Climate and Conflict in Africa

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Motivation

• Is there a link between climate and conflict?
  – Google “Africa Drought Images”

• Intuitively:
  – Drought $\rightarrow$ Food Scarcity $\rightarrow$ Conflict
  – High Temperatures $\rightarrow$ Heat Stress (crops, animals) $\rightarrow$ Scarcity $\rightarrow$ Conflict

• Debate within the conflict community
  – Changing climate = more conflict (Burke, Lobell et al. 2009)
  – Changing climate $\neq$ more conflict (Buhaug 2010 and Theisen et al. )
This work: Disaggregated Statistics

• Combine climate and conflict data
• Focus: East and Sub-Saharan Africa
  – High vulnerability to climate variability & change
• Unique: spatial and temporal disaggregation to a 1x1 degree monthly grid
• Results: Higher Temperatures have been a significant contributor to recent conflict in Africa

Methodology

• Focus on E. Africa (Kenya, Uganda, Tanzania)
  – 1990-2009
  – Extend to Sub-Saharan Africa
• Geo-located and gridded conflict data set
  – Thousands of hand coded entries
  – Riots to Civil wars
• Geographic data (location parameters)
• Socio-economic data (population, government)
• Climate data: SPI6 drought index and TI6 temperature index (looks at last 6 months relative to a long term mean)
  – HadCRU data for temperature and precipitation (Climatic Research Unit, University of East Anglia)
• Generalized Additive Model
  – multivariate regression model
Conflict Data (ACLED)

- Armed Conflict Location and Event (ACLED) Database
Climate Data: Temperature

Fig. S4. Number of (A) dry and (B) hot months by 5-y period.
A: Increased rainfall reduces conflict, though decreased rainfall (drought) does not increase it.

B: High temperatures increase conflict tendency

Highly statistically significant
But Predictive Power is Small

Climate effects of Temperature are significant: but smaller than socio-economic effects
All Sub-Saharan Africa

**TI6** – Grid-cell (100km) temperature deviation from the long-term monthly mean (1949-2009).

**SPI6** – Grid-cell precipitation deviation from the long-term monthly mean (1949-2009).

**Conflict** – ACLED events (n= 55, 427), excluding non-violent types, aggregated to the grid observation units.

Control variable data is listed in additional slides.
GAM model with expanded predictors

For explanation of the generalized additive modeling approach see Wood (2006)

Again: temperature is significant: positive correlation with conflict
Predictive power results from GAM: All Sub-Saharan Africa

Methodological approach adopted from Ward, Greenhill, and Bakke (2010)
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Temperature is a significant effect, more than many other factors:
But Smaller than geography or population
Summary & Future Work

• Climate Contribution to Conflict is significant using Generalized Additive Model
• Temperature is more important than Precipitation
• Robust when compositing is done (high & low temps)
• Small in comparison to socio-economic and political indicators, but significant

Next Steps:
  – Repeat the analysis with CCSM4 ‘synthetic’ climate statistics (how robust)?
  – Attempt to project into the future using CCSM4 RCP8.5 scenarios: how much impact will climate have on conflict in the late 20th Century given this regression
# Additional slides (control variables)

