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Drought and Civil War in sub-Saharan Africa

According to the group of intergovernmental experts on Climate Change (GIEC), climate changes will generate an increase in the number of atypical climate events throughout the world, such as droughts and floods. These climate anomalies could have disastrous consequences for countries that experience problems accessing drinking water or whose economy depends on local agriculture. Some recent studies even assert that drought is one of the causes of civil war. The most emblematic case is Darfur, as the present consensus is that drought was one of the factors of civil war, although the conflict also had an ethnic component. In our study, we show that the link between precipitation, temperature and civil war found in the literature may be due to planetary impacts not linked to climate variations. The problem is due to the impossibility of distinguishing the effects of annual climate variations from other planetary phenomena such as large-scale political changes like the end of Cold War or global macro-economic variations like financial crises. When we consider this type of factors, precipitation and temperature variations have a much lower and non-significant effect on the risk of civil war. The use of the Palmer index, a local drought measure which describes the impact of the lack of water on social conflicts, shows in a more satisfactory way than precipitation and temperature measures that the drought effect on civil war is low but positive.

A few statistics on drought in sub-Saharan Africa

Sub-Saharan Africa is composed of 48 countries (including islands) and had 875 million inhabitants in 2011. It is one of the world's regions most affected by climate change because farming activities represent between 60% and 100% of the income of the poorest households, who often do not have access to drinking water.

Between 1945 and 2005, the great majority of countries in sub-Saharan Africa (76%) experienced at least a year of extreme drought and 23% at least a year of extreme rainfall. Globally, the sub-Saharan climate became drier and drier over 1945-2005 (Burke et al. 2009).

Dai et al. (2004) calculated the Palmer index (PDSI or severity index of droughts for all those countries, see frame 1) from data on temperature, precipitation and available water capacity (AWC) (or content) in the soil. The data came from meteorological stations, the number of which varied from 12 (for the smallest countries like Benin, Liberia, Lesotho, Sierra Leone and Swaziland) to more than 300 (in the biggest countries such as the Democratic Republic of the Congo and Sudan). The variation in the PDSI values between and within those countries is such that 54% of the index variation can only be explained by the year, 44% by the country concerned and 67% by the year and country considered.

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The values at year *t* are significantly correlated with the values in *t-1* within the countries, which conforms to the fact that the PDSI is a cumulative index. For the current month, the theoretical PDSI value is the PDSI value for the previous month to which an incremental value is added. However, the PDSI is not significantly correlated with its value at year *t-2*.

Chronological series on these data show that the PDSI and precipitation levels usually vary in opposite directions and that PDSI and temperature usually vary in the same way. 60% of the variation in PDSI and from 70% to 90% of the variation within each country can be explained by the variations in temperature and precipitation together. This is in accordance with the PDSI theoretical formula which is based on precipitation temperatures and available water content in the soil.

Frame 1: Measuring drought

The drought measure that we use is the Palmer drought severity index (PDSI) which is theoretically grounded and was developed in hydrology/meteorology by Palmer in 1965. The index value depends on the duration and extent of the humidity deficit. The PDSI integrates the meteorological conditions and combines contemporaneous and delayed values of temperatures and precipitation in a non-linear model including thresholds (because it takes into account the existence of two layers of soil, a surface layer and a deep layer.) First, the index captures major interactions which were not taken into consideration in the previous studies. For instance, a low recorded rainfall makes drought worse during hot months, because evapotranspiration is significant. High temperatures may prevent abundant rain from recharging the sub-soil. Second, the index depends both on the limited accumulation capacity of the sub-soil and on the local characteristics of the soil. Consequently, if there is abundant precipitation when the accumulation capacity of the soil is reached, rainwater will not be stocked in the soil and will stream. Third, The PDSI takes into account the heterogeneousness of the local conditions and their differences in the historical local climate. The PDSI values depend on the soil texture at the place considered and on the filling of the layers at the moment considered.

The PDSI considers the humidity level in relation to the climate norm. It is based on a model of demand and supply of the soil humidity and is calculated on the local precipitation and temperature data as well as on the AWC. The level of humidity available in the soil at the beginning of the time is used as a measure of past climate conditions. The notion of abnormality is important here: we talk of the lack of humidity when the water demand exceeds the humidity content at a given instant and a lack of humidity when the demand excess is high compared with the average. In this model, all the basic terms of the equation of hydric assessment may be calculated, including evapotranspiration, sub-soil supply and stream and humidity loss of the surface layer.

