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Drought, Mechanisms and Terror

The role of crop harvests in increasing the intensity of terrorism.

Abstract

The aim of this study is to investigate whether crops are a mechanism through which drought affects terrorist activity. The theory suggests that drought can affect conflict if the group or country affected also is dependent on agriculture, experiences low economic development and is politically excluded. This study adds the perspective that decreased crop harvests, due to drought, can be understood as economic shocks through the opportunity cost effect. Previous research indicates that the current big question within the climate-conflict field is *how* climate change affects conflict. This study employs a time series panel data approach and concludes that decreased harvests of millet can be one, of many mechanisms, through which drought affects conflict in a sample of sub-Saharan countries. Establishing causal factors, like this study tries to do, could help us more effectively mitigate the effects drought have on fragile states in a warming climate. Another contribution is that it tests whether drought anomalies has had an impact on terrorist activity and concludes that the results show a significant positive trend when tested over time and space.

Key words: Climate Change, Drought, Terrorism, Conflict, Food Insecurity, Economic Shocks
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1 Introduction

Drought, and its connection to conflict is increasingly being noticed. The conflicts where climate change seems to act as a threat multiplier are not that far away from the public eye. However, the scientific conundrum to as of *how* drought affects conflict is, as of 2021, debated (Uexkull, d'Errico and Jackson 2020, p. 1995). These conflicts sometimes attract attention from national news outlets in Europe and the global north, but mainly in a peripheral way and with spotted attention. We sometimes get reports from the UN peacekeeping mission in Mali, Boko Haram's activity in the Maghreb or ISIS recent revival in the Democratic Republic of Congo to give some examples (Reuters 2021; Der Spiegel 2021; Faucon, Bariyo and Parkinson 2021). What is most of the times withheld from these news reports is that they exist in an environment marked by severely increasing climate anomalies. Climate warming is predicted to rise faster in sub-Saharan Africa, than in the rest of the world (IPCC 2014). Further, Africa is probably the least equipped continent to handle this, due to a combination of low state capacity, particular eco-climatic conditions and socio-economic situations that most of these countries are burdened with (FAO 2017). Increasing levels of drought and water shortages make it harder for the around 50 million people dependent on agriculture in the Sahel to support their families (Middendorp & Bergema 2019). Non-state armed groups seem to utilize this vast group of people's grievances and thereby becoming the mobilizing force through which grievances become violence (Mobjörk et al. 2016, p. 17; Uexkull et al 2016a, p. 12391). Add the already existing structural factors to the equation and the picture becomes even more complex. The plethora of reasons for any given group or individual to take up arms can be exemplified by the conditions facing Mali, in wake of the UN intervention in 2012, just after the coup d'état.

> *Weak state institutions; ineffective governance; fragile social cohesion; deep-seated feeling among communities in the north (of Mali) of being neglected, marginalized and unfairly treated by the central government; a weak and externally dependent, albeit vibrant, civil society; and the effects of environmental degradation, climate change and economic shocks (Vermeij 2015, p. 1).*

The above excerpt from a policy brief about the Multidimensional Integrated Stabilization Mission in Mali (MINUSMA) highlights the complexity of both peacekeeping, conflicts and cause and effect in the 21^{st} century. The title of the UN operation in itself is complex and says something about this. It is never as clear-cut as a single issue, nor one single problem that has to be dealt with, in order to bring about peace and security. This apparent complexity might also be why news reports on this issue remain peripheral and with spotted attention.

Going back to the *how*, we can establish that any mechanism through which drought affects conflict alone is not possible to find, for resilience measures to be put into place. However, it could be possible to find out which mechanisms seem to affect conflict the *most*. If we find these, we might have a chance of remedying some of the harm climate change can do, such as contributing to more conflicts. Most researchers seem to agree that it is when drought happens during growing season, that it has the worst effects (Uexkull et al. 2016a; Harari and La Ferrara 2018; Linke and Ruether 2021; Vesco et al. 2021). Crop harvests have been linked to conflict variability and as such might be one of the areas where resilience could be built in areas where such a vast group of people rely on crops for their livelihood (Linke and Ruether 2021; Vesco et al. 2021).

Building upon the findings of Uexkull et al. (2016a) this study is concerned with to what degree decreased crop harvests, mainly maize and millet, affect terrorist activity in countries inhibiting low human development as well as a large population dependent on agriculture for their livelihood. It is a statistical time-series production, aimed at showing changes over time. It has tried to incorporate as many observations as possible, given the limited time for producing it. As terrorism have increased to such an abhorrent level in many of the countries analyzed in recent years, a time series study was the only logical choice, since only spatiality would not encompass the same kind of analytical depth. As such, the years observed span from after the cold war to as late as the data allowed, 1990 to 2016. The guiding research question is as follows:

Does drought affect terrorist activity through crop harvests?

The study is structured as follows. In part two, following the introduction, earlier research within the field is presented, along with the theory as well as hypotheses. Part three gives the reader insight into the methodological considerations. Part four displays the empirical findings and is followed by a discussion of these in part five. Part six provides the conclusions of the analysis and gives the reader suggestions on resilience measures that could be brought into place.

2 Earlier Research & Theory

This section introduces the reader to earlier research within the climate-conflict area of research as well as the theoretical framework upon which the study builds.

