Impacts of agricultural expansion on natural ecosystems of Lambwe Valley, Kenya

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AFRICAN SAVANNAH

- Savannah expanse
- Savannah importance
- Moist savannahs as hot spots for agro-ecosystems.
- ⅔ of African savannahs under agroecosystems
- Savannah croplands - altered ecosystem's structure
- Long grazing history vs current high livestock densities of African savannah.
- Grazing & cropping feedback into the local climate thro' Δ s in mass & energy balances at land surface

PROBLEM STATEMENT

- Africa's high pop^{n} growth rate (UN, 2009), poverty & technological backwardness.
- Savannah - agroecosystems conversion - expansive cropped, abandoned/fallow & (over)grazed lands.
- Scientific knowledge of agro-ecosystems' effects on the ecosystem structure & productivity for sustainable agro-utilization of this savannah.

Clockwise from top left: cropped; abandoned; abandoned & grazed; grazed; Fenced; integrated

OBJECTIVES & HYPOTHESES

Objective

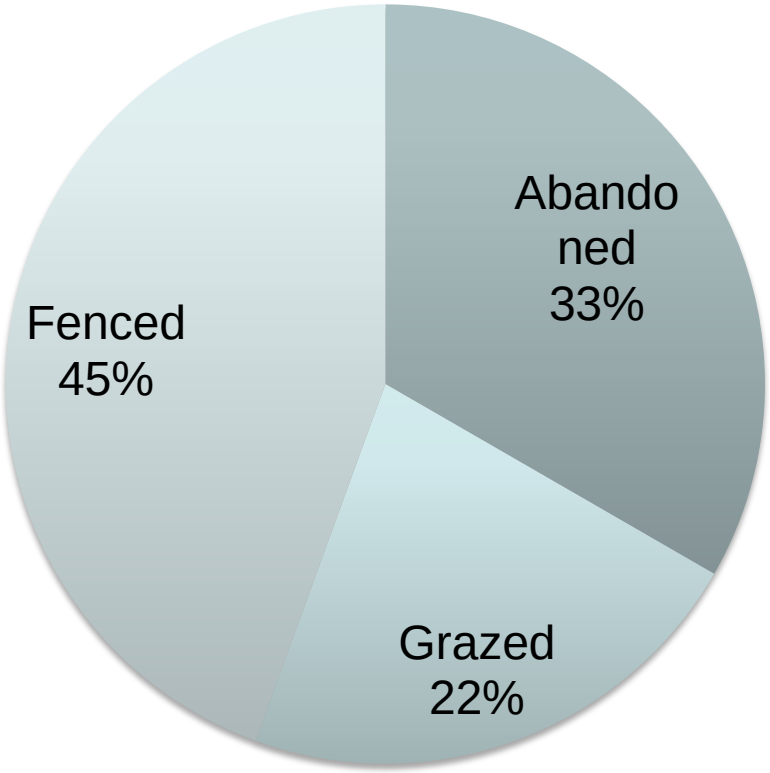
- Identify & quantify effects of land uses (grazing & cropping) on the ecosystem productivity of a moist savannah.