According to the Palmer classification, the PDSI values may be divided into 11 groups: extreme drought, high drought, moderate drought, light drought and drought that is just beginning, normal climate, humidity that is just beginning, light humidity, moderate humidity, high humidity and extreme humidity. The available PDSI data (Dai et al. 2004) cover the whole world, from 1870 to 2005, are geo-localized and available at a resolution of 2.5 by 2.5 degrees (about 250km to the Equator). Figure 1 shows the maps of the PDSI average raw data for five periods: maps (a) to (e) contain information on the average PDSI values for successive periods of times between 1945 and 2005; the areas in red are the driest areas and the areas in yellow are the most humid areas of sub-Saharan Africa.

Reexamination of the effects of meteorological variables on civil war

In the literature, the positive link between meteorological variables and civil war risk has often been questioned on various points. Most criticism concerns the sensitivity of the results to the way the climate is modeled as well as to minor variations, to encoding choices (like the minimum number of deaths linked to war in order to consider that a country was at civil war or not for the year considered, see frame 2), and to the lack of consideration of the spatial data coordination.

As well as these criticisms, we add the fact that the main works in the literature (for instance, Burke et al. 2009, Miguel et al.2004 and several results reported in Hsiang et al. 2013) do not lead to the conclusion of a causal relation between climate and risk of civil war. By observing time series, it can be seen that the proportion of countries at civil war progresses in the opposite direction from the average level of precipitation (correlation is -0.51, significant at a 1% threshold) and in the same direction as the average temperature (correlation is 0.33, significant at a 5% threshold). But these simultaneous variations do not help distinguish the effect of the yearly world climate variations from the effects of other major variations such as large-scale political changes, for example the Cold War, or global macroeconomic variations like financial crises. The link between climate and civil war risk obtained in those studies may be fallacious. In other words, while it may be concluded that there is a link between climate variables and civil war at local level, it is only due to world-scale phenomena and even to phenomena which are independent of climatic factors.

Frame 2: Data on civil wars

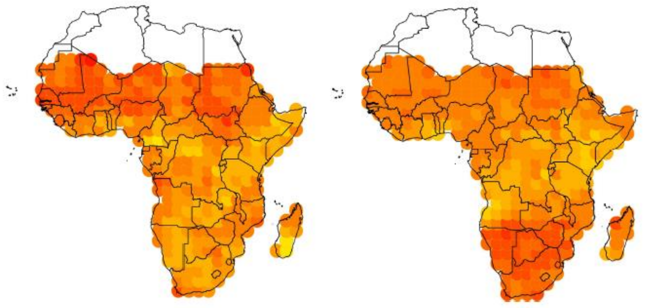
We use data on armed conflicts from the “Uppsala Conflict Data Programme” (UCDP) from the Peace Research Institute Oslo (PRIO). We use the usual indicator of civil war occurrence. For a given year, a country is considered at civil war if the number of deaths due to armed combat is higher than 1000. Alternatively, we also use the civil war trigger index as well as a measure of the intensity of civil wars. The trigger index only takes into account the first year of war. Civil war intensity directly uses the number of deaths linked to armed combat.

It is important to note that the inclusion of decolonization processes and the emergence of new states constitutes an empirical and theoretical challenge. The question of inclusion of anticolonial wars is posed in all the analyses about civil wars. According to studies carried out in political sciences, the most careful strategy is to exclude the colonial period and concentrate on civil wars in independent African States. Consequently, we consider each country from its independence until the most recent year in our data, that is to say 2005. For instance, Ghana obtained its independence in 1957, Mozambique and Angola only in 1975 while most French colonies in sub-Saharan Africa were independent in 1960.

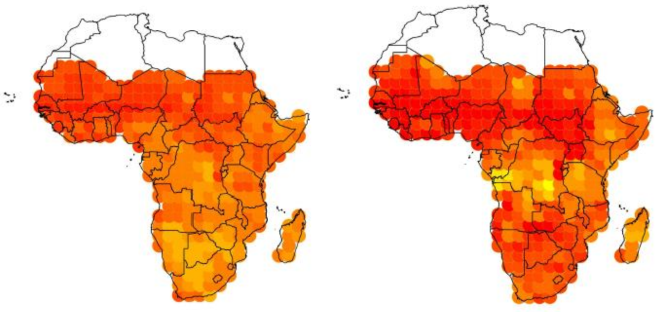
It must also be noted that our analysis concerns the drought effect on civil war risk at country-year scale. In other words, for a given country, drought is measured as an average of PDSI monthly data (and localized within the country).

We went back over the analyses performed in the literature, removing the analysis of the yearly variations in global factors. Without that correction, the precipitation effect is negative, the temperature effect is positive and both effects are significant.