2.1 Earlier Research

Moving onwards, this section will provide the reader with a broad overview of the climate-conflict area of research. It will first discuss how earlier studies has measured climate. Secondly, it will search the literature for whether it is crops, external shocks or other factors that acts as mechanisms. Thirdly, it will discuss which kind of conflicts that has been the area of attention and lastly it will assess which gaps in the research this thesis aims to remedy. To start off, the link between climate change and conflict is indirect, and the efforts in finding the micro-level pathways through which the relationship is best described, is where most research currently stands (Uexkull, d'Errico and Jackson 2020, p. 1994-1995). Right now, the area is a scientific 'conundrum' of sorts, and it is noticeable that this has led to an increase in attention more recently, with a large increase of quantitative studies being conducted from 2012 and onwards (Ide 2017, p. 3). The Intergovernmental Panel for Climate Change (IPCC) points out, in its fifth assessment report (2014), that climate warming is starting to accelerate and specifically some regions, like the Middle East and sub-Saharan Africa, are at risk of an even faster pace than the global average. This explains the societal relevance of studies being conducted, as these regions already are unstable due to other factors, but also the increased scholarly attention, as we are beginning to see the effects of a warming climate already today, in some areas of the world. Earlier research was merely able to find inconclusive signs to whether the link is statistically significant (Hauge and Ellingsen 1998; Nordås and Gledditsch 2007). The relationship has however been brought up as a focus-issue by a selection of interest-organisations and NGO:s, which has stressed that climate change might act as a threat multiplier to conflicts in unstable regions (Nett and Rüttinger 2016; Rüttinger et al., 2015; CNA Corporation 2007). One of the first scholarly studies to provide the conclusive causality needed between the two elements, was a study conducted by Uexkull et al (2016a), where they found evidence for drought prolonging civil conflict under certain conditions. In countries with a high infant mortality rate (IMR), an agriculturally dependent population, high degrees of exclusion and low economic development drought might prolong conflict (Uexkull et al. 2016a, p. 12391).

However, the micro-level pathways through which this complex causal chain ensues is harder to pinpoint. Some studies suggest that external income shocks might be one of the explaining factors (Dube & Vargas 2012; Berman and Couttenier 2015), others point to food insecurity (Bellinger & Kattelman 2020; Jones, Mattiaci and Braumoeller 2015) or water insecurity (Ide et al 2020) and some directs their attention to state vulnerability (Jones, Mattiaci and Braumoeller 2015) A convincing argument is made by researchers suggesting the linking mechanism most likely operates through low agricultural yields, and that climate outside of the growing season has little to no effect (Harari and La Ferrara 2018; Linke and Ruether 2021; Vesco et al 2021). Arguably, this is an aspect within the broader field of food security, as the focus of this essay concerns maize and millet. These are two of the most critical crops for food security in Africa, while at the same time being two of the most at-risk crops in a changing climate (CGIAR 2015, p. 6-7; Santpoort 2020, p. 1). Economic shocks as an explanatory factor has also been proven highly significant in explaining the intensity of conflicts (Dube and Vargas 2012).

Research combining climate and conflict has mostly focused on precipitation or temperature in relation to conflict-related deaths (Harari and La Ferrara 2018). A common index used in that regard is the Standardized Precipitation Index (SPI), first proposed by McKee, Doesken and Kleist (1993), which adds drought beginning, ending, intensity and magnitude to the information received. Drought indices must in some way be connected to a temporal unit to be able to successfully monitor different usable water resources, which explains the wide acceptance of the SPI within the research community (CSIC 2021). More recently, studies within this area has started to use the Standardized Precipitation-Evapotranspiration Index (CSIC 2021) (Von Uexkull et al 2016a; Harari and La Ferrara 2018; Vesco et al 2021). It captures variations and anomalies within precipitation, but also variations in determinants of evaporation such as temperature and wind speed (Uexkull et al 2016a, p. 12392). As this research is based on the success or failure in growing crops and its effect on terrorism, the extent to which the soil can retain water is an important factor to include in the analysis, which the evapotranspiration does within the SPEI data (Harari and La Ferrara 2018, p. 594).

Another thing large-N studies within this field of research tends to focus on specifically is civil conflict (Von Uexkull et al. 2016a; Berman & Couttenier 2015; Linke & Routher 2021). Few statistical studies have shown a similar attention to the link between climate and terrorism. Bellinger and Kattelham (2018) demonstrates the effect food insecurity have on terrorism, while Adelaja and George (2019) investigates the effect Boko Haram's activities has had on land use in northern Nigeria. To my better knowledge, no similar studies as the ones done on the link between climate change and conflict, has been done with drought and terrorist activity.

Going back to Von Uexkull et al (2016a) and their findings, we can with some certainty assert that the way in which drought affects conflict is through climate anomalies during growing season. As their study presents the most comprehensive and convincing results yet, it will form the basis for the theory in this study. Their preconditions for drought prolonging conflict are that a population affected by drought must also lack decent economic opportunities, be somewhat politically excluded and agriculturally dependent. Furthermore, there seems to be evidence for factors like state vulnerability and water insecurity being important when explaining this indirect causality. However, state vulnerability, food- and water insecurity can also be explanatory variables for the level of conflict in their own right (Jones, Mattiaci and Braumoeller 2015).

In a former qualitative study, I managed to provide some consistent proof for the causal chain provided by Uexkull et al. (2016a) and their results, in the context of extremist groups. It was however clear that the links were quite indirect. But there is proof that extremist groups such as Boko Haram incorporate the conditions drought creates, within their strategy. Farmers losing their harvest due to drought normally face harsh conditions when searching for other opportunities in these drought-prone, low-governance areas. It is at that time in need Boko Haram uses deliberate recruiting strategies to strengthen their ranks. Promises of better welfare and improved economic conditions in exchange for taking up a gun are very appealing in the face of starvation (Maza, Koldas and Akzit 2016, p. 6). However, it should be noted that terrorist groups pay their members quite well. It might in fact be as simple as terror group membership is more profitable than other economic activities in the area, regardless of drought or not (Bellinger and Kattelham 2018, p. 2). In regard to this, Dube and Vargas (2012) points to an 'opportunity cost' effect involved in the risk for conflict. If the possibility to join any armed insurgency exists within areas producing labor-intensive products such as crops, then conflict variability could be affected by prices on that product or fluctuations in harvests. Further studies conducted on the efficacy of this theory has indicated its robustness, which points to economic consequences to be more important than for an example state capacity and thus political agendas in determining whether grievances become rebellions (Berman and Couttenier 2015, p. 773). Here lies another aspect through which this study contributes, as it tests whether economic shocks affect terrorism intensity. Most studies on economic shocks and its effect on conflict has previously focused on civil conflicts (Dube and Vargas 2012; Berman and Couttenier 2015).