Hypotheses

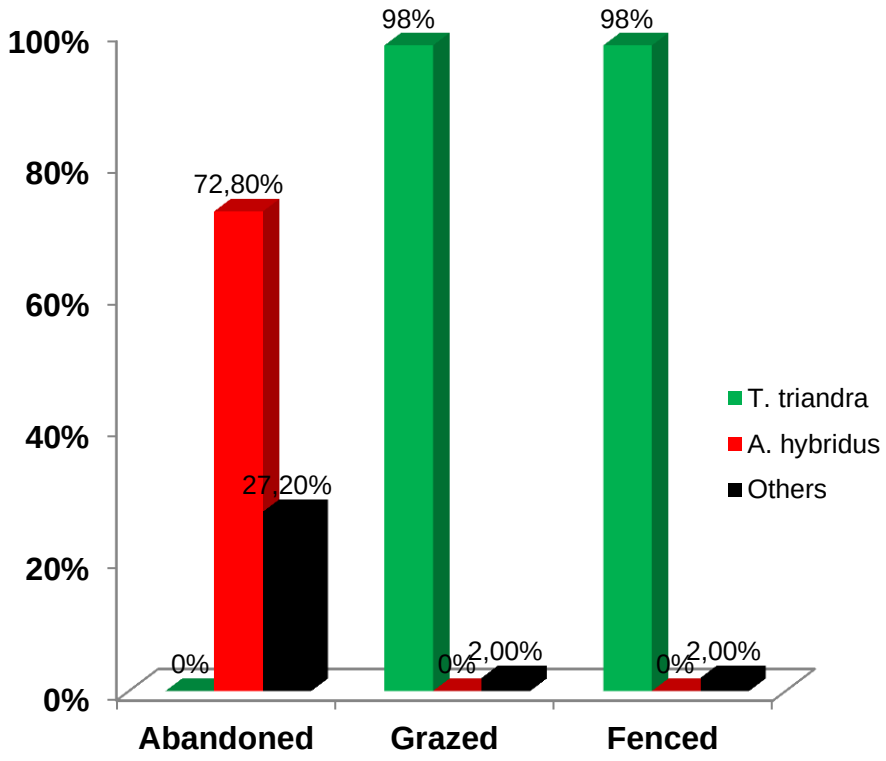
- Agro-ecosystems (grazing & croplands) have altered ecosystem structure & productivity.

