Conflict, Climate and African Development

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Motivation

• It is well-known that Africa is the world’s poorest region, with the slowest economic growth since 1970.

• There is less consensus on why.

• Barro (1991) noted the large negative “Africa dummy” in growth regressions: a measure of our ignorance.

• Economic growth has improved since 2000.
African per capita income, 1960-2010
Motivation

• Many scholars emphasize the role of political conflict and violence in Africa’s poor economic performance
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• Over 70% of African countries have experienced civil conflict since 1970, with adverse consequences, e.g.:
  2) Millions of civilian deaths in DR Congo since 1997

• Understanding the causes and consequences of violence is critical for Africa’s future economic prospects.
African per capita income, 1960-2010

Civil war: 40% drop
This talk: Climate and conflict

- Based on a new paper with **Sol Hsiang** (Princeton) and **Marshall Burke** (Berkeley)

- We comprehensively assess existing research, and analyze (and re-analyze) multiple datasets, to estimate the impact of climatic conditions on political conflict and violence in Africa, other societies, and throughout history

- **Main conclusion**: a striking degree of agreement that high temperatures and other extreme climate outcomes are associated with more violence.
This talk: Climate and conflict

• The consequences of climate change are of critical public importance beyond Africa (Weitzman 2009)

• There is currently a contentious debate about the nature of the link between climate and violent conflict globally in the United Nations’ IPCC process.
• Climatic change may be particularly important for Africa
  1) Models predict that temperature increases will be large for Africa by 2050, at 2º C (3-4º F) on average
This talk: Climate and conflict

• Climatic change may be particularly important for Africa
  1) Models predict that temperature increases will be large for Africa by 2050, at 2º C (3-4º F) on average
  2) African economies are sensitive to climate:
     • Rainfall and temperature linked to economic growth in low-income countries (Miguel et al 2004, Dell et al 2012)
     • Africa’s historically low precipitation in the 1980s and 1990s has been linked to slow growth, explaining up to 40% of the “Africa dummy” (Barrios et al 2010)

• Will climate change increase violence and derail Africa’s incipient economic revival?
The literature on climate and violence

- Existing research spans multiple academic disciplines (economics, political science, criminology, history, archeology, climate science), timeframes, scattered datasets, statistical methods, and conceptual frameworks.

- **No comprehensive assessment, synthesis or meta-analysis exists** to make sense of this growing literature, with its important implications for understanding climate change impacts, and policy priorities, in Africa and elsewhere.
The literature on climate and violence

• The **four main goals** of our paper are to:
  (1) Comprehensively assess this growing literature, using broad inclusion criteria (violence ranging from crime, land grabs, riots, irregular political leader exit, to civil war);
  (2) Obtain data, replicate, and reanalyze data using a common, rigorous statistical approach (where possible), i.e., use panel data with location and time fixed effects;
  (3) Highlight patterns in the findings and broad areas of agreement across studies;
  (4) Identify gaps in the literature, and research approaches that will shed more light on the speed of adaptation and the underlying mechanisms, e.g., economic vs. psychological factors (i.e., aggression). Ongoing work.
The literature on climate and violence

- **50 studies** (published, unpublished), using 37 datasets.
- The field is expanding rapidly: since writing we have found >10 new studies (currently being incorporated), and the median study year is 2011.

- New analysis: we obtained 16 different datasets, and **re-analyzed data from 11 papers and reinterpreted results from 6 others**, sometimes with divergent results and conclusions than the original article.

- Many existing studies do not include year or location fixed effects; include outcomes (i.e., income) as “controls”; do not jointly estimate the impact of climate variables.
The literature on climate and violence

- E.g., Buhaug (2010) critiques Burke et al.’s (2009) estimated impacts of high temperature on civil war in Africa by **dropping country fixed effects**, and including outcome variables including income as “controls”.

- The best-known recent survey is Gleditsch (2012), which only surveys 8 of the 50 papers and 5 of the 37 datasets that we consider in this paper, and does not put more “weight” on methodologically rigorous studies, i.e., he considers under-powered studies with no statistically significant effect evidence of no impact.
The literature on climate and violence

• Three main types of studies:

1. **Observational studies using panel data (N=38)**
   - Mainly economics, political science, criminology
   - E.g., is armed conflict more common in Africa in high temperature and/or low rainfall years?

2. **Experimental psychology studies (N=2)**
   - Are lab subjects more aggressive at high temperatures?

