Warming increases the risk of civil war in Africa

Dataset
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***If you are using these data, even just idly, we would be interested to know. Please send an email to marshall.burke@berkeley.edu, including (if you wish) a brief description of what you're up to.**

1. Conflict data

Our dependent variable, the incidence of civil war, comes from the Armed Conflict Data database developed by the International Peace Research Institute of Oslo, Norway, and the University of Uppsala, Sweden (referred to as PRIO/Uppsala), Version 4-2008[1] (1). Civil war is defined in the PRIO/Uppsala database as "a contested incompatibility which concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 1000 battle-related deaths". All country-year observations with a civil war in progress are coded as ones, and other observations are coded as zeros.

2. Climate data

Our historical climate data are derived from three sources:

(i) CRU: Our main source is the Climatic Research Unit of the University of East Anglia (2), which provides monthly minimum and maximum temperature and precipitation on a 0.5x0.5 degree grid, for the period 1901-2002. We use version 2.1 of these data[2].

(ii) NCC: A second source is the National Center for Environmental Prediction/National Center for Atmospheric Research, which is available on a 6-hourly time step and a 1x1degree grid for 1948-2000[3] (3). We construct the daily minimum and maximum as the min and max of the four daily observations. We thank Wolfram Schlenker for making the processed data available.

(iii) GCPC: Our third source of precipitation data is the Global Precipitation Climatology Project of NASA's Goddard Space Center[4] (4), which is a monthly product on a 1x1 degree grid, available for 1979-2008.

From these data we construct country-level time series of average temperature and precipitation, using two different spatial and temporal averages:

(iv) Averaging climate over all grid cells in a country, for a given year. That is, temperature (precipitation) is averaged over all cells, and then averaged (summed) over all the months in a year.

(v) Averaging climate data over the areas and months in which crops are grown. Leff et al (2004) (5)provide 0.5x0.5 degree gridded estimates of the percent of land area sown to a given crop, which we use to weight the climate cells in a given country to build a monthly time series of country-specific crop climate (0.5 degree is roughly 50km at the equator). Following Lobell et al (2008) (6), we average (for temperature) or sum (for

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[1] Available at http://www.prio.no/CSCW/Datasets/Armed-Conflict/.
[2] Available at http://www.cru.uea.ac.uk/cru/data/
[3] Available at http://thanh.ngoduc.free.fr/wiki/index.php/Main/NCCDataset
[4] Available at http://precip.gsfc.nasa.gov/

precipitation) over estimates of the primary maize growing season in each country to construct annual time series. We develop separate weighted averages for maize, the primary African cereal, and for all crop area.

3. Control data

Because changes in economic and political variables over time could influence conflict risk in our countries, we use two types of data to control explicitly for economic and political performance.

3.1. Income data

We control for economic performance using levels of annual per capita income (PPP, 1985 dollars), lagged one year, which we derive from the World Development Indicators and the Penn World Tables (7, 8).

3.2 Political regime type data

To capture the role the development of democratic institutions could play in reducing conflict risk, we use the Polity2 measure from the Polity IV dataset[5] to describe the extent to which countries are democratic. Scores are reported annually on the country level, and range between -10 (full autocracy) and +10 (full democracy), and we lag this variable by one year.

4. Projections for future climate

4.1 Climate models

Changes in the incidence of civil war due to climate change are derived by combining the historical response of conflict to climate, modeled above, with climate projections from 20 general circulation models that have contributed to the World Climate Research Programme's Coupled Model Intercomparison Project phase 3 (WCRP CMIP3). Our main projections use the A1b scenario, reported by 18 climate models in the CMIP3 database. These models are CCMA, CNRM, CSIRO, GFDL0, GFDL1, GISS.AOM, GISS.EH, GISS.ER, IAP, INMCM3, IPSL, MIROC.HIRES, MIROC.MEDRES, ECHAM, MRI, CCSM, PCM, HADCM3. See Randall, Wood et al (2007) for a complete treatment of climate models (9).

We derive estimates of 2030 African climate by calculating model-projected changes in temperature (deg C) and precipitation (percent change) between 2020-2039 and 1980-1999, and then adding (for temperature) or multiplying (for precipitation) these changes to the observed record. We thank Claudia Tebaldi for help with these data.