RESULTS

Species number



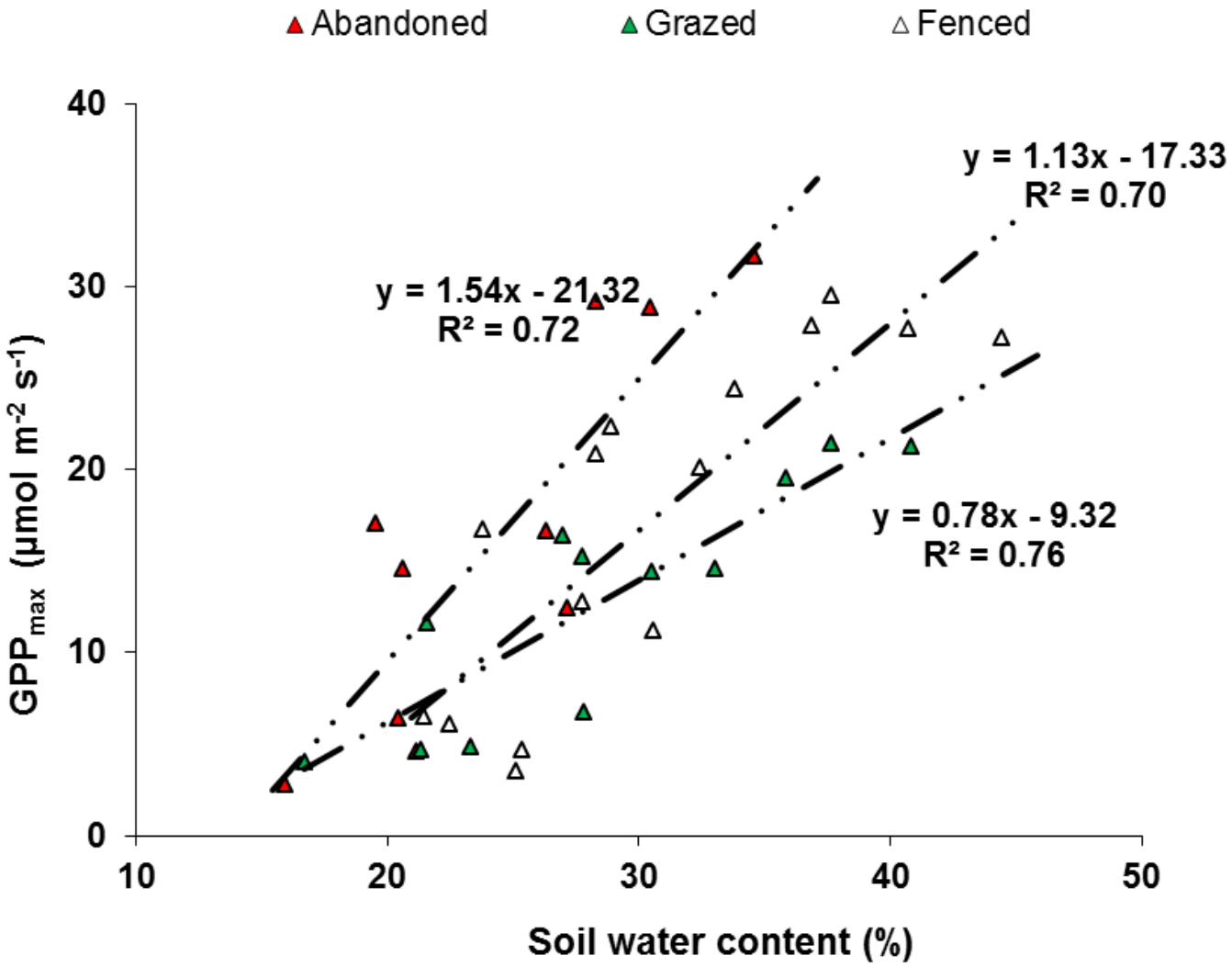
Dominant species



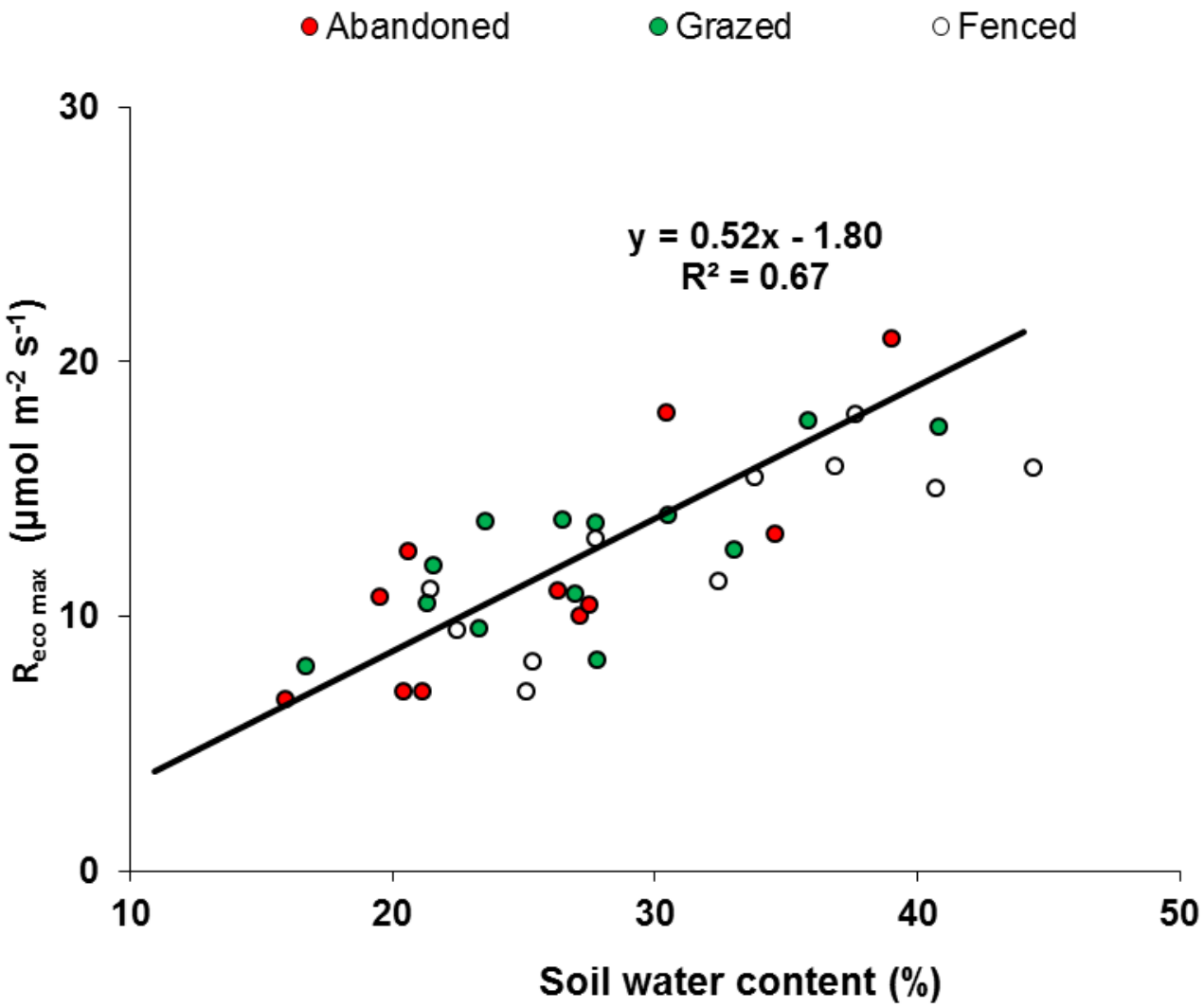
CO_2 exchange

Treatment	Grazed	Fenced	Abandoned	LSD (0.05)
Parameter				
NEE ($\mu molm^{-2}s^{-1}$)	0.49	-2.76	-1.35	1.05
Reco ($\mu molm^{-2}s^{-1}$)	11.35	12.85	11.06	0.75
GPP ($\mu molm^{-2}s^{-1}$)	11.08	15.67	12.47	1.55
NEE_{max} ($\mu molm^{-2}s^{-1}$)	-1.81	-4.97	-4.77	1.45
$R_{eco\ max}$ ($\mu molm^{-2}s^{-1}$)	12.15	13.53	12.42	0.96
GPP_{max} ($\mu molm^{-2}s^{-1}$)	13.96	18.49	17.19	1.92
Biomass normalised NEE_{max} ($\mu molm^{-2}s^{-1}g^{-1}$	-0.024	-0.014	-0.022	0.004
Biomass normalised $R_{eco\ max}$ ($\mu molm^{-2}s^{-1}g^{-1}$	0.10	0.02	0.08	0.01
Biomass normalised GPP_{max} ($\mu molm^{-2}s^{-1}g^{-1}$	0.12	0.03	0.09	0.01

