“Domesticating Ecology”: Situating humans within ecological models of savanna dynamics

Photo by Cullen Strawn

Paul Laris
California State University
Long Beach

Chris Duvall
Department of Geography
University of New Mexico

Fadiala Dembele
Katibougou, Mali
Rethinking Disturbance Regimes

• Disturbances as catalysts to rapid change
• Interactions among different disturbances
• Relations between disturbances and society, especially the intersection of land use and disturbance
• Feedbacks from disturbance to global drivers

--Monica Turner 2010: 2834
Savanna Heterogeneity
According to the “buffer model” savanna may shift along a continuum between grassland and woodland depending upon the disturbance regime.
Domesticated Savanna Ecology: Coupled Human-Ecological Savanna Model

Landscape ecology + Domesticated Landscape

Natural and Humanized Heterogeneity
Multiple and interacting Disturbance regimes

Long term Human Impacts or Legacy landscapes
Intentional altering of disturbance regimes
Intentional and unintentional consequences of land use practices

Pattern ← Process
A Coupled Human-Ecological Model?

Plowing

Anthropogenic fires

Clearing, farming & tree selection

Foraging

Field Preparation

Grazing

Hoe Farming

Fallow
Studies Areas in southwestern Mali, Manden Plateau Region.

Maps:
http://mali.pwnet.org/img/mali_map_small.jpg;
http://agtr.ilri.cgiar.org/library/docs/x5531e/x5531e1w.gif
Mosaic Fire Regimes

Photo by Cullen Strawn
Patch-Mosaic Fire regime

Underlying ecological theory is based on succession: each patch is in a different stage of succession and the return interval and pattern of fire is in part a function of succession.
Seasonal Mosaic Burning in Mali

NOV 2006-APR 2007

Source: Laris 2011
November burned area and burn frequency maps

November 1975

November 2002

November 2000

November Frequency
Land-Cover & Fire Regime are Linked

November 2000

January 2003

Source: Laris 2010
What happens on fallow land?

Sample Plots from Dogoro

Unfarmed plot

Farmed plot

Source: Laris 2008
Gullivers are small trees trapped by a perpetual cycle of fire

3 ecological pathways to escape

1) 3-5 consecutive fire free years
2) Years of unusually high rainfall
3) Termite activity (breaks-up soil)
Anthropogenic Escape Route

**All Plots Combined**

(n=12)

**Number of Trees**

**Circumference (cm)**

- **Long Fallow**
- **Unfarmed**

- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- +100

- 100
- 90
- 80
- 70
- 60
- 50
- 40
- 30
- 20
Short Term Field Study of Fallow Plots

Fallow plot

Farmed plot
Influence of fire and grazing (above) on the **total density** of woody vegetation on young fallow (Clay soils)
Influence of fire on density of woody vegetation by resprouting (grazed, clay soils)
Influence of fire on density of woody vegetation from seed on clay soils

UNGRAZED

GRAZED

Dembele
Influence of fire on the total density of woody vegetation from seed

Ungrazed, clay soils

Ungrazed, sandy soils

Clay Soils

Sandy Soils

Dembele
Infiltration rates after 4 years as function of fire and grazing

Time to infiltrate the soil in minutes
Clearing a new field, breaking soil crust
Impact of soil type on savannas

The Walter/Walker model of tropical savannas (reproduced from Walker & Noy-Meir, 1982).
Impact of soil texture on tree cover depends on anthropogenic disturbance regime.

*Humanized savanna ecology model*

- Influence of late fire
- Influence of hoe farming

**Diagram:**
- X-axis: Rainfall
- Y-axis: Soil Texture (Sand, Clay)
- Legend:
  - Red dashed line: Influence of late fire
  - Blue dashed line: Influence of hoe farming
- Zones:
  - Grassland
  - Savanna
  - Woodland

Increasing woodiness
Komana Kouta, Mali
Low population density & low agricultural intensity

Siby, Mali
High population density & high agricultural intensity

Parkland landscape

Shea Nut Trees
Baobab Tree Propagation

Abandoned Hamlet

Foraging for fruit

Abandoned Hamlet

Duvall
Baobab Trees are:

- Fire intolerant (when young)
- Adapted to aridity (500-800 mm)

How did they establish in this moister more fire prone landscape?

See:
Wickens, *Kew Bulletin* 37(2), 1982;
Areas protected from fire 1972-2009

Woodland/Forest

Short fallow/Settlements
A Coupled Human-Ecological Model?

Unfarmed plot

Anthropogenic fires

Clearing, farming & tree selection

Mosaic fire regime

Unfarmed plot

Anthropogenic fires

Clearing, farming & tree selection

Mosaic fire regime

Farmed Parkland

Shortened fallow (w/tree selection)

Long fallow (30+ yrs)

Foraging fruit
Thanks to all of those people in Mali who made the research possible