Ecosystem carbon-water interactions of tropical Pasture and Afforestation

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FLUXNET sites – global distribution
Motivation & Objectives

- Mainly tropical forest, few other land-use types:
  - Croplands (3 sites), Pastures (4), Afforestations (1)

- Little known about role in tropical C and H₂O cycle
  - Controls? Drought sensitivity? Changing climate?
  - C sinks or sources? Carbon-water interactions?

- Objectives:
  - Investigate NEE and ET of tropical Pasture & Afforestation in Sardinilla, Panama
  - Main focus: seasonality, C budgets and carbon-water interactions
Sardinilla, Location
Sardinilla, Land-use

- Logged in 1953 ⇒ 2 years cropland ⇒ Pasture
  - Dominated by C₄ grasses, grazing

- 2001: Pasture ⇒ Afforestation (in parts)
  - Native tree species in mixture
Sardinilla, Climate

July ITCZ

January ITCZ

Sardinilla, Panama (9.2° N, 79.4° W, 70 m)
2007–2009

Temperature [°C]

Precipitation [mm]

2289 mm
25.2 °C

J F M A M J J A S O N D
Seasonal variations in NEE

Pasture

Afforestation

Source

Sink

Overgrazing

Thinning

Synthesis
Carbon budgets

Source

Sink

Pasture
Afforestation

Dry

Wet season

~60 d

2007
2008
2009

2007: 251 gC/m²
2008: 261 gC/m²
2009: 260 gC/m²

2007: −292 gC/m²
2008: −442 gC/m²
2009: −419 gC/m²

Cumulative NEE [gC m⁻²]

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Seasonal variations in ET

<table>
<thead>
<tr>
<th>Seasonal mean ± SD</th>
<th>Dry season</th>
<th>Wet season</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4 ± 0.8</td>
<td>2.7 ± 0.5</td>
<td>2.7 ± 0.8</td>
</tr>
<tr>
<td>2.5 ± 1.1</td>
<td>2.1 ± 0.6</td>
<td>2.5 ± 1.0</td>
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<tr>
<td>2.1 ± 0.6</td>
<td>2.7 ± 0.5</td>
<td>3.8 ± 0.8</td>
</tr>
<tr>
<td>2.7 ± 0.8</td>
<td>2.7 ± 0.8</td>
<td>4.1 ± 0.7</td>
</tr>
</tbody>
</table>

Evapotranspiration [mm d⁻¹]

Day of Year

Afforestation
Pasture

SWC
Radiation
Grazing
Carbon-water interactions

Pasture
- Dry season (slope=0.35, $R^2=0.65$)
- Dry-wet transition (slope=0.24, $R^2=0.16$)
- Wet season (slope=0.25, $R^2=0.26$)
- Wet-dry transition (slope=0.39, $R^2=0.33$)

Afforestation
- Dry season (slope=0.48, $R^2=0.4$)
- Dry-wet transition (slope=0.43, $R^2=0.47$)
- Wet season (slope=0.33, $R^2=0.31$)
- Wet-dry transition (not sign.)
Water use efficiency

![Graph showing water use efficiency over different seasons and years.](image)
Carbon and water fluxes in 2008

**Pasture**

- **GPP**: -2345 gC m⁻² yr⁻¹
- **NEE**: 261 gC m⁻² yr⁻¹
- **TER**: 2606 gC m⁻² yr⁻¹

**Afforestation**

- **GPP**: -2082 gC m⁻² yr⁻¹
- **NEE**: -442 gC m⁻² yr⁻¹
- **TER**: 1640 gC m⁻² yr⁻¹

- **Rₜₚₐₜ**: 50%
- **Rₚₐₜₙ**: 51%

Carbon fluxes in gC m⁻² yr⁻¹ and water fluxes in mm yr⁻¹
Summary & Conclusions

- **Afforestation** was strong carbon sink
- **Pasture** was substantial carbon source
  - Sensitivity to seasonal drought and overgrazing
- Conversion Pasture $\Rightarrow$ Afforestation
  - Reduced seasonal variations of NEE and ET
  - Enhanced resilience to seasonal drought
  - Marginally affected annual ET, strongly increased infiltration
- Strong seasonality in carbon-water interactions
- WUE differences decreased
Thanks for your attention!

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FLUXNET Young Scientist Network (YSN)

- Young Scientist (YS) = Students & Postdocs
- Mailing list & interactive Website:
  - Informal exchange platform for questions regarding research, career & funding
  - YS can present themselves and meet others through this network
- FLUXNET Website – About FLUXNET – Young Scientist Network
  (www.fluxnet.ornl.gov/fluxnet/youngscientists.cfm)

⇒ Become part of the YSN & inform colleagues