Many researchers argue that other factors such as religion merely is a 'smokescreen' for socioeconomic grievances (Cottee 2017, p. 443). This is why this study has focused on an economic aspect of how grievances become violence. Many terrorist groups today seem to work very actively with religion and ideology in proclaiming their reasons, but the reality seems to be different, something the insurgency in the Maghreb can tell us. As hinted about above, Boko Haram employs various complex recruitment strategies to attract individuals to join their cause, such as cash loan traps, forceful conscription, as well as promises of improved economic conditions (Maza, Koldas and Akzit 2020, p. 5; Torbjörnsson and Jonsson 2017, p. 46). Research indicates these recruitment strategies to be very effective in these areas, which is why financial incentives are the focus for the proposed causal chain within this study. The structural conditions present in many communities within the Maghreb such as poverty, unemployment and poor welfare are then exacerbated by drought (Maza, Koldas and Akzit 2020, p. 2). Once again, this indicates some form of grievance mechanism, as people with their livelihoods threatened might sometimes believe they have less to lose from using violence or joining armed groups, than continuing with legitimate work (Mobjörk et al 2016, p. 17). Here, some form of mobilizing force is required for sgrievances to become violence, which armed rebel groups provide (Von Uexkull et al 2016a, p. 12391). People are then more or less inclined to join with these groups depending on a cost-benefit analysis of their current economic situation (Dube and Vargas 2012, p. 1384-1385). To which extent terrorism plays into this relation has thus far, to my better knowledge, not been measured in a large-N country study, thus motivating the purpose of this study.

2.2 Theoretical Framework

The theoretical framework in this study is based on two theories. The main frame of understanding lies in accordance with Uexkull et al. (2016a) and their results. By investigating to which extent conflict behavior of spatially defined ethnic groups is sensitive to agro-economic shocks, they found that drought might prolong conflict in areas inhibiting low economic development, while at the same time having groups who are agriculturally dependent as well as politically excluded. The occurrence and duration of drought increases the likelihood of sustained conflict involvement (Von Uexkull et al. 2016a, p. 12394). In this study however, I will instead argue that drought also increases terrorist activity. Thus, the study is concerned with the role armed groups play in exacerbating structural conditions, worsened by drought. The hypothesis I derive from this is the following:

Hypothesis I: An increase in drought anomalies have a positive effect on the amount of terrorist attacks in countries where the population is agriculturally dependent and suffers from low human development.

The additional theory builds upon economic shocks. The ‘opportunity cost effect’, as described by Dube and Vargas (2012) stipulate that when the price of labor-intensive products such as agricultural commodities rises, conflict falls. Naturally, the effect is opposite as well so that when the price drops, conflict thus increases. Their research also indicates an opposite effect, which this study will not include in its framework, called the ‘rapacity-effect’. It instead found a positive effect with conflict when the resources were labor-effective (Dube and Vargas 2012, p.

1384-1385). This theory can help explain the role crop production has on terrorism, as lower wages, which this study conceptualizes as being in the form of reduced harvests due to drought, seem to be a causal mechanism for recruitment into armed groups (Dube and Vargas 2012, p. 1392). It is argued here that a drop in production due to drought could be interpreted as having a similar effect as a drop in prices due to world market fluctuations. Decreased crop harvests in areas where most are dependent on farming for their livelihood can thus lead to farmers taking up arms. The theory simply stipulates that the "cost" of fighting decreases with every dollar less earned from non-violent sources, which might be why crop harvests can have an impact on conflict levels in these areas. Farmers that have experienced recurrent drought for several years might be in a situation where "they have nothing to lose". Thus, the cost of taking up arms should be very low in areas burdened by recurrent droughts (Dube and Vargas 2012, p. 1410-1413).

In this study, "price" or "income" will be defined as harvests of two of the most critical crops for food security in large parts of the sub-Saharan Africa – maize and millet. This is a valid conceptualization due to the fact that 80 percent of African farmers are small-holder farmers, farming less than two hectares (Adelaja and George 2019, p. 1). We can thus expect the shock of a decreased harvest to impact farmers income, thereby also validating the use of this theory.

The connection this has to terrorism thus seems to be that, in the face of a reduced income due to drought anomalies and a threatened livelihood, terror groups provide the agency necessary for grievances to become violence, thus reducing the "opportunity cost" in joining for individuals. Therefore, the measuring of terror attacks yearly and for a selection of countries has been employed in this study as the dependent variable. Millet and maize, being among the widest used crops in this area, is tested as the mechanism through which drought affects terrorism activity. This gives us the following hypothesis:

Hypothesis II: Lowered income through decreased crop harvests increases terrorism activity in countries where the population is agriculturally dependent and suffers from low human development.

This study has employed these concepts through the selection of cases, the choices of dependent and independent variables as well as control variables. The control variables will take into account some of the other suggested micro-level pathways, discussed in the literature review. State fragility, political exclusion, economic shocks and water stress are the factors, except drought, that this study expects to have a positive impact on terrorism activity. To make this section consistent, I have derived another hypothesis from this:

Hypothesis III: State fragility, political exclusion, income shocks and water stress all impact terrorist activity.

3 Method

Here, the methodological choices for this thesis are presented. The study uses time-series panel data and fixed effects regressions. First, the selection of variations is motivated. Thereafter, the data and its use in regard to the theory is presented, followed by a discussion on the method used. Lastly, some limitations for the scope of this study are brought up.

3.1 Selection

The selection of cases, material and variations in this study are determined by the theory as well as how similar studies have been conducted. Presented below are the variations accounted for within the dataset.

3.1.1 Variations in Spatiality and Temporality

To cover the appropriate parts of this field, a measure of spatiality is needed, as well as a measure of temporality. The measure for spatiality is countries, while the measure for temporality is years. The cases analyzed in this thesis belongs to the following three categories: 1) they are countries within Sub-Saharan Africa, 2) they have an IMR of over 50 per 1000 births and 3) they have the highest percentage of employment within agriculture in the earlier two categories. The theoretical framework implies that the opportunity cost effect might have an impact in specifically agriculturally dependent areas, since income shocks is defined as crop harvests instead of in money. As we are not interested in knowing whether crops affect conflict in areas with very little agricultural dependence, it makes sense to homogenize the sample of cases with a very specific selection method like done here.

