market is open to exploitation, with no controls on who can sell carbon and no checks on the work carried out.

- Possibilities for local voluntary trade in carbon
  - not clearing
  - WALFA
- Risks significant? Yep.
- Perverse outcomes? Yep.

# Using National Carbon Accounting System (NCAS) in savanna carbon decision making

- **Need to determine our current ability to predict C stocks in northern Australian savannas with landuse change (fires, clearing and grazing) using FullCAM/NCAS.**
- **A range of users (NT Govt) require NCAS estimates for policy decisions.**
- **NCAS now being used as Global Carbon stock estimation tool by the Clinton Climate Initiative.**
- **LWA funded project, thru CRC to calibrate for savannas**

# Take home messages: Savannas and Carbon

- **Nth Australia international leaders in R&D capacity for savanna carbon**
- **Emerging carbon economies in the savannas**
  - Fire abatement demonstrable technology and investment potential
  - Grazing and soil carbon; tree planting on the horizon
  - Sequestration in soils ?
- **Winners and losers – gain in the grass, but lose in the nitrogen**
- **Look for multiple benefits of managing for savanna carbon**
  - Emissions reduction
  - Sequestration enhancement
  - Biodiversity benefits
  - Regional employment
  - Exportable technology
  - **Synergy:** the new energy source for the 21st C

# Thanks to those who

dug, chopped, weighed, crunched, critiqued

<b>Lindsay Hutley</b>	<b>Waqar Ahmad</b>
<b>Garry Cook</b>	<b>John Carter</b>
<b>Davis Rose</b>	<b>Sue Jackson</b>
<b>Michelle Allnutt</b>	<b>David Shelton</b>
<b>Adam Liedloff</b>	<b>Guy Boggs</b>
<b>Jason Beringer</b>	<b>Jeremy Russell-Smith</b>
<b>Damian Barrett</b>	<b>Malcolm Gill</b>
<b>Robert Eager</b>	<b>John Woinarski</b>
<b>Jon Schatz</b>	<b>Ross Bradstock</b>
<b>Jack Cusack</b>	<b>Robyn Cowley</b>
<b>James Collins</b>	<b>Chris Stokes</b>
<b>Ivan McManus</b>	

# And to those six wise men who were there at the very beginning



*Meeting of management committee CRC for Sustainable Development of Tropical Savannas, rear L to R: Professor Greg Hill, NTU, Dr Joel Brown, CSIRO, Dr Phil West, Director CRC, Tropical Savannas, NTU, front L to R: Peter Whitehead, Parks and Wildlife, Dr Paul Novelty, Department of Agriculture, WA, Dr Ross Hynes, Deputy Director, CRC, 1995*