Fluxing up the Deep North – an update

Mila Bristow (CDU), Jason Beringer (Monash), Peter Isaac (TERN), Stephen Livesley (U Melb), Stefan Arndt (U Melb), Matthew Northwood (CDU), Benedict Fest (U Melb), Lindsay Hutley (CDU)
Outline

• Northern Tropical Transect – CDU, Monash, UTS
  • TERN OzFlux
  • ARC Discovery program - *Australian savanna landscapes: past, present and future* (Beringer, Hutley, Yu, Haverd *et al.*)
    ❖ Dr Brad Evans – Project Research Fellow (MQ Uni)
• ARC Future Fellow – Beringer.com
• Land Use Change – CDU, Monash, Melb Uni
  • ARC Linkage project – *Impacts of deforestation and afforestation on greenhouse gas emissions, and carbon and water resources*
    ❖ Dr Mila Bristow - Project Research Fellow (MQ Uni)
  • ARC LIEF *Mobile Australian field isotope alliance (MAFIA)* JCU, ANU, CDU
• Tropical Savanna Super Site – CDU, Monash, NT Gov
• Carbon Farming Initiative: SOC and afforestation – Qld Gov, USC, CDU
• ARC DP - Deciphering pre-human records of vegetation from northern Australian savanna
Tropical savanna
North Australian landscapes
Savanna burning – 2011 fire scars
Spatial patterns of mass and energy exchange

UTS managed arid zone tower
Savanna land use change

- Savanna clearing and conversion to agricultural production – GHG emissions
- Afforestation and plantation establishment – impact on water balance and environmental flows?
Land use in Australia today

Data source:
Australian Native Vegetation Assessment 2001 (Figure 11, p. 43)
Data used are assumed to be correct as received from the data suppliers
© Commonwealth of Australia 2001
Land Use Change – Impacts of deforestation and afforestation fluxes of C and water

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

>60% of Australia’s water resources

TRaCK
Tropical Rivers and Coastal Knowledge
LUC Program - Savanna clearing and GHG

Red Dirt Melon Farm (RDMF) Flux Tower

Daly River: uncleared savanna

Red Dirt Melons Farm – converted savanna

Australian Government
Australian Research Council
RDMF Tower - Expansion of an established watermelon farm

- 3 plots cleared in March 2012
- 3 plots remain intact savanna

12 chambers in each plot
36 flux measures per treatment
Measures start Oct 2011
Savanna clearing and GHG

- Flux towers on paired sites
- Non-CO$_2$ program
- Track emissions from LUC
- Scale up to annual sink/source
Tools used: standing biomass

• Need to know stocks as well as fluxes
• How much biomass in the savanna?
• Fire emissions calculations
Non-CO$_2$ fluxes, soil C & N stocks with LUC

- Temporal and spatial sampling of soil efflux CO$_2$ and non-CO$_2$ and drivers
- Replicated cleared and uncleared plots
- NO$_3$, NH$_4$ pool size and net nitrification
- Soil physico-chemical characteristics
LUC phases

- Tower install pre-clearing
- Late dry season, Sep 2011
- Uncleared site running
LUC phases

- Wet season 2011/12
• Clearing, March 2012
LUC phases

- Post-clearing debris, April
• Curing and decomposition, regrowth, May-August 2012
• Fire event, 16 August 2012

LUC phases
• Post-fire, stock-pile, re-burn, August
• Post-fire, debris removal, late dry season, September-October
- Early wet season, re-growth, December to Feb 2013
• **Wet season, re-growth, site preparation**
• Dry season, site preparation, disc ploughing, June
• Final prep and planting August 2013
LUC flux time series – CO$_2$ + non-CO$_2$
• Melon production
Soil methane flux in relation to soil moisture change

Soil CH$_4$ flux (µg C m$^{-2}$ h$^{-1}$)

Savanna
Cleared

Soil water content (%)

savanna
cleared

Clearing event

CH$_4$

H$_2$O

Clearing event

14/09/11  3/11/11  23/12/11  11/02/12  1/04/12  21/05/12  10/07/12  29/08/12  18/10/12  7/12/12
Soil nitrous oxide flux in relation to soil moisture change

Soil N$_2$O flux (µg N m$^{-2}$ h$^{-1}$)

savanna

cleared

Soil water content (%)

savanna

cleared

N$_2$O

H$_2$O

14/09/11  3/11/11  23/12/11  11/02/12  1/04/12  21/05/12  10/07/12  29/08/12  18/10/12  7/12/12
Soil carbon dioxide flux in relation to soil moisture change

Soil CO$_2$ flux (mg C m$^{-2}$ h$^{-1}$)

- savanna
- cleared

Soil water content (%)

- CO$_2$
- H$_2$O
Soil methane at a chamber level
CO$_2$ from clearing: comparing cleared and uncleared tower sites

- Equivalent to 31.4 t C ha$^{-1}$ (or 115.4 t CO$_2$-e ha$^{-1}$)
- Equivalent to 12 years of carbon sequestration
LUC and water resources - afforestation

- Savanna v pasture v plantation forestry
- Preliminary modelling of water balance

Summary of water balance components for contrasting land uses in the Douglas-Daly catchment, NT using the 3PG2 forest growth model. This modelling is described in Section 4 of this report. All units are mm y⁻¹.

<table>
<thead>
<tr>
<th>Water balance components</th>
<th>African mahogany plantation</th>
<th>Tropical savanna</th>
<th>Improved pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>1286</td>
<td>1260</td>
<td>1260</td>
</tr>
<tr>
<td>Canopy Transpiration</td>
<td>637</td>
<td>270</td>
<td>898</td>
</tr>
<tr>
<td>Understory transpiration</td>
<td>n/a</td>
<td>392</td>
<td>n/a</td>
</tr>
<tr>
<td>Interception</td>
<td>90</td>
<td>64</td>
<td>56</td>
</tr>
<tr>
<td>Soil Evaporation</td>
<td>180</td>
<td>184</td>
<td>191</td>
</tr>
<tr>
<td>Total evapotranspiration</td>
<td>907</td>
<td>910</td>
<td>1157</td>
</tr>
<tr>
<td>Runoff/drainage</td>
<td>403</td>
<td>379</td>
<td>74</td>
</tr>
<tr>
<td>ΔSoil</td>
<td>24</td>
<td>30</td>
<td>-28</td>
</tr>
</tbody>
</table>
Savanna Super Site – Litchfield NP

- Fire and fluxes
- Remote sensing savanna structure – tree:grass dynamics
- TERN OzFlux
- TERN AusCover

- Progress:
  1. AAPA clearance
  2. Soil testing
  3. LiDAR
  4. Vegetation surveys, LAI comparison

Savanna Super Site core area ca. 5km x 5km homogeneous, suitable for RS cal/val

long term (15years) fauna and flora monitoring plots

multi-temporal LAI/FPC monitoring sites (SLATS methodology + hemispherical photography)

Tower with flux and remote sensing instrumentation. CO₂, ET fluxes, albedo, net radiation, surface reflectance, phenology

North Australian Tropical Transect (NATT)

existing NT OzFlux network