The selection has been done using indicators for the end-year (2016), within the variations. The first category aims to provide the study with cases that are roughly similar to each other, with similar climate, social composition and level of development. The second category narrows it down further, as IMR according to Uexkull et al (2016b) is a good macro-measurement for social development, as it directly captures the well-being of humans. It is also less directly affected by global financial developments and international commodity prices (Uexkull et al. 2016b, p. 2). The third category aims to capture the most at-risk countries concerning drought related to income-loss. As only around 4% of all land is irrigated in sub-Saharan Africa, but most farmers rely on rain-fed agriculture, the best meta-category I identified for this is through employment in the agricultural sector (Buhaug and Tiesen 2012, p. 44). This selection resonates with the theory provided above, as both the second and third category covers two of the factors Uexkull et al (2016a) deems important for whether drought has an impact or not: agricultural dependence and economic development. The last factor from the theory, political exclusion, is covered as a control variable, instead of in the selection. This is due to this variable being a key factor which seems to affect terrorism, according to the already existing literature.

However, from these resulting 20 countries, some had to be excluded from the analysis on the grounds of lacking data. The recently formed South Sudan lacks in collection of the relevant data before 2012. According to the FAO, neither Equatorial Guinea nor Liberia grows any maize, also excluding them from the study[1]. It is important to point out that the selection here might lead to what statisticians' call "selection bias" (Keele 2015, p. 321-322). However, the most general case selection, that most often is the hardest to analyze, might not be the most empirically fruitful (Heckman 1990, p. 317). Being a qualitative researcher by nature, I therefore believed it important to employ the theory within the selection of cases as well. I realize this might have an effect on the results in the form of making it less generalizable, but more specific.

The selection of years (1990-2016) follows a similar structure as many other studies within this field, such as Von Uexkull et al (2016b). It is mainly determined by the availability of data on all of the important variables, but why 1990 was chosen specifically, and not later or earlier, was due to the fact that this time period is more alike in terms of the geopolitical considerations that might affect the analysis. However, both the data for terrorism and drought goes back longer than 1990. But to be able to include all of the relevant variables, some limitations in years had to be done.

3.2 Data

In this subsection, I will present the data and how it has been operationalized within the analysis. First, the main variables are presented. They are the dependent (terror attacks) and the independent variables (drought and crops). Since crops is the focus for this study, I interpret maize and millet harvests as also being a main variable, even though it is discussed about as a mechanism.

[1] The resulting list of countries in the study are Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Dr. Rep. of Congo, Côte d'Ivoire, Guinea, Guinea-Bissau, Lesotho, Mali, Mozambique, Niger, Nigeria, Sierra Leone and Somalia.

Thereafter, the control variables are presented. All of the variables in this study are numerical ones.

3.2.1 Main Variables

The data covering the dependent variable comes from the Global Terrorism Database (GTD), produced by the University of Maryland. It is the most comprehensive database thus far on terrorism and it is a continuation of the Pinkerton Global Intelligence Service (PGIS) database on terrorism events. Their lead researchers claim that collecting data on terrorism is more challenging than collecting on conflict-related deaths (LaFree & Dugan 2007, p. 182). This may be why this database is less used for this purpose than, for an example, the Armed Conflict Location & Event Data Project (ACLED), which many other similar studies have used. GTD has two bigger drawbacks. First, it is collected from news sources, hence only the most newsworthy terrorist attacks are included. Secondly, as with many other open-source databases it lacks information on other important issues related to terrorism. For an example, since it yet again relies on news sources, it does not cover to an appropriate extent the amount of terrorist attacks conducted by states against its own citizens (LaFree and Dugan 2007, p. 188-189). Nonetheless, for the research purposes in this study it is well suited, as these same lead researchers states that it is particularly useful for determining the impact of any given event on future risks of terrorist attacks (LaFree and Dugan 2007, p. 198).

This study interprets terrorist activity in the form of terrorist attacks. That is attacks that are one of the following: 1) have a political, economic, religious or social goal, 2) have an intention to coerce, intimidate or publicize to larger audiences and 3) they are outside of international humanitarian law, ergo targeting non-combatants or civilians (Lafree and Dugan 2007, p. 188). Within the GTD metadata-file I have calculated the amount of terrorist attacks during every year and for every country, as well as the number of deaths inflicted by these attacks. The value for terror attacks for each year is then interpreted as a measure for terrorist activity within that country.

The data covering climatic changes comes from the European Commission ‘Copernicus’ project. Its global Drought Observatory (GDO) project provides six measures of precipitation and evapotranspiration. These are measures of anomalies in precipitation for 3, 6 and 12 months as well as precipitation combined with evapotranspiration, also for 3, 6 and 12 months. This study uses the 12-month SPEI measure as it suits this study’s temporal variations as well as being the most aggregated measure, as compared to SPI. SPEI measures the anomalies compared to the historical average during these time periods on an intensity scale of 1 to 25, with 25 being the biggest anomaly in loss of precipitation and evapotranspiration and 1 being the lowest anomaly. A zero in the data represents no significant difference from the historical average (CSIC 2021).

Earlier research has shown these measurements to be effective in providing causality between drought and conflict and they are also the best indicators thus far of drought (Uexkull et al. 2016b, p. 1-2). As this study's spatial unit of observation is countries, the SPEI data has been manually coded from the Global Drought Observatory's timeline of drought events. In the data analysis, the values from SPEI-12 are generated as standard deviated versions. Hence the values 0-21 are interpreted in the study instead as 0 equals -1, 10 equals 1 and 21 equals 2. Standardizing makes it easier to read the regression results as well as ensuring the variables contribute to a scale when put together. This helps us to mitigate the risk of obtaining misleading results. As seen above, the values are distributed appropriately and does not affect the p-values in the regression.

The data covering the two main crops comes from the United Nations Food and Agriculture Organization's (FAO) statistical service (FAOstat). Millet and Maize was chosen as the measure for crops, as they are two of the most critical crops for food security in Africa and are widely used within the countries analyzed, with one exception (CGIAR 2015, p. 6-7). That exception is Somalia, which, according to the FAO, is not producing any millet. Somalia will thus not be accounted for in regressions on millet. The fact that Maize increased its area of use with 60 percent between 2007 and 2017 will be something that may affect the results (Santpoort 2020, p. 1-2). Nonetheless, as we are looking at anomalies in production, weather patterns and violence, maize is still relevant to include within the analysis.