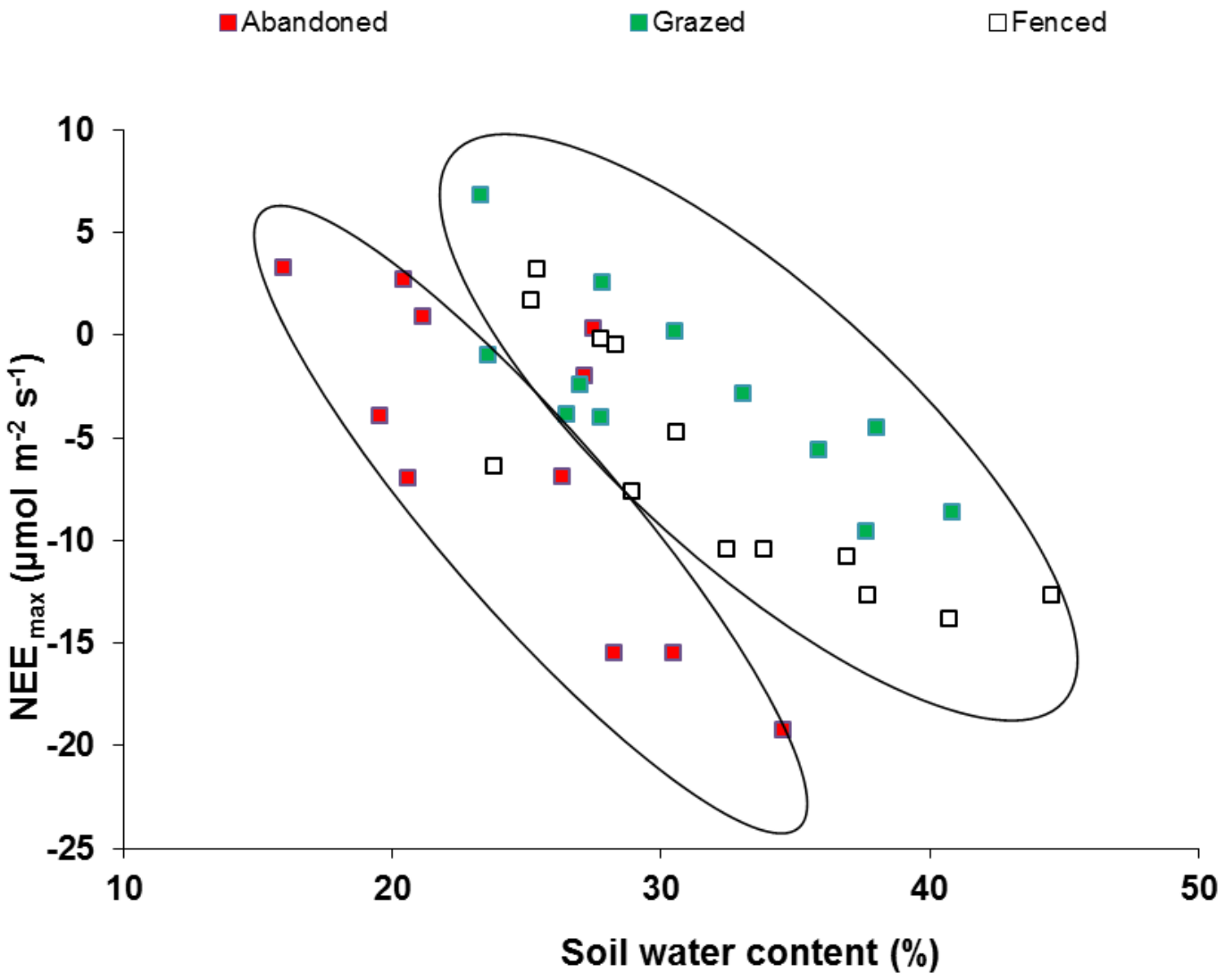
GPP_{max} - SWC


Abandoned
Grazed
Fenced
y = 1.13x - 17.33
R² = 0.70
y = 1.54x - 21.32
R² = 0.72
y = 0.78x - 9.32
R² = 0.76
GPPmax (µmol m-2 s-1)
Soil water content (%)
0
10
20
30
40
10
20
30
40
50

R_{ecomax} - SWC


Abandoned
Grazed
Fenced
y = 0.52x - 1.80
R² = 0.67
$R_{eco\ max}$ (µmol m^{-2} s^{-1})
Soil water content (%)
0
10
20
30
10
20
30
40
50

NEE_{max} -SWC


Abandoned
Grazed
Fenced
10
5
0
-5
-10
-15
-20
-25
NEE max (µmol m-2 s-1)
10
20
30
40
50
Soil water content (%)

Conclusions

- Ecosystem was a net C sink with a mean NEE of -0.81 μmol m^{-2} s^{-1} over the study period.
- Ppt & available SM largely determined ecosystem CO_2 exchange & biomass production in this moist savannah thus revealing its sensitivity to Δ in SWC.
- Great transformation of species in abandoned plots shows species alteration as a major consequence of on-going land use changes in the African savannah.
- Livestock grazing had lower biomass, GPP & NEE per unit area but higher biomass normalised NEE & GPP, underscoring possible stimulatory effects of grazing on this ecosystem.

Unanswered?

- Complexity of cropping- fallow system?
  - Land preparation
  - Cropped species
  - Fallowing
  - Fallowing & other land uses
- Grazing Complexity
  - Grazing intensity
  - Grazing species
- Insensitivity of $R_{eco\ max}$ to land uses?

THANK

YOU