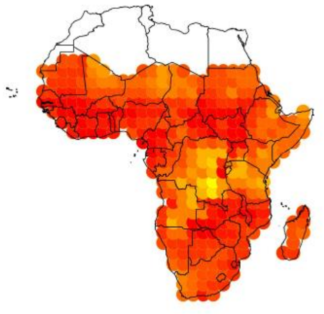
When the analysis is corrected as previously explained, it can be found that the precipitation effect on civil war risk is not significant and may even turn out to be positive. The temperature effect is reduced by 2/3 and is not significant. Whether for precipitation or temperatures, the difference between the results obtained can be explained by the fact that the precipitation or temperature effect on civil war risk is “removed” from the joint variations between world conditions and aggregated risk of civil war.



a. 1945-1960 b. 1960-1970



c. 1970-1980 d. 1980-1990



e. 1990-2005

Drought effect on civil war

A major argument in favour of the use of the PDSI instead of measures of precipitation and temperatures is that it preserves some degree of freedom compared with a more general specification which can get complicated with precipitation, temperatures, delayed values and interaction terms. When we go over the method used in the literature, the drought effect on civil war risk is significant at a 1% threshold. According to this result, a climate change from a normal climate to a moderate drought would increase the risk of civil war by 17% over 10 years and this is true for each country in sub-Saharan Africa. However, we previously asserted that this link could be fallacious. So, we carried out an analysis in which we corrected the problem raised. We “remove” the drought effect on civil war risk from all the world’s yearly changes such as variations in the world economic situation, global technical progress and variations in the international prices of natural resources as well as global political changes such as the Cold War. Our assessments show that the drought effect becomes slightly less significant (it is significant at a 12% threshold). The size of the PDSI effect on civil war risk falls by 2/3 compared to the result obtained when the method used in the literature is applied. Even if the result obtained is only significant at a 10% threshold, it remains positive. There is a noteworthy difference with the results obtained when measures of temperature or precipitation are used. The temperature effects (and its delayed values) on civil war risk is positive but not at all significant. The precipitation effects (and its delayed values) is slightly non-significant but has an ambiguous sign (some delayed values have a positive effect). It may be concluded that drought such that it is considered in the PDSI does indeed have a positive effect on civil war risk, but not as big as the literature suggests. Our assessment of the drought effect on civil war risk shows that a climate change from a normal climate to a moderate drought increases the risk of civil war by 0.7% per year on average, in other words a risk of civil war increased by 7% over 10 years for each country in sub-Saharan Africa. A sharper shock whereby the climate changes from normal to extremely dry would increase the risk of civil war by 1.1 % per year on average (that is to say an additional risk of 11% over 10 years). A simple calculation also shows that 9% of the civil wars contained in our sample may be associated with drought. By going a little deeper into the analysis, we note that the effect of a drought increase is bigger when the drought level is already high, that is to say for the PDSI values which indicate at least one light drought in the Palmer classification.

Numerous sensitivity tests have been carried out. The result is affected by the suppression of the most influential observations (the effect becomes significant), by the use of various periods of time (the effect is significant for the times between 1970 and 1999), or by modifying the threshold of 1000 deaths due to combat (the effect is never significant for lower thresholds but it becomes significant for threshold values higher than 1000 deaths).

A comparison of the models using PDSI with those using precipitation and temperature was made. The results suggest that the Palmer index describes the impact of water shortage on social conflicts in a more efficient way than the measures of precipitation and temperature (see Couttenier and Soubeyran, to be published, for further details).

A few ideas on the underlying mechanisms

In the literature, the main argument to explain the fact that drought may increase civil war risk is that by reducing income from agriculture, drought reduces the opportunity cost of engaging in a conflict for rural populations. An alternative argument is that drought may also have a negative effect on public revenues, weakening the government and generating opportunities for rebel groups. In order to suggest ideas on the mechanisms underlying the drought effect on civil war risk, we analyse the drought effect (PDSI) on other economic and political variables. Drought has a positive effect on local prices of foodstuffs and a negative effect on the yields of cereal production, which is consistent with the climate effect on agricultural yields. Drought has a negative but non-significant effect on national farm income per capita, on GDP per capita as well as on GDP growth. These results contrast with the recent but increasing literature which asserts that climate affects economic performance. Globally, these results suggest that an opportunity cost mechanism could explain a positive effect of drought on civil war through the negative effect of drought on agricultural output. The drought effect on the variables of public finances is analysed and it turns out that drought has a positive and significant effect on the consumption expenditure of general government (as a % of GDP), but no significant effect on the share of public consumption (as a % of GDP per capita). Put end-to-end, these results suggest that drought has effects on both the rural populations and public finances; it is therefore difficult to settle the argument in favour of one of the two mechanisms proposed in the literature.

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For further information

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