The two crop values are then divided by 1000 in the analysis for each year to get a more easily interpreted coefficient. This study interprets this as a meta-value for how successful crop growth is during any given year and as most farmers are small holders in these countries, a decrease or an increase represents a significant impact upon the livelihoods of farmers. Further, as the theory stipulates that shocks in decreased income can lead to conflict, the measure for maize and millet have been converted into difference-in-difference variables as well, used in some of the models. For longitudinal panel data studies such as this one it is suitable, as diff-in-diff measures the difference between years, meaning shocks from year to year.

3.2.2 Control Variables

The data for the control variable *polity2* is collected from the Center for Systemic Peace polity V project. The polity project assigns scores of -10 to +10, based on the other indicators for each country, during each individual year (Marshall and Gurr 2020). The polity score from the polity V project is used as a measure for the country's degree of political exclusion, which is a part of the theory, but interpreted as more of a control within the analysis. This is to not exhaust the theoretical implications of this study, but still control for the political aspect.

Another of the controls measure for state capacity through the state fragility index (SFI) and is widely discussed in earlier research as having implications for the degree of both conflict and terrorism. Low state capacity often leaves a vacuum of operating space for non-state armed groups. A high ranking on this index would theoretically imply a higher degree of terrorist activity. The SFI is also collected from the Center for Systemic Peace. It is similar to the polity2 score in that it assigns scores based on sub-indicators, however the score ranges from 0 to 25 instead, with zero being no fragility (Marshall and Elzinga-Marshall 2018).

The control variable *wstress* is collected from FAO's AQUASTAT. It is a calculation of the proportion of available freshwater resources, through total freshwater withdrawn by all major sectors and the total renewable freshwater resources. It also takes into account environmental flow requirements (FAO 2021b). Unfortunately, it only has data for every five years. Rather than leaving the years in between empty, I saw it fit to include the value for the year included also for the coming four years, until the value changed. Hopefully this makes the dataset more consistent. Water stress could be interpreted as a similar measure as the indicator for drought – SPI and SPEI. However, it is not synonymous, as it is used as an indicator for the availability of fresh water accessible to the population and as such represents a value indicating the degree of water scarcity. The literature within this field also indicates that strategies to target and destroy water infrastructure is a staple within extremist organizations operations (Torbjörnsson and Jonsson 2017, p. 19).

The last variable *gdpc* is collected from the World Bank Open Data. It is the GDP per capita for each year (World Bank 2021). However, data for a few years within some countries are not available. They are therefore left blank within the dataset. GDP per capita is another indicator for income, however quite sweeping, as GDP per capita is a value of a country's gross domestic product divided by the number of citizens. It has been used in other similar studies to capture economic and sociodemographic characteristics (Bellinger and Kattelham 2018, p. 14). It will be used in a similar way in this study. It is interpreted as another measure for income shocks. It has also been generated as a diff-in-diff version, used in the last model to capture the "shock" of a decreased or increased income adequately, by accounting for yearly changes.

3.3 Choice of Method

Now that the selection, the data and its use within the study is covered, a discussion will follow on the suitability of the chosen method for this essay. The method choice for this essay can be motivated by the fact that we want to explain many cases over time to be able to tell if there is a correlation between drought and terrorist activity (Allison 2011, p. 2). Given the limited time for this study, it was preferable to quantify the results. It is also a common choice of method for this field of research (Ide 2017, p. 3). A time-series panel data approach is suitable when we want to explain many cases. Within the panel data in this study, the *i* spans between 1 and 17 and the *t* spans between 1 and 27. This is a balanced panel data set, as the time period is the same for all of the countries. This gives us a cross section of 17 countries and a period of 27 years. Further, no correction in regard to the variations have been done, as there are no suspicions of the data being heteroskedastic. This because the data analyzed stays somewhat even during the time period analyzed (Teorell and Svensson 2007, p. 109).

Due to the fact that our data spans 27 years, there are a number of deviations that could be explained by external factors. This requires of us to account for this within the models in this study. To do this, I will use the fixed, or random effects model. If we use random effects, we have to be under the assumption that the data within our models are random between periods and sections. Given the fact that this thesis will study variations within countries over time, the fixed effects approach will be used. This model takes into account individuals to explain the variations that emerge in our data (Allison 2011, p. 2-4). The data collected for this study fulfills the basic requirements for using fixed effects methods. The dependent variable is measured for each entity over time. The predictor variables of interest within the data does also change in value across all of these 27 occasions (Allison 2011, p. 7-8). The equation for linear fixed effects looks like the following:

$$Y_{i,t} = \beta_1 X_{i,t} + \alpha_i + u_{i,t}$$

The above equation shows how we find out the value of Y on our scale. Alpha denotes the intercept on the Y axis, hence what Y should be on average where drought is zero. The main difference between this and the random effects equation is that fixed effects takes into account individual effects and corrects for this (Allison 2011, p. 2-4). The main rule with this model is that it should be used if we suspect that individual effects in the error term is correlated with our independent variable. To phrase it differently, this means that, if α_i (Our individual error term) correlates with the drought index, then we should use fixed effects (Allison 2011, p. 2-3) To phrase the above equation in a way that fits the model to our study, the following equation is created:

$$Tattacks_{i,t} = \beta_1 Drought_{i,t} + \beta_2 Crops_{i,t} + \alpha_i + u_{i,t}$$

The sample of countries within this study share similar important characteristics which the theory deems important in determining whether drought affects conflict or not. This quite elaborated selection of cases is the main reason why I will use the fixed effects estimator both cross-sectional as well as over time. To measure a time series, fixed effects needs to be combined with a dummy variable approach, incorporating a categorical variable for each period and for each entity (Allison 2011, p. 14-17). For many other studies within this field, the temporal variation is the most important, as climate change anomalies has increased in recent years and studies often want to measure differences between years with drought and years without drought (Ide 2018, p. 348; Dube and Vargas 2012, p. 765-767). Adding a layer of temporal variation has been a necessity for this study to provide significant results, as many other of the studies investigating this field has shown (Uexkull et al. 2016; Dube and Vargas 2012). To determine the robustness of our results and models, a robustness test which accounts for how well the model fits the data will be done. This syntax within Stata is *vce(robust)* and displays the variance-covariance matrix of the estimators after model fitting.

