Untangling the factors that cause fire regime changes in West African savannas

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Why do fire regimes vary from place to place?

“Fires...were probably lit by pastoralists for grass regeneration or hunting. In the absence of a tight landscape organization the process of burning went **out-of-control** with the result depicted in the image...Towards the Ivory Coast, the **mixed pattern of ...land use suggests a form of landscape organization** different from Guinea...while the area is **densely occupied, better fire management** practices have evolved (2123, emphasis added).
“The most extensive burning consistently occurred in Africa... however, we found that the lowest interannual variability in area burned occurred in the savannas of Southern- and Northern-Hemisphere Africa” (Giglio et al. 2010: 1184).
How and why do fire regimes change?

**Biophysical Causes**
- Climate/weather
- Land Cover Change
- Landscape Pattern Change
- *Vegetation* Cover Change

**Human Causes**
- Land Use Change
- Population Density Change
- Policy Change
- Burning Practice Change
How and why do fire regimes change in African Savannas?

**Biophysical Causes**
- Climate/weather
- Land Cover Change
- Landscape Pattern Change
- *Vegetation Cover Change*

**Human Causes**
- Land Use Change
- Population Density Change
- Policy Change
- Burning Practice Change
NORTH (arid)  SOUTH (moist)
Annual grasses → Perennial grasses → Woodland/forest
Pastoral → Agro-pastoral → Agricultural
LESS FIRE   MORE FIRE   LESS FIRE

More pastoral (North)
More agricultural (South)

Source: Mbow et al 2000

Broad Scale Factors

Source: OILSS; FAO; FEWSNET; SWAC/OECD
Study Area for Fire Research
“Early” Savanna Fires, Nov 2006

Source: Laris 2011
“Late” Savanna Fires, Feb 2007

Siby

Bougouni

Source: Laris 2011
November burned area maps: 1975, 2000, 2002 and frequency

**Siby:** Much early fire, less late fire

**Bougouni:** Little early fire, more late fire
Hypothesis: Vegetation (grass) cover change drives fire regime change in savannas.
Factors of fire regime change in southern Mali

1. Policy
2. Practice and logic
3. Land use
4. Vegetation cover pattern

Methods:
Comparative analysis of two sites
(i) Satellite Image Analysis
(ii) Interviews and Focus Groups
Policy: Fire Suppression

When we tried that, the fire jumped the Niger River and burned all the way to la Guinea!

Laris and Wardell 2006
“Bin be and a jeni waati.”
Every grass has its (appropriate) time to burn
Video Clip

Early fire/
Hot fire
SPEAKERS!
Land Use?
Vegetation Cover & Fire Regime

Source: Laris 2011
### Survey and Imagery Results

#### Image Analysis Results

<table>
<thead>
<tr>
<th>Average Burn Date</th>
<th>Area Burned (%)</th>
<th>Fire Type</th>
<th>Vegetation Type</th>
<th>Rural Calendar</th>
<th>Common Reasons To Burn</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/18/2002</td>
<td>17.56</td>
<td>Very early</td>
<td>Short Grass Savanna</td>
<td>Peanut Harvest</td>
<td>Protect against late fires, separate landscape to clear paths and form firebreaks, prepare hunting grounds, protect trees, regenerate pasture, eliminate pests</td>
</tr>
<tr>
<td>12/12/2002</td>
<td>8.09</td>
<td>Early</td>
<td>Short Grass Savanna &amp; Fallow</td>
<td>Millet Harvest</td>
<td></td>
</tr>
<tr>
<td>12/28/2002</td>
<td>15.8</td>
<td>Early</td>
<td>Fallow Lands</td>
<td>Harvest End</td>
<td>Hunt, clear grasses and pests to promote wood cutting or gathering, accidents, unknown</td>
</tr>
<tr>
<td>1/21/2003</td>
<td>10.54</td>
<td>Late</td>
<td>Woodland/Forest</td>
<td>Cool Season</td>
<td>Hunt, field preparation, accidents, unknown</td>
</tr>
<tr>
<td>2/22/2003</td>
<td>4.91</td>
<td>Late</td>
<td>Woodland/Forest</td>
<td>Hot Season</td>
<td>Hunt, field preparation, accidents, unknown</td>
</tr>
</tbody>
</table>
Does increasing young fallow (annual grasses) and agriculture result in a more fragmented landscape that allows for more fire control?
Land in agriculture near Bougouni

1975 2006

1986

0 2 4 6 8 10 12 14


Other Crop Area
Sorghum and Millet Area Planted
Maize Area Planted
Cotton Area Planted

Source: Laris and Foltz 2011
Video Clip
Farmer reaction to fire
Koori be jeni i na fo essanci!
Cotton burns like gasoline!

--Bougouni Farmer 2011
Summary of Key Findings

• Policy
  – Suppression policy did not result in fewer fires and the immediate (short term) impact was a shift to later, more contiguous fires.
  – Longer term impact has been a hesitancy to set early fires and a lack of organized burning (a change in practice), and a fear of setting fires.

• Practice and logic of burning
  – The common practice remains to set fires to dryer uplands early to fragment the landscape but,
  – there is less early burning of fallow lands in part due to fear of damage to cash crops and in part due to lack of organization and common practice
Summary of Key Findings

• **Land Use**
  – Differences in land use do not explain the variation between the two study areas shown; however,
  – changes in land use have impacted practices of burning as a result of increased cash cropping.

• **Vegetation Cover Pattern**
  – Vegetation cover is the main determinant of fire regime and explains the key differences in spatio-temporal patterns observed, but
  – vegetation cover is also function of land use which will change over time perhaps reaching a threshold when agricultural pattern impacts fire.
Conclusions and Applications

- Fire regimes are linked to vegetation patterns which are a function of natural patterns and land use. As land use intensifies, fire patterns should eventually change.
- Fire policy legacy and a shift to cash crops has had an impact on the burning regime in some areas (perhaps countering the above).
- A need to work with organizations in village clusters to develop and map desired early burning strategies
  - The lack of early fire is a problem resulting in too much uncontrolled late-season fire
  - A fear of setting fire on fallow lands
  - Agreement that organized burning (at the level of the village clusters) would help them manage fire
Fire is a good slave but a bad master!
Thanks to all of those people in Mali and elsewhere who made the research possible
Changing Agricultural System

Less hand farming

More permanent cropping with maize and cotton

Shorter fallow periods and less rotation

More use of plows, fertilizers and herbicides
Tall Perennial Grasses
How and why do fire regimes change in Southern California?

**Biophysical Causes**
- Climate/weather
- Landscape Pattern Change

**Human Causes**
- Population Density Change
- Policy Change
Savanna Belts

Mali

Sahara < 200 mm
Sahel 200 – 400 mm
Sudano-Sahelian 400 – 800 mm
Sudanian 800 – 1200 mm
Guinean > 1200 mm
Fire Regime—
The frequency, intensity (timing), type and pattern of fire

Disturbance Regimes
A “Humanized” Burning Regime

Q: Why do people burn when and where they do?

Landsat ETM image, 2002
Impact of grazing on grasses and fire
How and why do fire regimes change?

**Biophysical Causes**
- Climate/weather

**Human Causes**
- Policy Change

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**Figure 1. Acres lost to wildfire in the western United States, 1916–2004**

*NOTE:* The area burned in western wildfires has increased in recent decades as suppression efforts become less effective. The values above are sums of totals from the 11 states west of Colorado's eastern boundary.

*SOURCE:* Data for 1916 through 2004 were compiled from a variety of sources by Anthony L. Westerling of the Climate Research Division of Scripps Institution of Oceanography (University of California–San Diego) and used by permission.