3. **Historical climatology and paleoclimatology (N=10)**
   - Did key episodes in Chinese history (dynasty collapse) occur during climatic anomalies, using “tree ring” data?
Historical climatology and paleoclimatology

- Evidence from a variety of civilizations (Maya, Angkor Wat, Chinese dynasties, Akkadian empire) that exceptionally dry and/or hot periods are associated with political collapse.
- E.g., the **Maya civilization** experienced three extended multi-year droughts in the 9th century AD that are thought to have precipitated its collapse (Haug et al. 2003, *Science*)
Historical climatology examples

Major phases of collapse for the “Classic” Mayan empire

Mexico

Tt (counts s⁻¹)

(Dry) 20

(Wet) 40

700 800 900
(3) Historical climatology and paleoclimatology

• Evidence from a variety of civilizations (Maya, Angkor Wat, Chinese dynasties, Akkadian empire) that exceptionally dry and/or hot periods are associated with political collapse

• E.g., the Maya civilization experienced three extended multi-year droughts in the 9th century AD that are thought to have precipitated its collapse (Haug et al. 2003, *Science*)

• Collapse of the 9th century Chinese Tang dynasty linked to the same extended drying (Yancheva et al. 2007, *Nature*)

• Relevance: had incomes similar to poor countries today, i.e., historical Maya (~$400), China (~$600)

• Caveat: looking for “keys under the lamppost”? These studies do not test hypotheses on the universe of societies.
(2) Experimental psychology studies

• Laboratory studies find impacts of ambient temperature on subject aggression; possible hormonal channels.

• Vrij et al. (1994): Dutch police in a training exercise were more likely to shoot at a simulated intruder when randomly placed in a high temperature room (27°C / 80°F) than at lower temperature (21°C / 70°F).

• Also perceived the intruder as more dangerous in surveys.

• Does aggression lead to “escalation” of potential conflicts?

• Kenrick et al. (1986): high temperatures are linked to more horn honking in a field experiment, when experimenters deliberately stood still when lights turned green.
(1) Observational studies using panel data

- The largest number of studies estimate impacts of climate on national-scale violence, often on armed civil conflict.
- **Miguel, Satyanath and Sergenti (2004)** were first to show that civil conflict is more likely following adverse rainfall shocks across African countries during 1981-1999. Rainfall correlates with GDP growth (IV first stage).
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• Building on MSS, many recent studies regress outcome $y$ on temperature deviation (rather than changes, Ciccone 2011), precipitation deviation, and country and time fixed effects:

$$y_{it} = \alpha + \beta_1 Temp_{it} + \beta_2 Precip_{it} + \eta_i + \delta_t + \varepsilon_{it}$$
Observational studies using panel data

- The results are remarkably consistent: all 21 empirical studies (using 13 different datasets) that focus on temperature estimate a positive association between higher temperatures and violence. This pattern seems extremely unlikely to happen by chance.
- 14 of 16 rainfall studies have a consistent sign.
- Three quarters of these estimates are statistically significant at 95% confidence.
- The pattern emerges at scales ranging from the village, to region, country and even global scale, using a common econometric specification.
Temperature and violence in Africa, across scales

- Four studies illustrate the relationship across scales:
  - **Village level:** re-analyze the link between climate and witch killing in Miguel (2005, *REStud*), using temperature instead of extreme rainfall.
Temperature and violence in Africa, across scales
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- **Village level:** re-analyze the link between climate and witch killing in Miguel (2005, *RESTud*), using temperature instead of extreme rainfall.
- **Region level:** re-analyze O’Laughlin et al. (2012, *PNAS*) with pixel FE and show higher temperature is associated with more violence (raids, clashes, riots, battles) since 1990.
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  - **Country level:** higher temperature increases civil war risk in Sub-Saharan Africa (Burke et al. 2009, *PNAS*).
  - **Global level:** higher temperature is associated with more civil conflict in the tropics, exploiting climatic variation induced by El Niño (ENSO) (Hsiang et al 2011, *Nature*). ENSO variation explains 21% of conflict onsets since 1950.
Temperature and violence in Africa, across scales
Climatic impacts on intergroup violence, crime

### Kenya

- **Political & inter-group violence (Kenya)**
  - Pixel-by-year: N = 13,520
  - Theisen (J. Peace Res., 2012)

### Brazil

- **Redistributive inter-group conflict (Brazil)**
  - Municipality-by-year: N = 50,521
  - Hidalgo et al. (Rev. Econ. Stat., 2010)

### India

- **Inter-group riots (India)**
  - State-by-year: N = 206
  - Bohlen & Sergenti (J. Peace Res., 2010)

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### USA

- **Violent personal crime (USA)**
  - Jurisdiction–by-week: N = 26,567
  - Jacob et al. (J. Hum. Res., 2007)

- **Rape (USA)**
  - County–by-month: N = 1,434,832
  - Ranson (2012)

- **Violent inter-group retaliation (USA)**
  - Play–by–day: N = 595,500
  - Larrick et al. (Psych. Sci., 2010)

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Implications for African development

• **Four issues** are key to assessing impacts:
  1) Magnitude of effects
  2) Channels of impacts (i.e., economic vs. psychological)
  3) Adaptation to a warmer climate
  4) General equilibrium effects (speculative)
Magnitude of the effects

- Are effects “large”?
- The median effect size: a 1 s.d. change in climate is associated with a **+13% increase** in intergroup conflict.

- In a meta-analysis, the mean impact of a 1 s.d. change is a **13.5% (s.e. 3.4%) increase** in intergroup conflict.