3.4 Limitations

There are some considerable limitations of this study, as it was not able to control for monthly variations, group-level dynamics or whether the drought happened during growing season. Neither was it able to include a larger sample of countries, say on another continent, as this would have taken too much time given the manual coding of the data. A larger sample from more diverse samples would have made it more significant and generalizable. An inter-disciplinary study such as this one, combining climatology with conflict-studies as well as development, truly require a wide set of factors incorporated within the analysis as well as a comprehensive data collection. I was not able to control for all the factors I would have liked to, such as production prices on crops, additional crops and levels of corruption. However, the factors that are included do cover the appropriate parts of the theory in a satisfying way. Lastly, concerning the temporal aspect, monthly data is available for many of the measures worked with here, which could have given the analysis better depth. However, that data collection would have taken too much time as it was manually coded. I was therefore only able to control for yearly changes.

4 Empirical Findings

The following part of the study seeks to address the hypothesizes for the study in two different sections. The first presents the results for the correlation between the SPEI-12 measure and Terror attacks in three different models. The second section represents the main part of the results. It addresses the way in which maize and millet interacts with terror through drought by introducing two tables with two, respectively five models.

4.1 Correlation Between Drought and Terror

The first hypothesis for this study seeks to address the effect of drought on terrorism directly, both spatially and temporally. The results for this are presented in table 1. The dependent variable is defined as terror attacks and the independent variable is defined as a standard deviated version of the SPEI-12 value. The values for std_spei12 ranges from -1, being the actual zero and 2 being the highest value in for the variable, which is 21. This means that for each increase in standard deviation by 1 in the std_spei12 value, the dependent variable terror attacks increase by x amount.

Following below is the first table of the analysis, with three models included. Model (1) is a fixed effects regression that tests spatial aspects of the effect drought has on terror attacks. Model (2) is a fixed effects regression that tests both spatial and temporal aspects, as a dummy variable for each year is included. The model with a dummy for each year is included in all of the following models, as the R-squared value on these regressions showed better results than without a dummy. Since this is a time-series panel data study, this kind of model is more apt than a fixed effects regression with only between-country variation. Model (3) is similarly structured as (2) but takes into account the control variables. Incorporating the control variables means that we lose some of the observations, due to missing data on some years. The same fact can be discerned within models (4) and (5) in table 3 as well.

Table 1. Fixed effects regressions in three models.

Terror attacks	(1) Fixed Effects	(2) Fixed Effects	(3) Fixed Effects
std_spei12	12.65***	14.93***	15.61***
	(3.776)	(3.629)	(3.417)
polity2			0.978
			(1.544)
sfi			7.833***
			(1.807)
gdpc			0.0279***
			(0.00747)
wstress			25.98***
			(5.683)
Constant	20.05***	2.242	-202.8***
	(3.553)	(17.16)	(38.34)
Observations	459	459	356
R-squared	0.025	0.208	0.295
Number of id	17	17	17
Country FE	YES	YES	YES
Year FE	NO	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: standard errors clustered at the department level are shown in parentheses. The variables not shown are the year fixed effects.

The coefficients for model (1)-(3) show that drought has a positive relationship with terror attacks. When drought increases by 1 standard deviation, we can expect 12.65 more terror attacks for model (1), 14.93 when accounting for within country variations (2) and 15.61 when accounting for within country variations in addition to the control variables (3). This study had anticipated some kind of clear effect here, as the standardized SPEI-12 value represents a significant climatic shock of almost 10 on the regular SPEI-12 value. However, it seems the effect of water stress is significantly higher on the amount of terror attacks. If our drought indicator and our water indicator is combined, their combined effects seem bigger than the rest of the variables. Hence, it could be argued here that climatic factors and basic needs has a bigger influence on the level of terrorist activity than political and economic ones. However, the values on these two variables are significantly more compressed than, say state fragility, which ranges between 0 and 25 and still have a significant effect as well as a heavy influence.

The results in model (3) show promise in that the various factors have significant effects on the amount of terror attacks. However, additional results in the appendix indicate that the models lack in robustness, as no other results than the constant remains statistically significant[2]. This could mean that the data collected was not sufficient to provide a clear picture, or that the effects that drought and the other factors upon terror attacks have, cannot be fully confirmed. Another aspect probably affecting the results in model (3) is the lack of data on some of the control variables, which means less observations. The coefficients stay largely the same, as well as the relationships, however we cannot with the same degree of certainty say that these models are sufficient for explaining causality between these variables. But as the above model indicate significant effects, we should be able to conclude that we are onto something.

Notwithstanding robustness tests, these results still indicate that we cannot rule out the possibility that the first hypothesis is correct. That is to say, that drought anomalies in fact have a positive relationship with the amount of terror attacks during any given year, within this sample of countries.

4.2 What explains the correlation?

To introduce the results for the main part of this part of the study, we need to pinpoint the effect drought have on each of the crops analyzed. The results for this are presented in table 2. Here, two regressions have been tested with each respective crop, including dummy variables for each year except the first, which is the reference year. The two crops have thus been placed as dependent variables instead and drought still remains as our independent variable. The values for both crops have been divided by 1000 in variables called “maize1000” and “millet1000”. This is because the change in crop harvests each year have such massive values, that a change between years gives very small values. However, the relation will stay the same, but with a disaggregated version such as here, we can more easily interpret what happens for every “cell” of harvested crops, when put in relation to the other variables. Simply put, by reducing the values like this, we get a more reasonable co-efficient.

[2] See table 4 in the Appendix.

Table 2. Fixed effects on only drought and the two crops in two separate models.

	Maize1000	Millet1000
std_spei12	49.64***	-112.1***
	(16.45)	(21.83)
Constant	593.7***	738.5***
	(77.76)	(103.2)
Observations	459	459
R-squared	0.257	0.082
Number of id	17	17
Country FE	YES	YES
Year FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: standard errors clustered at the department level are shown in parentheses. The variables not shown are the year fixed effects.