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[5] Data available at: http://www.systemicpeace.org/polity/polity4.htm

5. Replication

We implement our analysis in Stata and in R. Table 1 in the main manuscript and Tables S1-S8 in the supplemental can be replicated in Stata using the climate_conflict.dta file and the associated climate_conflict.do file.

Figures 1 and 2 and Table 2 in the manuscript can be replicated in R using the climate_conflict.R script and the additional data files included in the replication package and called by the script.

VARIABLE DESCRIPTIONS IN CLIMATE_CONFLICT.DTA

1. Identification Variables

COUNTRY
Country Name

COUNTRYISOCODE
Country ISO code

CCODE
Correlates of War (COW) Country Code

YEAR_ACTUAL
Year

2. Conflict variables

WAR_PRIO_NEW
PRIO/Uppsala conflict variable, dichotomous, coded "1" if there was an internal conflict with >1000 battle deaths (i.e. a "civil war"), "0" otherwise

WAR_ONSET_NEW
PRIO/Uppsala conflict variable, dichotomous, coded "1" if a conflict with >1000 battle deaths began in that year, "0" otherwise. Coded as missing if there was an ongoing civil war that began in an earlier year.

3. Climate variables

CRU levels variables are labeled as follows: "climate"_"weight"_"transformation", where

- "climate" denotes either temperature or precipitation
- "weight" denotes how the data were weighted, where
    - "all" = averaged over the entire country and all months of the year
    - "seas_crop" = averaged over all crop area and growing season
    - "seas_maize" = averaged over maize area and growing season
- "transformation" denotes if the variable is lagged or in first differences or both.

Thus, for instance, the variable **TEMP_ALL_LAG** is levels of country average temperature lagged one year, **TEMP_SEAS_CROP** is temperature levels averaged over crop area and growing season, and **PREC_SEAS_MAIZE_DIFLAG** is first

differences of precipitation averaged over maize area and summed over the growing season, lagged one year. Temperatures are in degrees C and precipitation in meters.

CRU_TEMP_DIFTREND and **CRU_PREC_DIFTREND** and their accompanying lags denote country level average temperature and precipitation measured as deviations from country-level trend.

NCC climate variables are denoted similarly, with **NCC_TAVG** denoting average temperature, **NCC_PREC** total precipitation, and the **_LAG** subscript denoting one-year lags.

GPCP precipitation levels are labeled **GPCP** and **GPCP_L** for the contemporaneous and lagged precipitation, and first differences labeled **GPCP_D** and **GPCP_D_L**.

4. Control variables

GDP
Real per capita GDP, PPP, in $1000.

GDP_L
Real per capita GDP lagged one year

POLITY2
Polity score, taken from the Polity IV dataset. Values range from -10 (most autocratic) to +10 (most democratic).

ICCODE*
Country fixed effects

YEAR
Common time trend

ICCYEAR*
Country-specific time trends

GUIDE TO CLIMATE_CONFLICT.R

We implement our regression bootstrap and figure construction in R. R is a delectably free program available here: http://www.r-project.org/

To run this code, users will need to install the Maps library.

The code loads a number of supporting data files, which are listed and annotated at the beginning of the file. Users will of course need to change the input and output directories in the file as needed.

Citations

1. Gleditsch NP, Wallensteen P, Eriksson M, Sollenberg M, Strand H (2002) Armed conflict 1946-2001: A new dataset. *Journal of Peace Research* 39:615.

2. Mitchell TD, Jones PD (2005) An improved method of constructing a database of monthly climate observations and associated high-resolution grids. *International journal of climatology* 25:693–712.

3. Ngo-Duc T, Polcher J, Laval K (2005) A 53-year forcing data set for land surface models. *J. Geophys. Res* 110.

4. Huffman GJ et al. (1997) The global precipitation climatology project (GPCP) combined precipitation dataset. *Bulletin of the American Meteorological Society* 78:5–20.

5. Leff B, Ramankutty N, Foley JA (2004) Geographic distribution of major crops across the world. *Global Biogeochemical Cycles* 18:16.

6. Lobell DB et al. (2008) Prioritizing climate change adaptation needs for food security in 2030. *Science* 319:607.

7. Heston A, Summers R, Aten B (2006) Penn world table version 6.2. *Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania* 10.

8. World Bank *World development indicators* (The World Bank).

9. Randall DA et al. (2007) Climate models and their evaluation. IPCC Working Group 1: Physical Science, 589–662.