- For interpersonal violence (e.g., crime), the median standardized effect is smaller, at **+4% per 1 s.d. change**.
Estimated climatic impacts and CI’s
Distribution of estimated climatic impacts

![Graph showing intergroup conflict with effect size distribution](image-url)
Magnitude of the effects

• Most of Sub-Saharan Africa is projected to experience average warming of at least 3 s.d. (2 C) by 2050, suggesting the risk of violent conflict could rise considerably.

• Beyond average changes, precipitation variability is likely to increase, potentially exacerbating effects
Projected temperature increase (s.d.), to 2050
The role of economic factors

1. Collier and Hoeffler (1998) argue that poverty leads to more conflict by reducing the opportunity cost of fighting, i.e., the poor have “nothing to lose”.
   – But there is also less to gain by fighting (Fearon 2003)
   – Economic “shocks” as triggers: temporarily reducing the opportunity cost relative to the size of the “pie” (Chassang and Padro-i-Miquel 2010)

2. Other hypothesized channels:
   2. Weak state capacity (Fearon and Laitin 2003)
   3. Precipitation and logistics (e.g., roads)
   4. Aggression and other psychological factors
The role of economic factors

• Economic channels seem to be important empirically:
  1) High temperatures reduce economic growth (Dell et al. 2012), agricultural output (Lobell et al. 2008), and labor productivity (Graff-Zivin and Neidell 2013, Hsiang 2010)

  2) In both the witch killing data and Harari and La Ferrara (2012), lagged growing season weather shocks have a much larger effect than non-growing season weather, suggesting that agricultural output is a key mechanism
Violence and growing season weather shocks
The role of economic factors

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• But the link between temperature and violent crime means aggression also likely contributes, although its precise contribution to inter-group violence remains unclear.
How likely is adaptation to climate change?

- A key unresolved question is the extent to which societies can adapt to future warming to limit adverse impacts.

- Unfortunately, the existing evidence suggests that any adaptation is likely to be partial.

1) Even with declining reliance on agriculture, African economic growth rates have not become less sensitive to high temperature over time: -1.5% growth per 1°C increase

2) The relationship is not significantly different for African countries at various levels of democracy and income

3) Rapidly rising temperatures over the coming decades will make adaptation even more challenging
Temperature and growth in Africa, 1960-2010
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Temperature and growth, 1960-2010

Total GDP

Agricultural GDP

Growth effect of +1°C (%)

mean temp 1950-70 (°C)

Freq.

Global

Global
Temperature and growth, 1960-2010

Total GDP

Agricultural GDP

Growth effect of +1°C (%)

Growth effect of +1°C (%)

Africa only

Africa only

mean temp 1950-70 (°C)

mean temp 1950-70 (°C)

Freq.

Freq.
Temperature and growth, 1960-2010
How likely is adaptation to climate change?

- Other work also indicates adaptation is likely to be costly:
  1) Minimal adaptation (~15%) of Indian agriculture to monsoon intensity over decades (Taraz 2013)
  2) **Even in the U.S.**, the sensitivity of agricultural output and crime to temperature is nearly unchanged over the past few decades (Burke and Emerick 2012; Ranson 2012)
  3) The short-run (annual) sensitivity of country economic growth to temperature is similar to medium-run (15-year) sensitivity (Dell et al. 2012), suggesting slow adaptation

4) **Preliminary analysis** indicates that the annual sensitivity of local conflict to temperature is similar to medium-run sensitivity
Medium-run adaptation to higher temperature

Change in temperature (C), 2005-09 minus 1991-95

Short vs long run response

% change in conflict per 1C increase

Panel 1991-2009 (N = 91,656)
Long diff. (2005-09)-(1991-95) (N = 4,824)
Global general equilibrium climate impacts

- Most studies are “local”, i.e., examining how temperature shocks in one country (or pixel) affects violence there.
- Broader impacts are possible on world food prices, through regional wars and refugee flows, etc.

- Complicated interactions are possible, e.g., observers have noted that record high global food prices in early 2011 – caused in part by the **historic 2010 drought in China** – may have helped “spark” North African Arab Spring unrest.

- High temperatures will increase relative productivity at far northern latitudes, and these effects could be amplified by faster innovation (Desmet and Rossi-Hansberg 2013).
Climate and conflict in Africa: looking forward

• With global mitigation (pollution control) efforts currently stalled politically, an adaptation agenda for Africa is desperately needed.

• E.g., the development of new crop varieties, weather insurance schemes, and peace-building programs that will reduce sensitivity to future climate change.

• “Rapid” targeted foreign aid to countries experiencing climate shocks might also be useful, if it dampens effects working through economic conditions (Miguel 2007).
Climate and conflict in Africa: looking forward

• The bottom line of the Hsiang, Burke and Miguel (2013) article and our ongoing work: there is a remarkably consistent relationship between adverse weather and human violence across time and space, including Africa.

→ Climate change could have serious implications for African political stability and economic development.
Estimated climatic impacts and CI’s
Distribution of estimated climatic impacts

Interpersonal conflict

- All studies (N=9): μ=2.6, σ=1.6
- Temperature studies (N=6): μ=2.6, σ=0.2

Effect size (%/sd)
Recent research at multiple time, spatial scales
Cross-sectional relationships with temperature
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