The results for these regressions indicate that for each increase by 1 in the standard deviated SPEI-12 value, maize harvests will increase by 49.64 per 1000 hectares. This indicates that maize is positively related to drought, which is quite surprising. On the contrary, millet harvests decrease by 112.1 for the same increase in SPEI-12, which means it has a negative relationship with drought. However, the models here lack in explanatory power according to the robustness tests. Possibly because one of the countries within the study does not grow any and therefore is excluded from the regression[3]. The results above, however, indicate that drought have a significant effect. The implications of this indicate that we might find a similar relationship, when put in the same regression as terror attacks. Unfortunately for the analysis, the positive relationship maize shows with drought means that it might not be one of the crops through which the theory enfolds. Because maize harvests seem to increase when drought increases. This is something that, upon further investigation, might depend upon the significant increase in production of maize in Africa the past few years. However, since it mainly is the land use for maize which have increased, it could have been wiser to investigate crop productivity indicators instead to fully grasp this (Santpoort 2020, p. 1).

Moving onwards, table 3 presents five models, where we indeed can find a similar relationship. Model (1) shows the effect maize1000 have on terror attacks, which quite surprisingly also indicate a positive relationship. This will be scrutinized further below. Model (2) replaces maize with millet1000. Model (3)

[3] See table 5 in the Appendix.

includes both crops and std_spei12 in relation to terror attacks. Model (4) includes all variables as well as control variables, this time with difference-in-difference variables for millet and maize. Model (5) includes the theoretical variables of interest, namely shocks in income by the difference-in-difference versions of millet. In this model, the GDP per capita variable is generated as a diff-in-diff version, to control our hypothesis that income shocks through decreased harvests generate conflict. A negative relation would indicate this to be correct.

Table 3. Five models.

	(1)	(2)	(3)	(4)	(5)
Terror attacks	FE	FE	FE	FE	FE
std_spei12			4.945	14.44***	15.84***
			(3.184)	(3.367)	(3.413)
maize1000	0.0761***		0.0244**		
	(0.0103)		(0.0103)		
millet1000		-0.0893***	-0.0783***		
		(0.00678)	(0.00777)		
diff_millet1000				-0.0204	-0.0249*
				(0.0147)	(0.0150)
diff_maize1000				0.0614***	
				(0.0177)	
polity2				0.385	
				(1.523)	
sfi				7.183***	6.232***
				(1.782)	(1.756)
gdpc				0.0237***	
				(0.00741)	
wstress				23.34***	27.34***
				(5.622)	(5.631)
diff_gdpc					-0.0183
					(0.0219)
Constant	-43.01**	68.18***	45.54**	-181.6***	-164.2***
	(17.54)	(15.53)	(17.74)	(38.04)	(37.35)
Observations	459	459	459	356	355
R-squared	0.271	0.419	0.430	0.326	0.266
Number of id	17	17	17	17	17
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: standard errors clustered at the department level are shown in parentheses. The variables not shown are the year fixed effects.

By looking at models (1), (3) and (4), we can conclude that maize does not have a negative influence on terror attacks and thus is not the explaining mechanism we are looking for. This could be due to maize being more resilient to drought than millet. Looking at model (2) and millet however, the results show promise in appropriateness for the model and the results are statistically significant. For each decrease in hectares harvested by 1000 we can expect an increase in terror attacks by 0.0893 during the years analyzed, taking into account only these two factors. When including both the millet1000 variable and maize1000 together with the drought indicator in model (3), we see similar values which also are statistically significant. However, this model does not share the same trend in regard to the drought indicator, as it displays insignificant effect on terror attacks here, as well as having a lower coefficient.

When including all of the variables in the same regression within model (4), we see that the SPEI value once again displays significant effect on terror attacks. The same cannot be said about millet harvests, when accounting for all of the control variables. It seems other factors than millet is more important in determining the level of terror activity within this model, even though it is more specific regarding shocks, as it here accounts for yearly changes through the diff-in-diff version of the variable. But other than the theoretical variables of interest and the polity indicator, the control variables coupled with the independent variable seem to exert statistically significant effects on the level of terror in any of the countries in the sample. We therefore cannot reject the possibility of the third hypothesis being correct. Notwithstanding that an increase in political exclusion does not seem to affect terror, an increase in state fragility and water stress seem to have significant effect on the amount of terror attacks. Peculiarly though, a rise in GDP per capita seem to have a positive relation to terror attacks. Model (5) is specifically addressed at explaining the theoretical underpinnings of this study. All of the variables in this model, except GDP differences, display significant effect on the level of terrorist activity. Here we can also notice that the GDP per capita variable shows a negative correlation with our dependent variable, even though it is not established to be significant. Further, robustness checks on this same model indicate that the negative correlation millet harvests have on terror attacks holds[4]. In fact, the only variable showing significant effect when put under robustness tests for all of the models in table five, is millet. This gives us reason to believe that the second and main hypothesis of this study is correct. We can therefore argue that lowered income through decreased *millet* harvests increases terrorism activity to a certain degree within the countries in this sample.

[4] See table 6 in the Appendix.

5 Discussion

Explanations for what the link between drought and conflict could be, are very important for finding the most appropriate mitigating measures, when we no longer can stop the accelerating heating of our planet. This because, both this and former studies on the link between climate and conflict, points out that drought seem to affect conflict under some specific circumstances. This study has partly aimed at using these circumstances within this study, with an almost intentional selection bias in the sample of cases chosen. The selection part about this study, which it argues is based on the theory, could be a point of critique. It could also be a unique feature for a quantitative study, as having this sophisticated selection has allowed me to zoom into the particular effects Uexkull et al. (2016) pointed out. Once again, they are that drought seem to affect conflict under circumstances such as when countries are agriculturally dependent, they have a low economic development and high degrees of political exclusion. They argued these circumstances prolong *civil conflict*; I argue these circumstances increase the intensity of *terrorist activity*.