## Table 1. Variables and their sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Temporal</th>
<th>Spatial</th>
<th>Source/Notes</th>
<th>Grid Aggregation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociodemographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACLED violent events</td>
<td>1980-2009f</td>
<td>Town</td>
<td>ACLED + Univ. of Colorado addition</td>
<td>Sum</td>
</tr>
<tr>
<td>Population (ln)</td>
<td>1990-2015b</td>
<td>2.5 minute</td>
<td>Gridded Population of the World, version 3 (GPWv3)</td>
<td>Sum</td>
</tr>
<tr>
<td>Youth population (15-20)</td>
<td>1970-2010b</td>
<td>Country</td>
<td>UN 2010 World Population Prospects report</td>
<td>Pop-weighted mean</td>
</tr>
<tr>
<td>Infant mortality rate (1-yr lag)</td>
<td>1950-2010c</td>
<td>Country</td>
<td>UN Inter-agency Group on Child Mortality Estimation</td>
<td>Pop-weighted mean</td>
</tr>
<tr>
<td>Political rights (1-yr lag)</td>
<td>1972-2010c</td>
<td>Country</td>
<td>Freedom House</td>
<td>Majority pop</td>
</tr>
<tr>
<td>Presidential election (buffer)</td>
<td>1990-2010d</td>
<td>Country</td>
<td>Buffer is ±3 months from election month</td>
<td>Majority pop</td>
</tr>
<tr>
<td>Ethnic leadership</td>
<td>1990-2009d</td>
<td>Sub-country</td>
<td>Archigos (Goemans, Gleditsch and Chiozza 2009) and Ethnologue's World Language Mapping System</td>
<td>Minimum 20% land area</td>
</tr>
<tr>
<td>Colonial legacy</td>
<td>Static</td>
<td>Country</td>
<td>Majority pop</td>
<td></td>
</tr>
<tr>
<td>Gov't consumption per capita</td>
<td>1970-2010c</td>
<td>Country</td>
<td>Penn World Tables v7.1, variable 'kg'</td>
<td>Pop-weighted mean</td>
</tr>
<tr>
<td><strong>Physiographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to border (ln)</td>
<td>Pre/post Entreatia</td>
<td>Country</td>
<td>ESRI World Country Boundaries</td>
<td>Mean 10km sub-grid</td>
</tr>
<tr>
<td>Capital city grid cell</td>
<td>Entreatia, Cote d’hoire, Nigeria</td>
<td>City</td>
<td>ESRI World Cities</td>
<td>Binary</td>
</tr>
<tr>
<td>Grassland (pct)</td>
<td>1700-1990a, 2000-05b</td>
<td>5 minute</td>
<td>History Database of the Globel Environment (HYDE) v3.1</td>
<td>Sum</td>
</tr>
<tr>
<td>Distance to road (ln)</td>
<td>Static</td>
<td>Polyline</td>
<td>Digital Chart of the World, primary &amp; secondary roads</td>
<td>Mean 10km sub-grid</td>
</tr>
<tr>
<td>Crop production index (pct Δ)</td>
<td>1980-2009c</td>
<td>Country</td>
<td>FAO agricultural production; annual percent change</td>
<td>Pop-weighted mean</td>
</tr>
<tr>
<td>Veg. cond. ind. (6 mnth lag)</td>
<td>1981-2011e</td>
<td>16 km</td>
<td>NOAA GVI-x Vegetation Health Product, (NDVicurr - NDVimin)/(NDVimax - NDVimin)*100</td>
<td>4-week mean of 16km data</td>
</tr>
<tr>
<td>Diamond mines/grid</td>
<td>2005</td>
<td>Point</td>
<td>PRIO Diamond Dataset</td>
<td>Sum</td>
</tr>
<tr>
<td>Oil &amp; nat'l gas value/GDP</td>
<td>1932-2009</td>
<td>Country</td>
<td>Michael Ross data normalized w/ World Bank GDP</td>
<td>Pop-weighted mean</td>
</tr>
<tr>
<td>Minerals (no diamonds) sites/grid</td>
<td>2012</td>
<td>Point</td>
<td>USGS Mineral Resources Data System</td>
<td>Sum</td>
</tr>
<tr>
<td><strong>Climate</strong></td>
<td></td>
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</tr>
<tr>
<td>Precipitation (SPI6)</td>
<td>1949-2009d</td>
<td>0.5°</td>
<td>Climate Research Unit</td>
<td>Mean of 1/2 degree data</td>
</tr>
<tr>
<td>Temperature (Tf6)</td>
<td>1949-2009d</td>
<td>0.5°</td>
<td>Climate Research Unit</td>
<td>Mean of 1/2 degree data</td>
</tr>
</tbody>
</table>

*a10-year interval, b5-year interval, cyearly, dmonthly, eweekly, fdaily

9Denotes variable added for this paper, all other variables included in O'Loughlin et al. 2012