What this "zooming in" also has led to is a study that shows that a) drought seem to have a positive relation with terror attacks, b) correlation between low millet harvests and higher degrees of terror attacks are significant when looking at countries such as the ones within this sample and, c) the opportunity cost effect may be explanatory for some of the developments that lead to conflict in complex conflictual settings burdened by various other societal stress factors. As pointed out in the beginning, conflicts in these very complex environments are unfortunately very common around the world and especially so in sub-Saharan Africa. Doing our best to counter the effects of drought in areas already under other stresses will be hard, but crucial for the livelihood of the many tens of millions living in these settings. It will be important for the rest of the world as well, as failed states produce more terror, something also indicated by control variables in this study. When the variable for state fragility increased by one, a significant effect was noted. This indicated we could expect between 6 and 8 more terror attacks in such instances.

Even though this study failed in proving the kind of correlation indicated by the hypotheses with maize, the correlation visible in the models with millet seem to hold for scrutiny. As mentioned above, the decision of conducting an analysis of this kind with maize seem, in retrospect, to be ill-advised. As the amount of land cultivating maize have increased so fast in sub-Saharan Africa in recent years, this most certainly skewed the data to some degree. However, one could have thought it is the shocks and not the growth then, which would hint of a negative relationship. But when testing for differences within the differences, we still got a significant positive correlation. This could mean that countries that have experienced more drought have increased their cultivation of maize. But what is more surprising is that an increased maize harvest had a significant effect on the amount of terror attacks. But similarly, this might be due to the countries experiencing more terror attacks also experience more drought, thus being more incentivized to start cultivating more maize. This would in this case also be supported by the results indicating drought has a positive effect on terror. There could also be some rapacity effect involved, which could mean that more maize harvested means more resources available and thus more incentive for terror groups to increase their activity.

But safe to say, is that millet could be argued to be an explanatory mechanism. If it in fact is so, then reasons for why small-holder farmers engage in violence after losing their livelihoods might be close to what the theory stipulates. Namely that the chance of a small-holder farmer joining an armed insurrection increases for every significant decrease of their harvests. The point with finding these mechanisms is to introduce mitigation where it is the most effective. As with every problem, preventive measures are always more effective, whilst reactionary measures are costly. This is something most interventions, such as MINUSMA, shows. What if we could prevent some of these people to join armed insurrections? Maybe then terrorist activity would be a little less intense where preventive measures have been put in place. When faced with a highly complex setting of factors contributing to conflict, one should look for the starting point - where things are set into motion. Maybe decreased harvests could be one such starting point. If so, this specific starting point could be where policy efforts to further peace and stability might be the most effective in environments such as the ones within this study.

6 Conclusion and Policy Implications

This study has had the aim of investigating whether crops could be a mechanism through which drought affects the level of terrorist activity. It had three hypotheses which have been investigated through a quantitative examination of a number of sub-Saharan countries. It has found that drought have had a significant effect on the amount of terrorist attacks in countries where the agricultural dependence is high and social- and economic development low during the timespan investigated. It has also found that crops, to some degree, might be one of the many mechanisms through which drought affects terrorist activity. The theoretical framework for this study has been that economic shocks in the form of reduced crop harvests increases terrorist activity in countries dependent on agriculture. The results of this study are indicative of such a development, most likely through the opportunity cost effect, which argues that when prices decrease on labor-intensive agricultural commodities, conflict levels rise. This study shows a similar relation with the more specific "terrorist attacks" operationalization of the level of terrorist activity.

If the conclusions of this study can be further established, through more research, policy decisions could help mitigate the deteriorative effect drought has on already complex and unstable environments. Firstly, these complex conflictual areas should get assistance with introducing more climate resilient crops. Secondly, a diversification of crops is preferable, as some crops seem to develop better and some worse in a heating climate. Thirdly, working to mitigate water stress might help both crops grow better in a warming climate as well as help local populations to sustain themselves better, even when faced with drought.

For further research, the results of this study seem to indicate that crops, as a mechanism for violence, should be studied more. A broader study with more crops tested on different samples of countries could be interesting, as the implications of this study are only applicable to countries that cultivates millet as well as having a high agricultural dependence and a low socioeconomic development. Another interesting aspect further studies could elaborate on is why increased harvest of maize seems to have a significant effect on the level of terrorist activity.

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8 Appendix

The following section provides the reader with robustness tests for all of the tables provided in the results part.

Table 4. Table 1 with robustness tests.

	(1)	(2)	(3)
Terror attacks	Fixed Effects	Fixed Effects	Fixed Effects
std_spei12	12.65	14.93	15.61
	(12.09)	(12.11)	(13.42)
polity2			0.978
			(1.888)
sfi			7.833
			(4.868)
gdpc			0.0279
			(0.0339)
wstress			25.98
			(20.11)
Constant	20.05***	2.242	-202.8
	(9.96e-08)	(10.09)	(139.8)
Observations	459	459	356
R-squared	0.025	0.208	0.295
Number of id	17	17	17
Country FE	YES	YES	YES
Year FE	NO	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Table 2 with robustness tests.

Terror attacks	(1) Maize Harvest	(2) Millet Harvest
std_spei12	49.64	-112.1
	(57.34)	(82.43)
Constant	593.7***	738.5***
	(62.85)	(92.32)
Observations	459	459
R-squared	0.257	0.082
Number of id	17	17
Country FE	YES	YES
Year FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Table 3 with robustness checks.

Table 6. Table 3 with robustness tests.

	(1)	(2)	(3)	(4)	(5)
Terror attacks	FE	FE	FE	FE	FE
std_spei12			4.945	14.44	15.84
			(4.979)	(12.30)	(15.02)
maize1000	0.0761*		0.0244		
	(0.0418)		(0.0314)		
millet1000		-0.0893**	-0.0783**		
		(0.0319)	(0.0302)		
diff_millet1000				-0.0204***	-0.0249***
				(0.00612)	(0.00795)
diff_maize1000				0.0614***	
				(0.0174)	
polity2				0.385	
				(1.554)	
sfi				7.183	6.232
				(4.407)	(3.928)
gdpc				0.0237	
				(0.0296)	
wstress				23.34	27.34
				(17.77)	(23.84)
diff_gdpc					-0.0183
					(0.0370)
Constant	-43.01	68.18**	45.54	-181.6	-164.2
	(32.08)	(26.66)	(32.26)	(125.8)	(122.5)
Observations	459	459	459	356	355
R-squared	0.271	0.419	0.430	0.326	0.266
Number of id	17	17	17	17	17
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1